## AUTOMOTIVE SUMMIT 2014

Green Mobility Changing the World 19 - 20 June 2014 Bitec Bangna, Bangkok

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Technology Features and Development Methods for Spark Ignited Powertrain to meet 2020 CO2 Emission Targets



### Technology Features and Development Methods for Spark Ignited Powertrain to meet 2020 CO2 Emission Targets

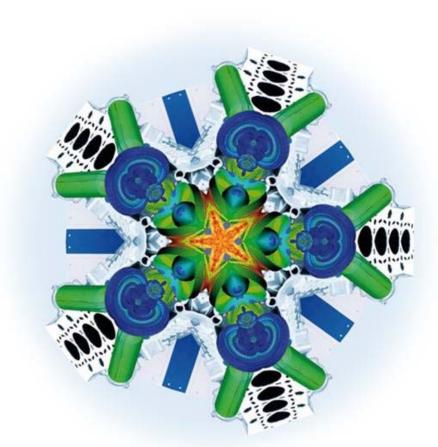
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AVL SEA & Australia Co., Ltd. Bangkok, Thailand





Automotive Summit 2014, Bangkok, 20th June 2014

## Technology Features and Development Methods for SI Powertrain to meet 2020 CO2 Emission Targets



### Content of Presentation:

- 1. General Trends and Forecasts
- 2. Technology Features for Highly Efficiency Combustion
- 3. Development Tools and Methods

### How can Gasoline Engine Technology support to meet 2020 CO2 Emission Targets?

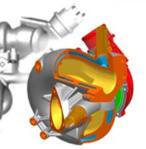




- Mechanical
  - Electrical

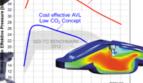
#### **Boosting**

- 2-stage
- electric boosting
- water cooled VGT





- high BMEP TGDI
- Low PN
- **CNG-DI**



#### Variable Valvetrain

- 2-step / 3-step



#### **Exhaust Gas Cooling**

- External cooled EGR
- Cooled / integrated manifold



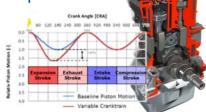
#### "Smart Hybridization"

- electric auxiliaries
- 48V systems



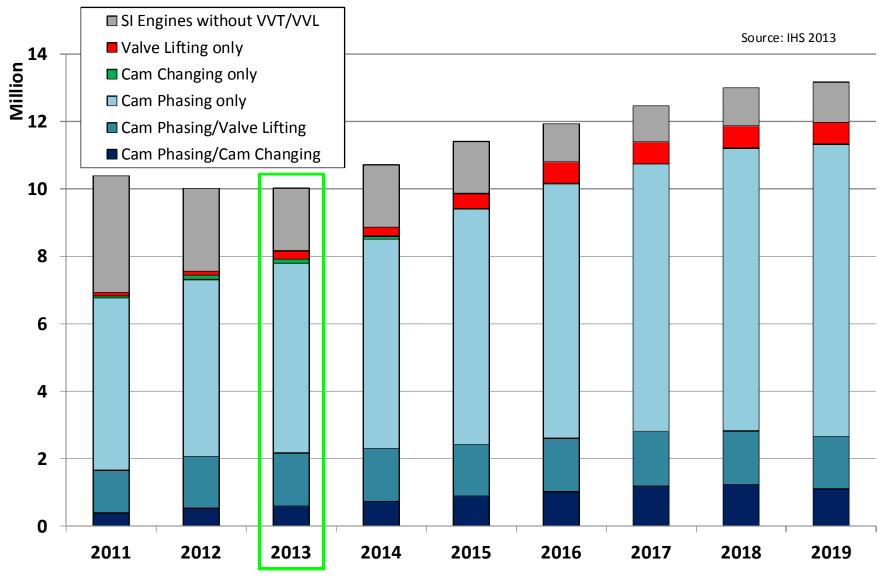
#### **Variable Crank Train**

- Var. Compression ratio
- Var. Expansion ratio



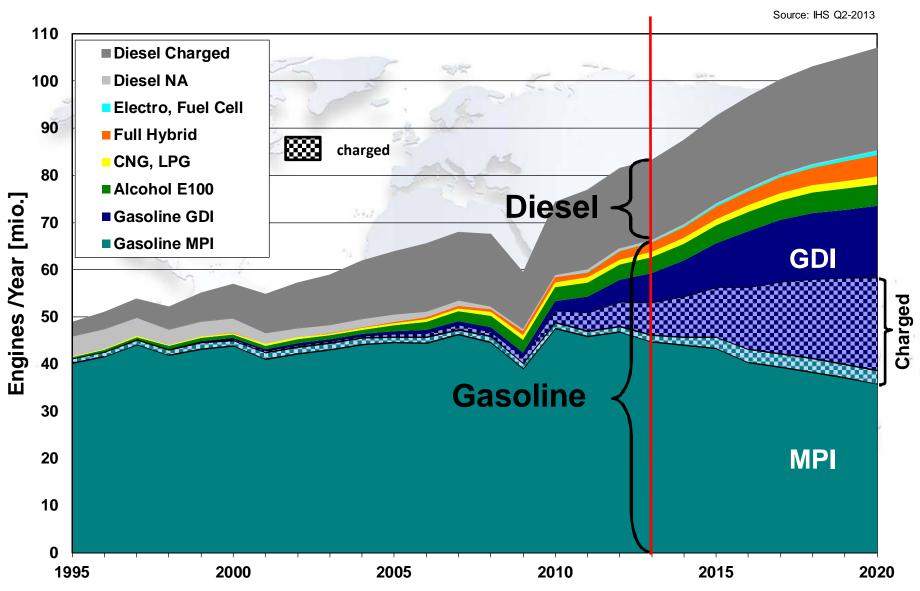
## VALVETRAIN TECHNOLOGY SHARES FOR GASOLINE PASSENGER CARS BUILT IN EUROPE





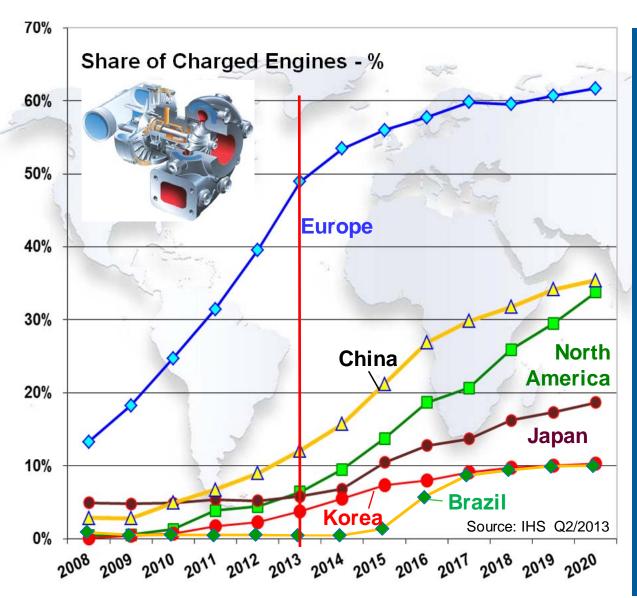
## GLOBAL VEHICLE PRODUCTION BY PROPULSION TECHNOLOGY











- Share of boosted Gasoline engines will dramatically increase
- China higher share than US
- Various TC-GDI launches also in Japan
- → Downsizing / downspeeding based on boosted engines is already the mainstream technology for FE improvement

# Technology Features and Development Methods for SI Powertrain to meet 2020 CO2 Emission Targets

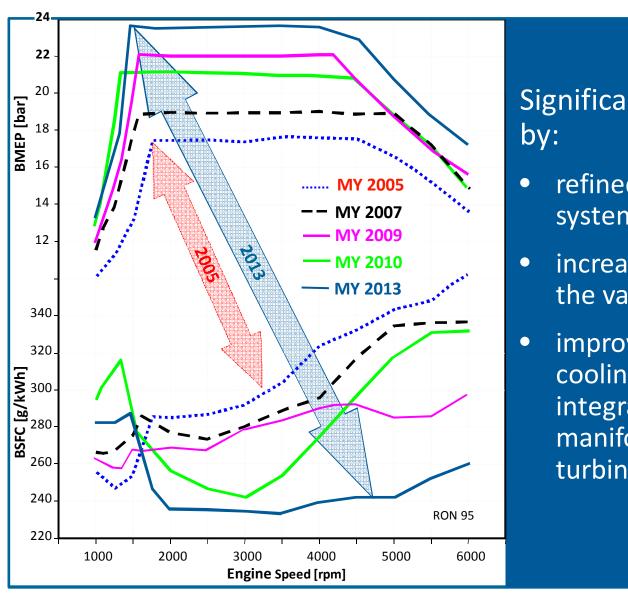


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### **EVOLUTION OF TURBOCHARGED GDI 2005-2013**



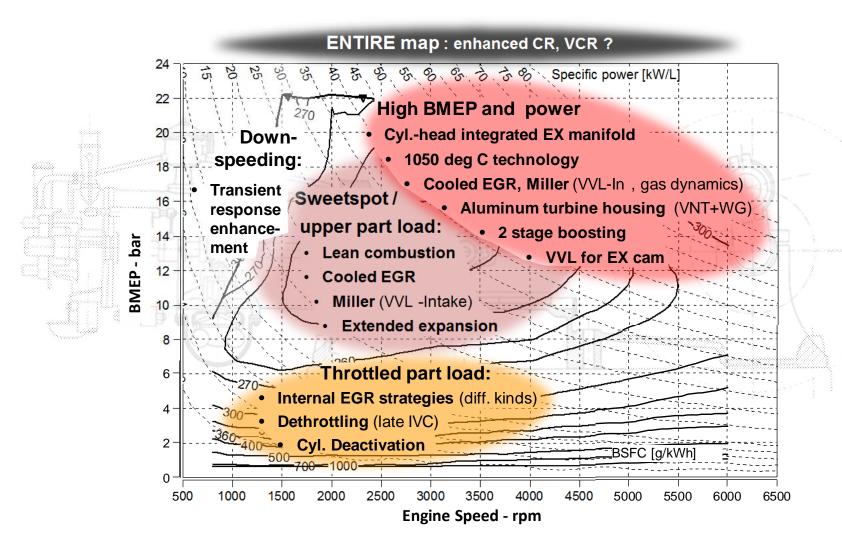


# Significant improvements by:

- refined combustion systems
- increased functionality of the valve train
- improved exhaust gas cooling (water cooled / integrated exhaust manifold, water cooled turbine housing)

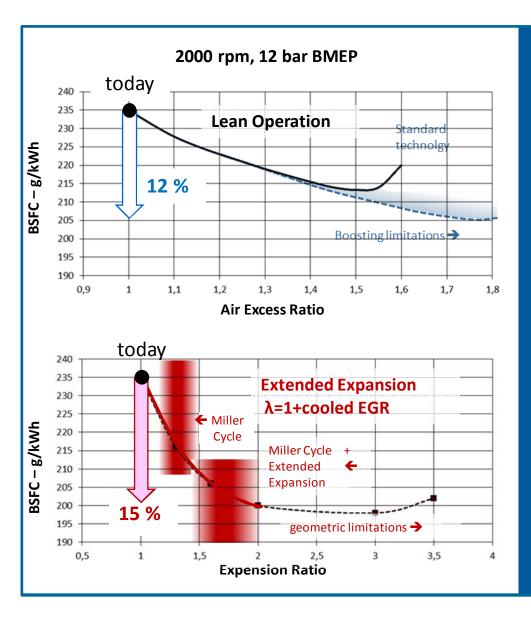
# Development Directions for Future TC-GDI Engines to extend the Range of High Efficiency Operation





# SI COMBUSTION TECHNOLOGIES FOR BEST HIGH LOAD EFFICIENCY





### Lean operation:

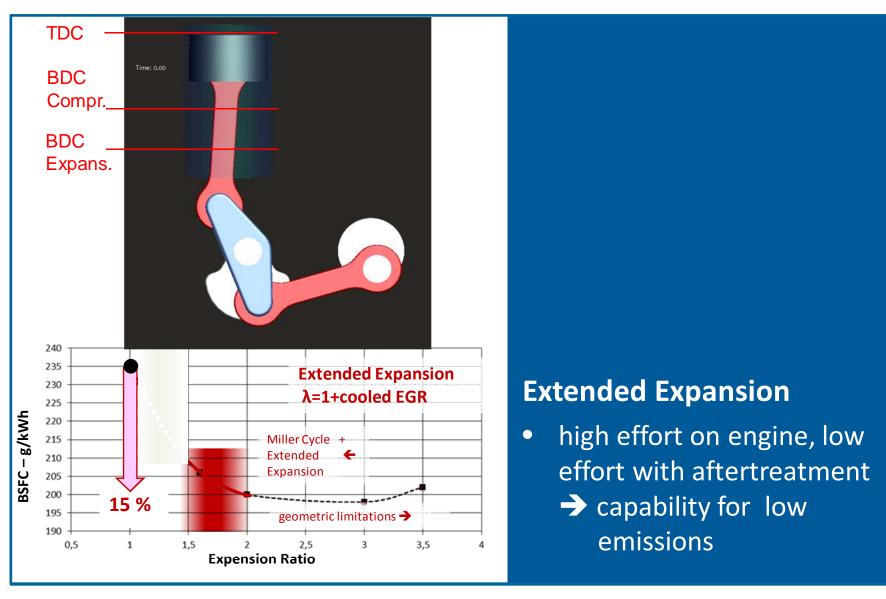
- low effort on engine, high effort with aftertreatment and boosting
- RDE requires SCR → Urea refill with SCR is a market disadvantage

### **Extended Expansion**

- high effort on engine, low effort with aftertreatment
  - capability for low emissions

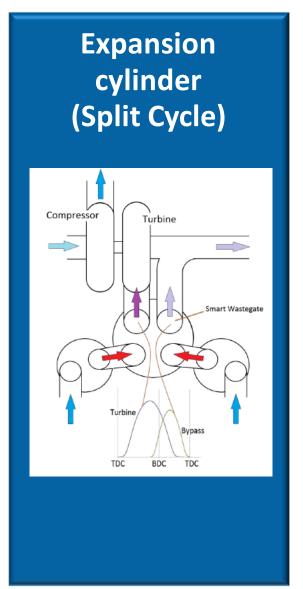
## SI COMBUSTION TECHNOLOGIES FOR BEST HIGH LOAD EFFICIENCY

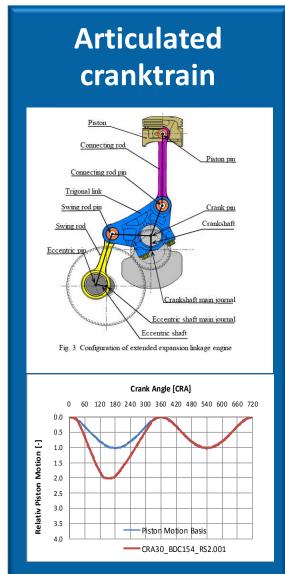


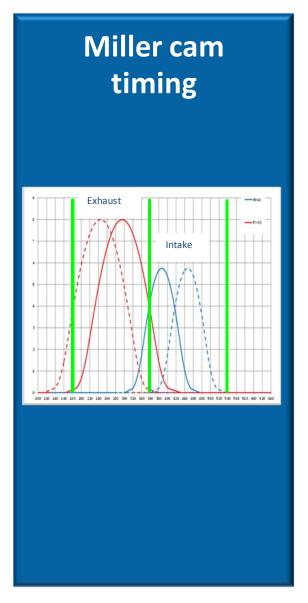


### **INCREASED EXPANSION RATIO REALIZED BY:**



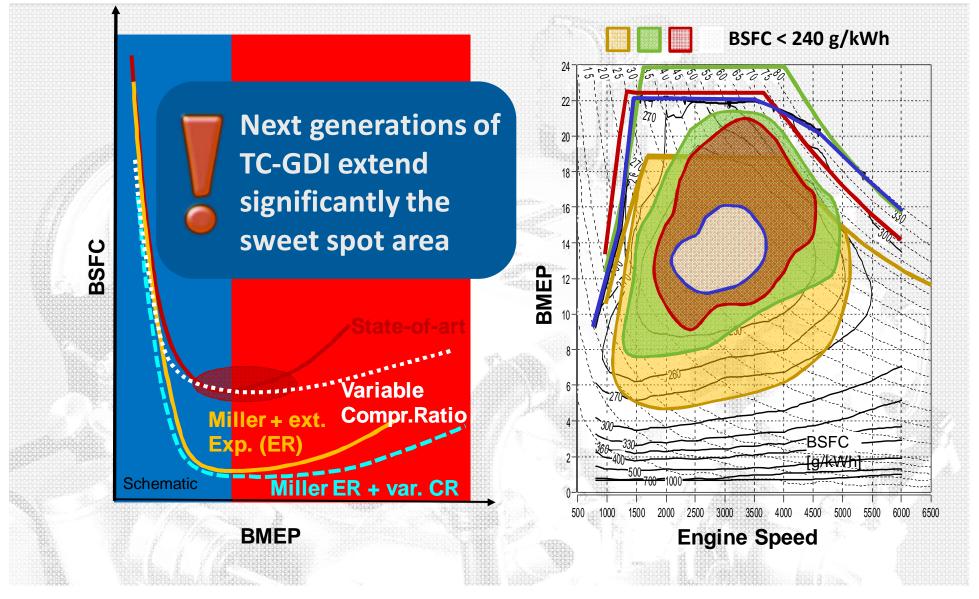






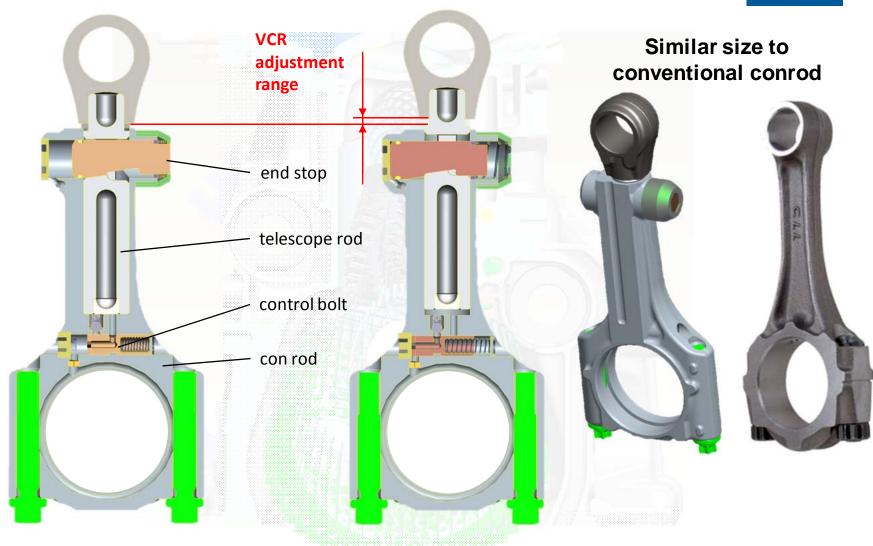
## GDI-TC EVOLUTION: EXTEND USABLE AREA OF HIGH EFFICIENCY OPERATION CONDITIONS





## AVL proposed System for VCR: Variable Con Rod



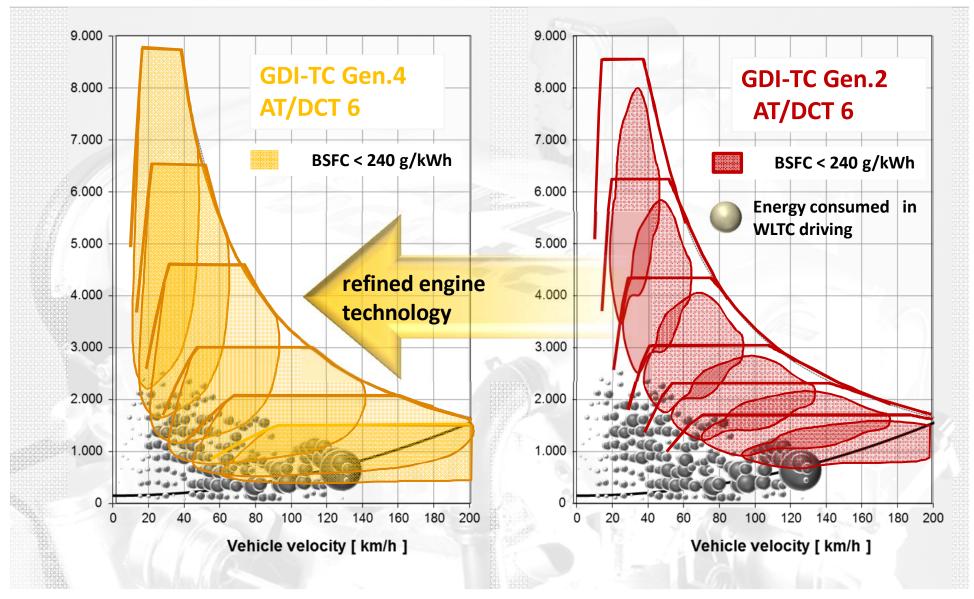


High oil pressure – low CR

Low oil pressure – high CR

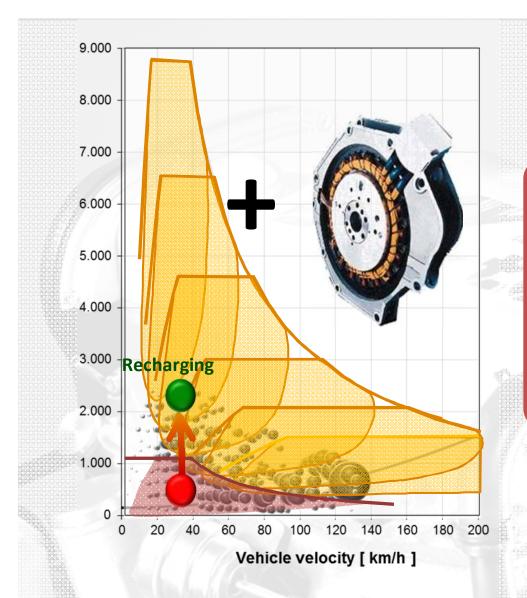
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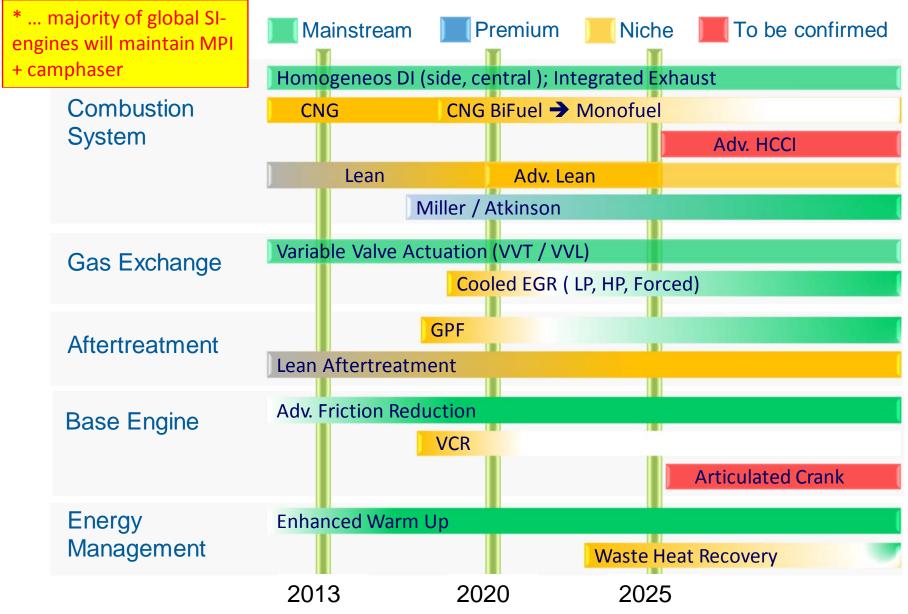
### FUEL ECONOMY IMPROVEMENT BY HYBRIDIZATION



Hybridization allows electric driving at low power requirements where the ICE would otherwise operate inefficiently



### Generic Technology Roadmap for SI-Gasoline Engines



## Technology Features and Development Methods for SI Powertrain to meet 2020 CO2 Emission Targets

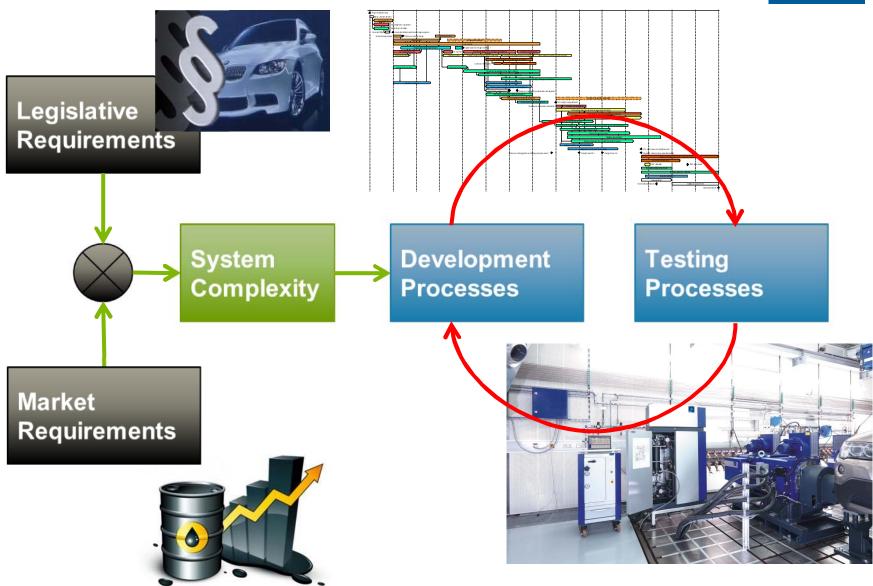


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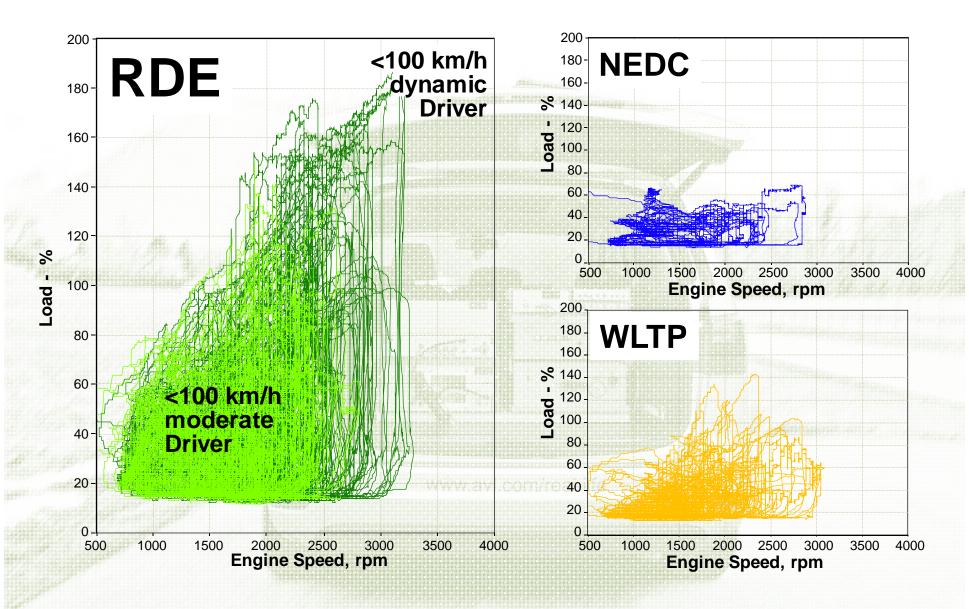
### DRIVERS TO PROCESS THE REQUIREMENTS FOR INCREASING DEVELOPMENT AND TESTING QUALITY





### New Test Cycles and RDE will come into Force

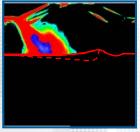


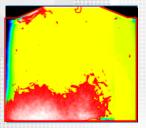


## ADVANCED EQUIPMENT FOR PARTICULATE MASS AND PARTICULATE NUMBER OPTIMIZATION

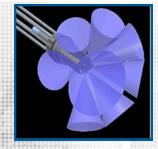














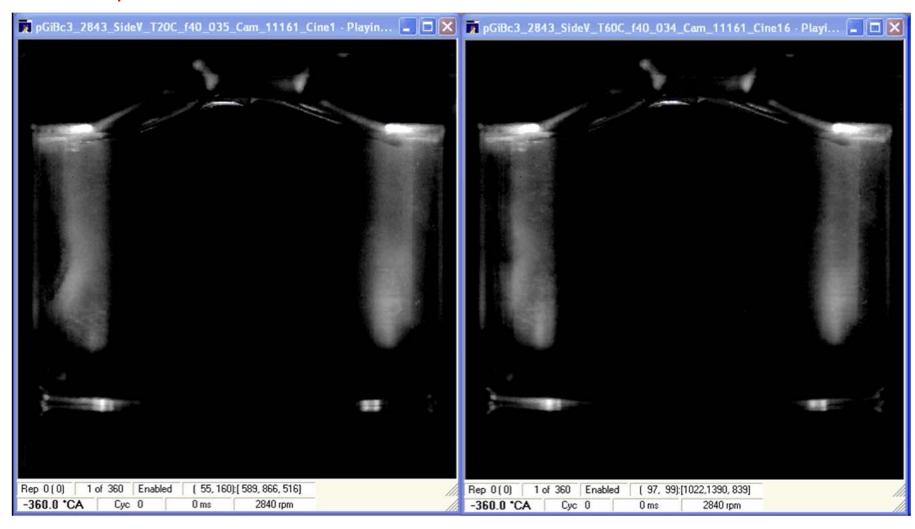
- Advanced equipment provides detailed information about particulate source: cycle to cycle, cylinder to cylinder, location in the combustion chamber
- → A "microscopic" view is required for an efficient optimization of particulate generation

## REDUCTION OF PARTICULATE NUMBER BY IMPROVED COMBUSTION SYSTEM AND CALIBRATION



NOT acceptable Diffusion combustion

appropriate combustion for EU6



### **AVL INTEGRATED TOOLCHAIN** FOR POWERTRAIN DEVELOPMENT

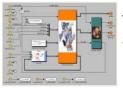


### AVL Instrumentation for Powertrain System Development & Optimization

**AVL-VISIOLUTION** 

**INDICOM** 

#### Powertrain Simulation



**AVL-CRUISE** 

Vehicle Simulation / SIL



**AVL-BOOST** 

Engine Test Bed & **Emission Systems** 



**AVL-EXCITE** 



**Driveline Test** 



**BATTERY** 

**TESTBED** 



Vehicle Development

SIL/HIL

**DEVELOPMENT** 



AVL- M.O.V.E.

**POWERTAIN** 

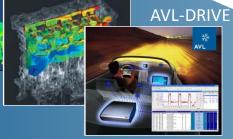
**TESTBED** 



Vehicle Validation **Production Signoff** 







**AVL-FIRE** 

AVL Software Tools for Powertrain System Development & Optimization

# THANK YOU