BASIC HCCI CONCEPT

1. Spontaneous ignition of fully or partially premixed fuel vapor/air plus burned gas mixture due to temperature (and pressure) rise during compression.

2. With lean and/or dilute mixtures, get low NO emissions due to low burned gas temperatures.

3. With sufficient “premixing” of fuel and air get low soot formation/particulate emissions.
HCCI HISTORY

1. Early work in Japan (Onishi et al. SAE 790501) on "Active Radical Combustion" in two-stroke cycle SI engines.


3. Work at MIT (Colella et al., SAE 870587) showed transition from normal diesel combustion process to (partially) premixed spontaneous ignition process as ignition delay lengthens.


5. Starting in mid-1990s, rapidly increasing interest due to potential for low NO and particulates emissions with diesel-like efficiencies (e.g.: work at SWRI, see SAE 1999-01-3682; and Lund Institute of Technology, Sweden, see SAE 1999-01-3679).


7. Substantial current interest!
CHALLENGES

1. Controlling ignition and rate of fuel chemical energy release relative to piston position (or top center) to obtain high torque.

2. Achieving control over a wide enough range of loads and speeds.

3. Achieving a high enough combustion efficiency (low HC emissions).
HCCI: SOME POSSIBLE CONCEPTS

1. Nissan MK diesel (SAE 981039, 1999-01-3681): Late injection at part load; long delay, substantial fuel-air premixing, non-luminous low sooting distributed combustion; very low NO; comparable efficiency—lower heat loss balances late combustion.

2. Two-stroke spark-ignition engine (e.g., Honda, SAE 980757): Exhaust port throttling at light load increases trapped residual and charge temperature; spontaneous controlled distributed energy release; very low cycle-by-cycle variations gives better fuel consumption.

3. Four-stroke spark-ignition engine (exploration stage): Attempting lean premixed light-load spontaneous distributed combustion; use of EGR, inlet air temperature, compression ratio, to control onset of combustion; use of EGR, excess air ratio to control rate of energy release; supercharging at higher load(?). (See SAE 972874).

4. Combined premixed and direct-injection diesel concept (for use at higher loads: SAE 980509): premix some of the fuel and direct injection of remainder to control ignition, to increase the load range. Knock limits the premixed energy fraction. Directly injected fuel significantly reduces the NO and soot benefits. HC and fuel consumption increase relative to standard diesel.