

# **EBDI<sup>®</sup> - Application of a High BMEP Downsized Spark Ignited Engine**

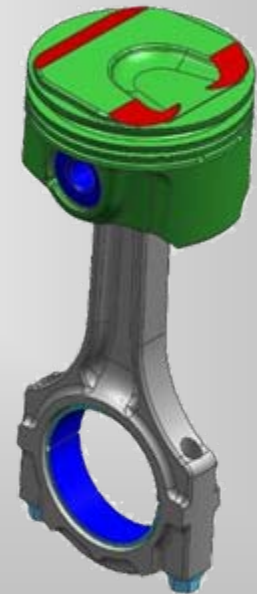
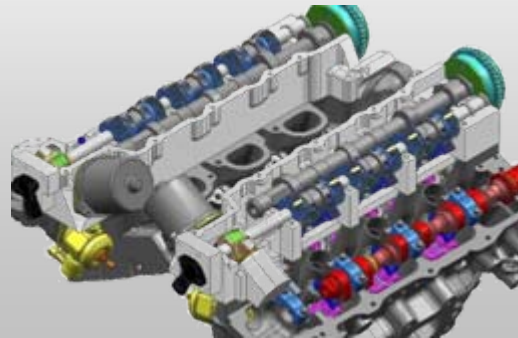
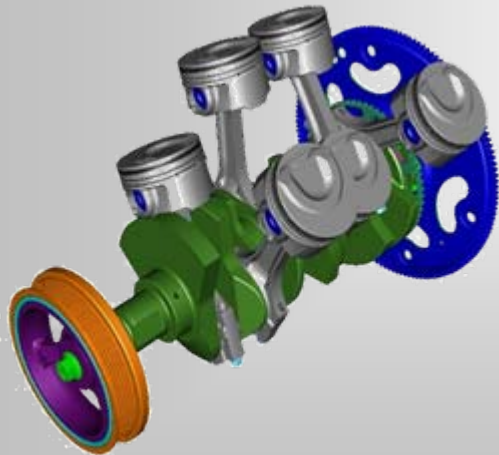
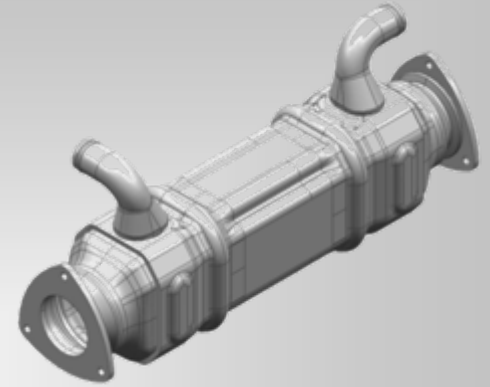
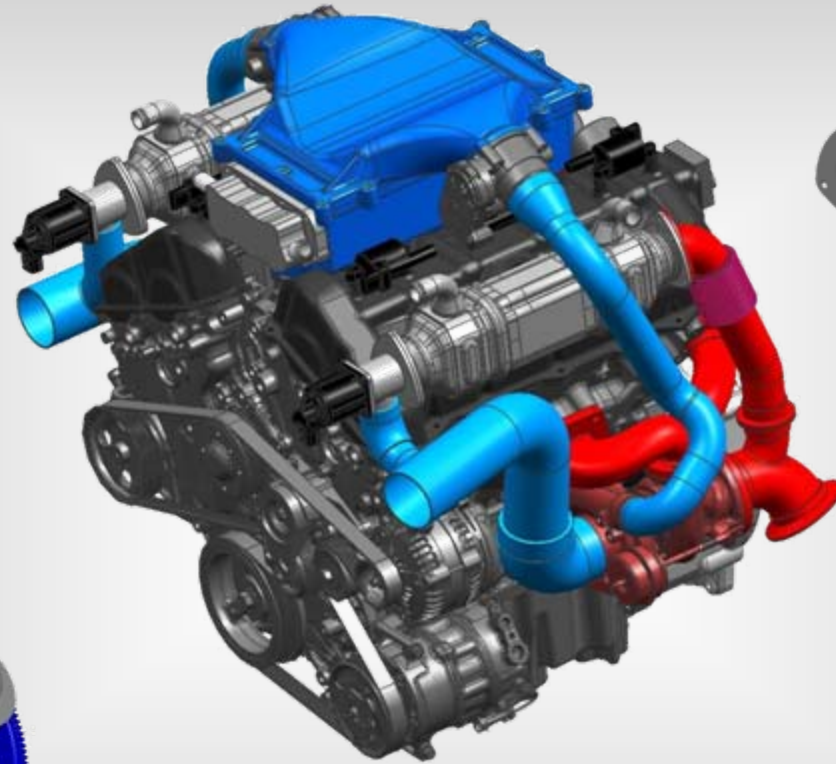
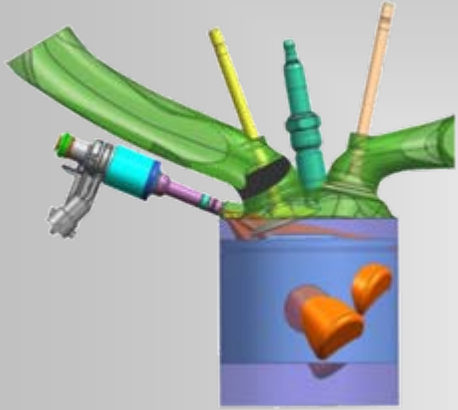
Rod Beazley

Vice President – Spark Ignited Engines

Ricardo Inc.



# Engine System



# Development Path

- The EBDI project is a natural “next step” in the evolution of the spark ignited engine

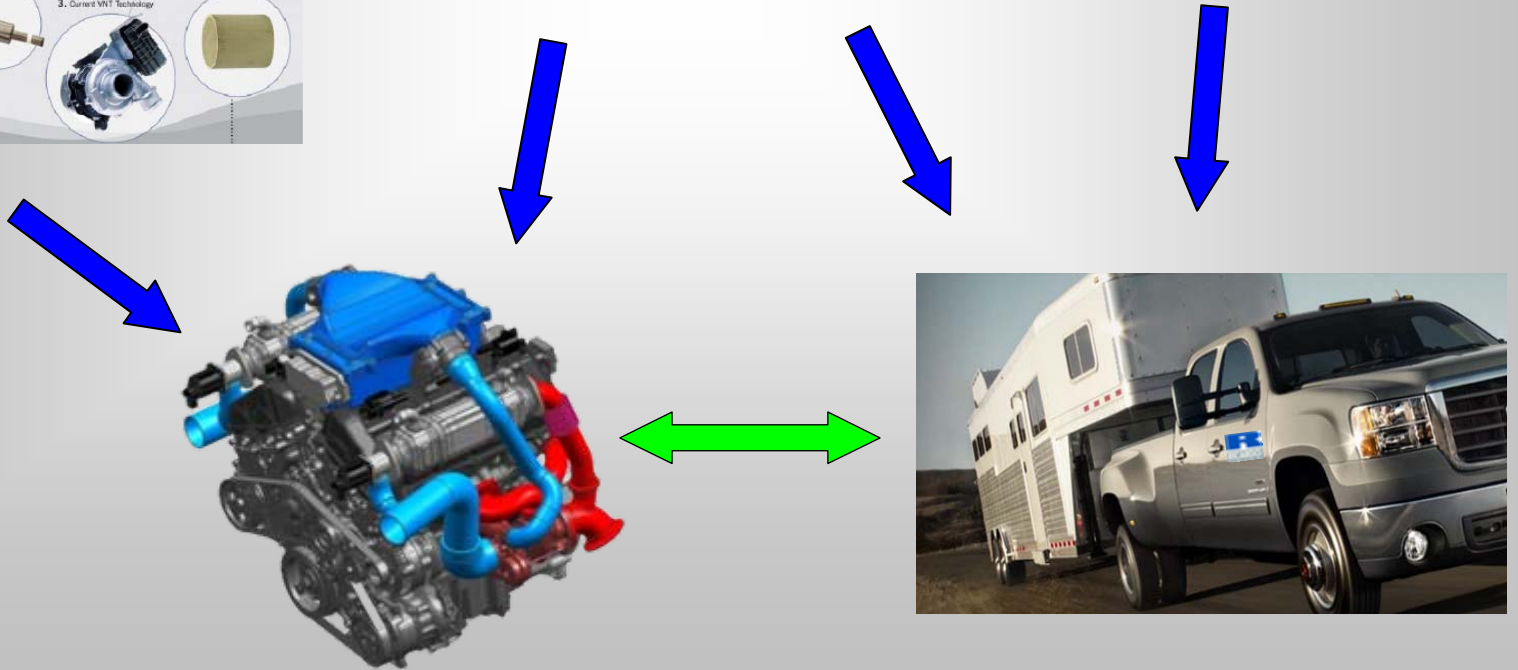
## DI Boost



## LBDI®



## Ongoing E85 programs



# Applicability

- Scalable technology by varying the number of cylinders with more cost efficient emissions solution



**Medium Duty On-Road  
2010 Emissions**



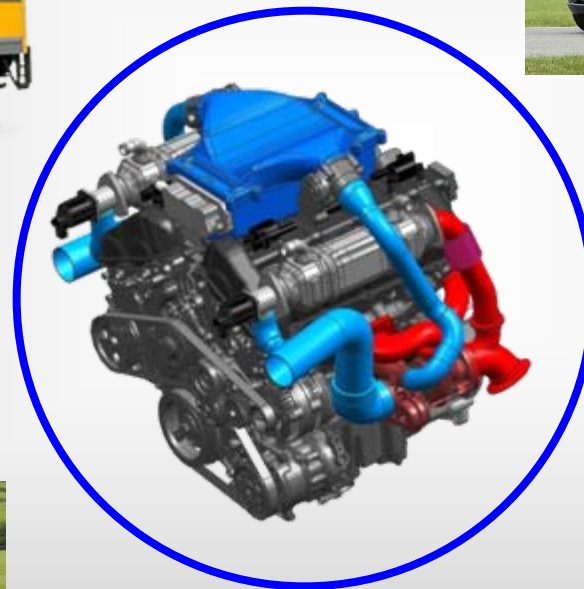
**Light Duty On-Road  
Tier2 / LEV2**



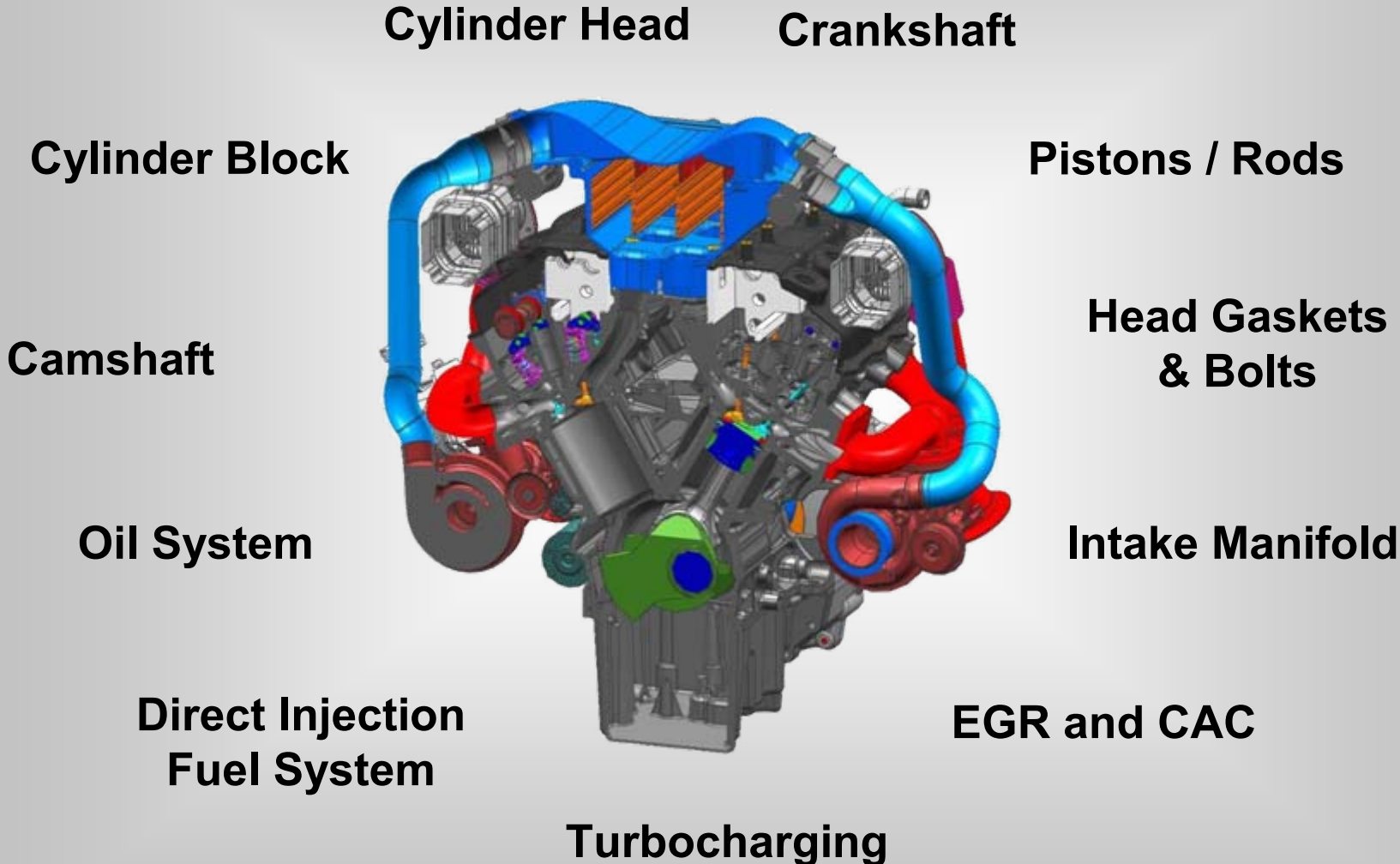
**Agricultural Off-Road  
Tier4**



**Construction Off-Road  
Tier4**



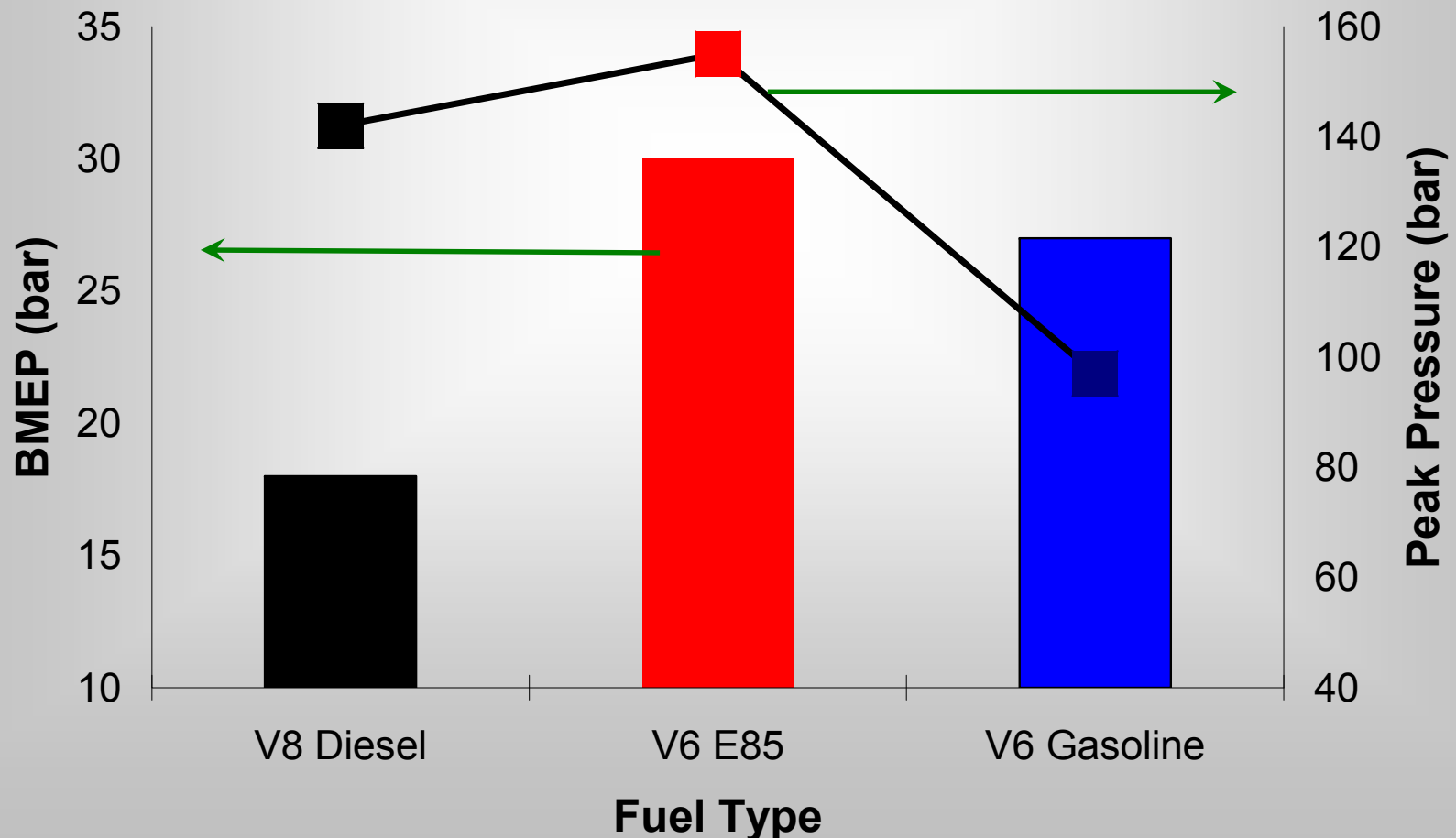
# Base Engine Impact



# Dyno Results (1)

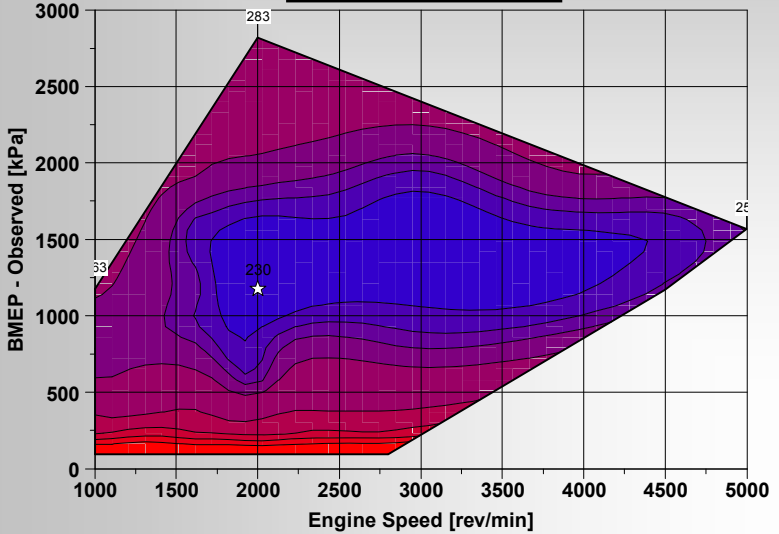
- Data shows that “high low speed torque” is not unique to diesel engines
  - SI engines can achieve higher low speed torque with less cylinder pressure

**1,600 rpm BMEP Performance Comparison**

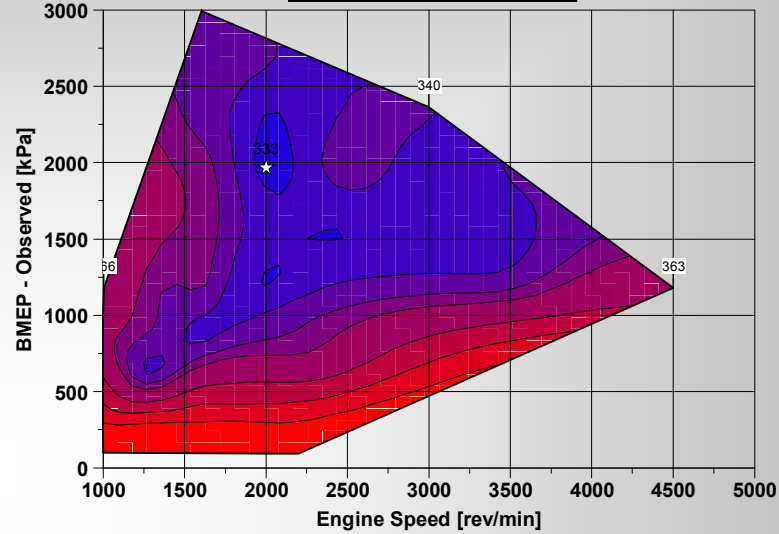


# Dyno Results (2)

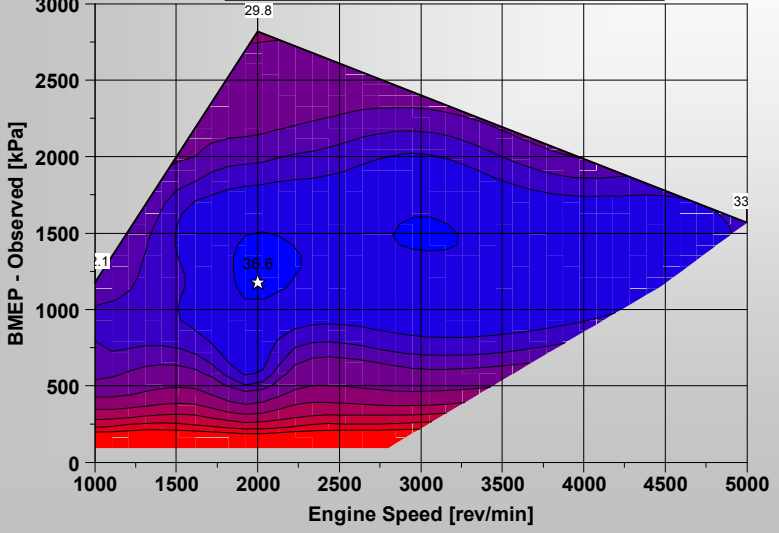
**E0 w/EGR BSFC Map  
(g/kWhr)**



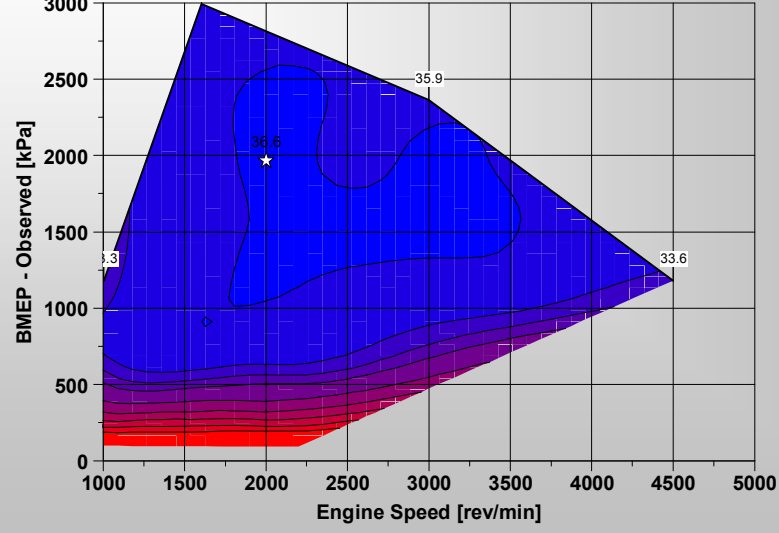
**E85 w/EGR BSFC Map  
(g/kWhr)**



**E0 w/EGR Brake Thermal Efficiency  
(%)**



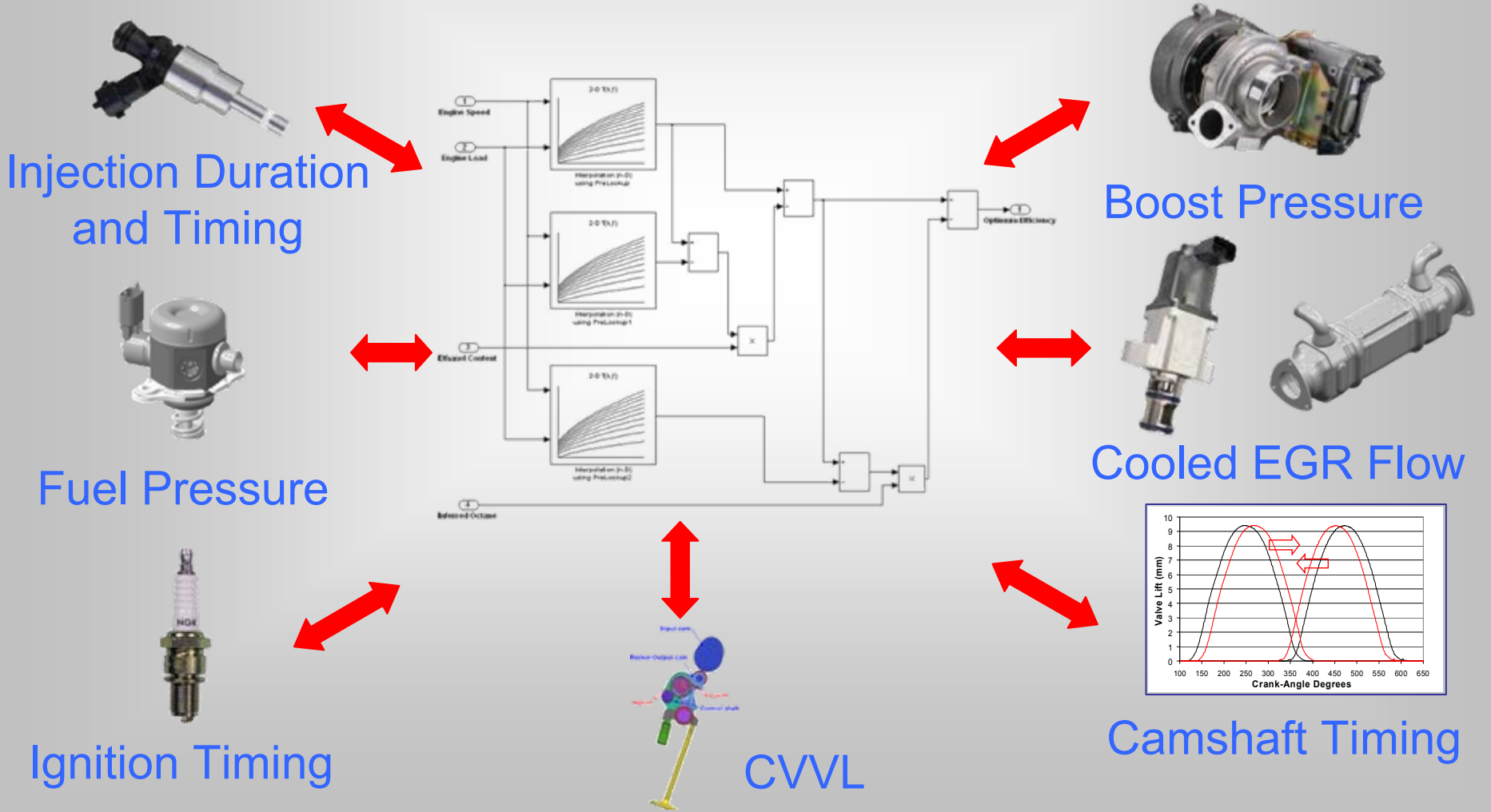
**E85 w/EGR Brake Thermal Efficiency  
(%)**





# Controls and Calibration

- Engine operation optimized dependent on fuel octane and ethanol content using advanced control strategies



Injection Duration and Timing

Boost Pressure

Fuel Pressure

Cooled EGR Flow

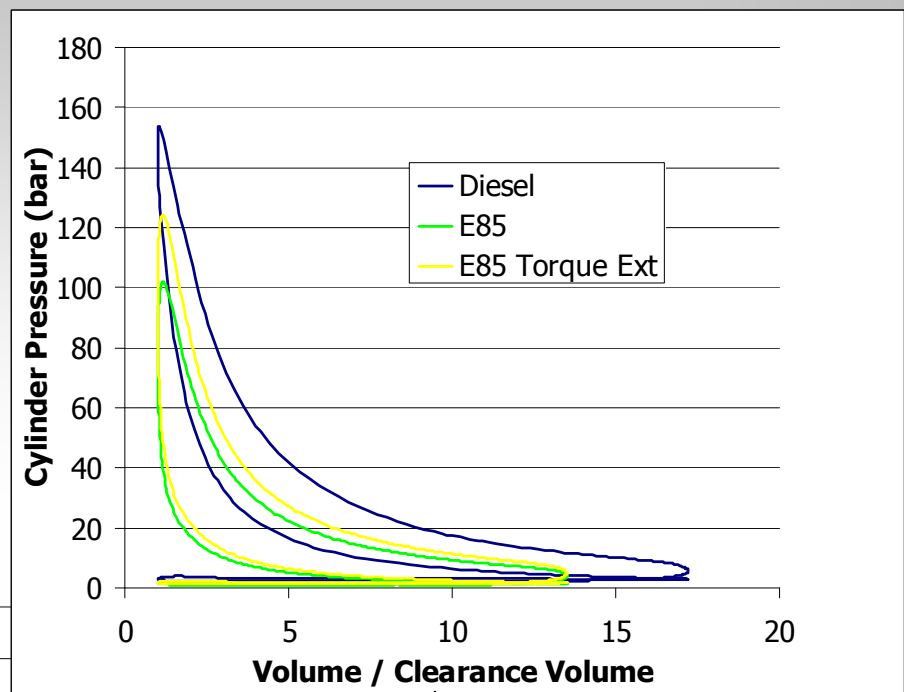
Ignition Timing

CVVL

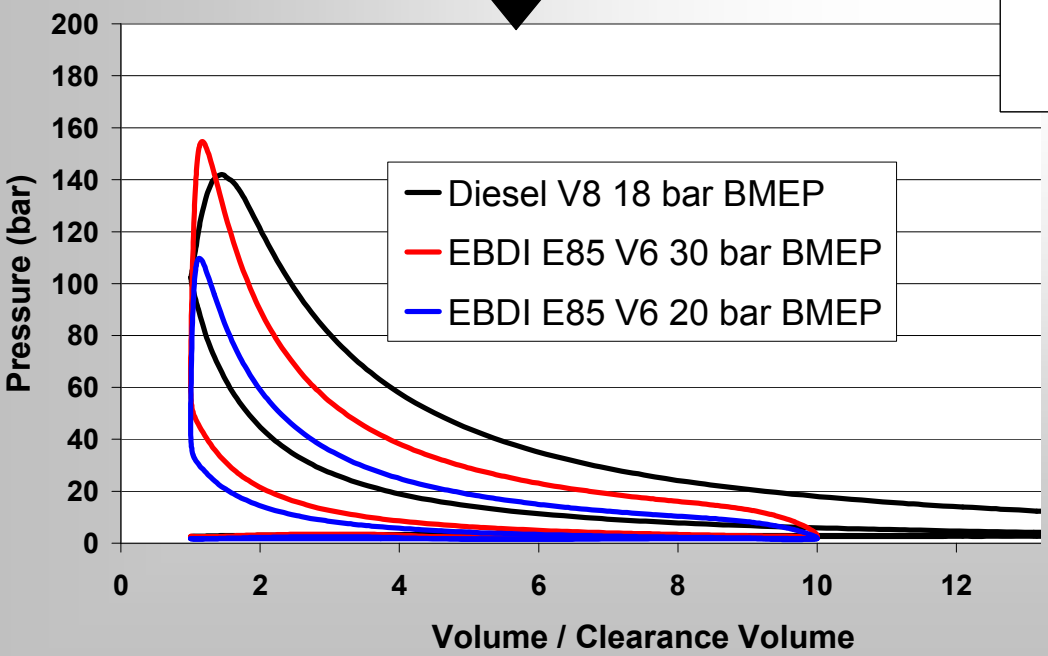
Camshaft Timing

# BMEP Extension Potential

Decreased Displacement  
Increased BMEP  
1,600 RPM



Equivalent Displacement  
Match or Extend BMEP  
2,400 RPM



# Future Opportunities!

