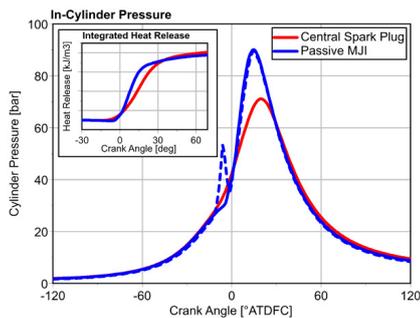
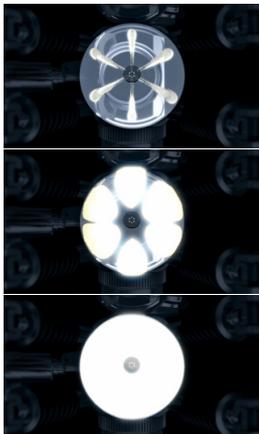


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Jet Ignition® (MJI) - Passive



Cylinder pressure

High Efficiency

Combustion development is a key enabler to achieving future vehicle fuel economy and emissions targets. For many years, MAHLE Powertrain has been conducting advanced combustion research, culminating in the development of the MAHLE Jet Ignition® system.

Passive MAHLE Jet Ignition® is a pre-chamber based combustion system, for spark ignited engines. The MJI insert features a small pre-chamber, housing the spark plug, connected to the main combustion chamber by a number of targeted nozzles.

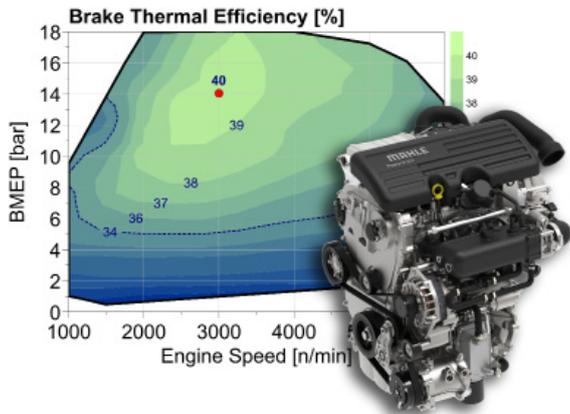
- Fast, stable combustion (up to 40% reduction in 10-90% burn durations)
 - › Higher compression ratio for greater efficiency
 - › Enhanced $\phi=1$ capability at high load
- Whole map operation without the requirement for a 2nd ignition system in the main chamber

- Compatible with PFI or DI fuelling
- Stoichiometric operation enabling use of conventional aftertreatment systems
- Synergies for use with Miller cycle & cooled EGR

Demonstrator Engine

- >40% BTE from 1.5l 3-cylinder featuring a low cost technology package:
 - › Passive MJI
 - › High geometric compression ratio
 - › Port fuel injection
 - › Low pressure cooled EGR
- 10% BSFC benefit over baseline T-GDI
- 110 kW at 5500rpm @ $\phi=1$
- Idle & catalyst heating capability & feed gas emissions equal to conventional central spark plug

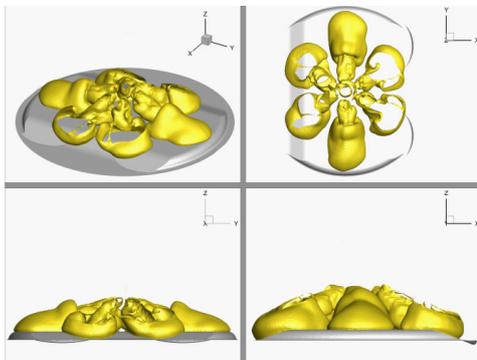
> **Fast, stable combustion**
Knock mitigation



Engine efficiency map

Compact Installation

- Compact installation solutions
- Passive MJJ fits M12 spark plug package space
- Passive MJJ capability as sole ignition source
 - › Engineering into existing cylinder head designs
 - › Potential to use same casting with only machining & assemble process changes



Combustion analysis



Dedicated cold engine test cell



Passive MJJ installation with DI fuel injector

Engineering Services

- Maximising Active MJJ benefits requires both pre-chamber & combustion system optimisation
- Full range of inter-related engineering services to develop solutions:
 - › Design
 - › Combustion, performance & structural analysis
 - › Engine development & testing
 - › Transient & cold emission capabilities
 - › Calibration & controls