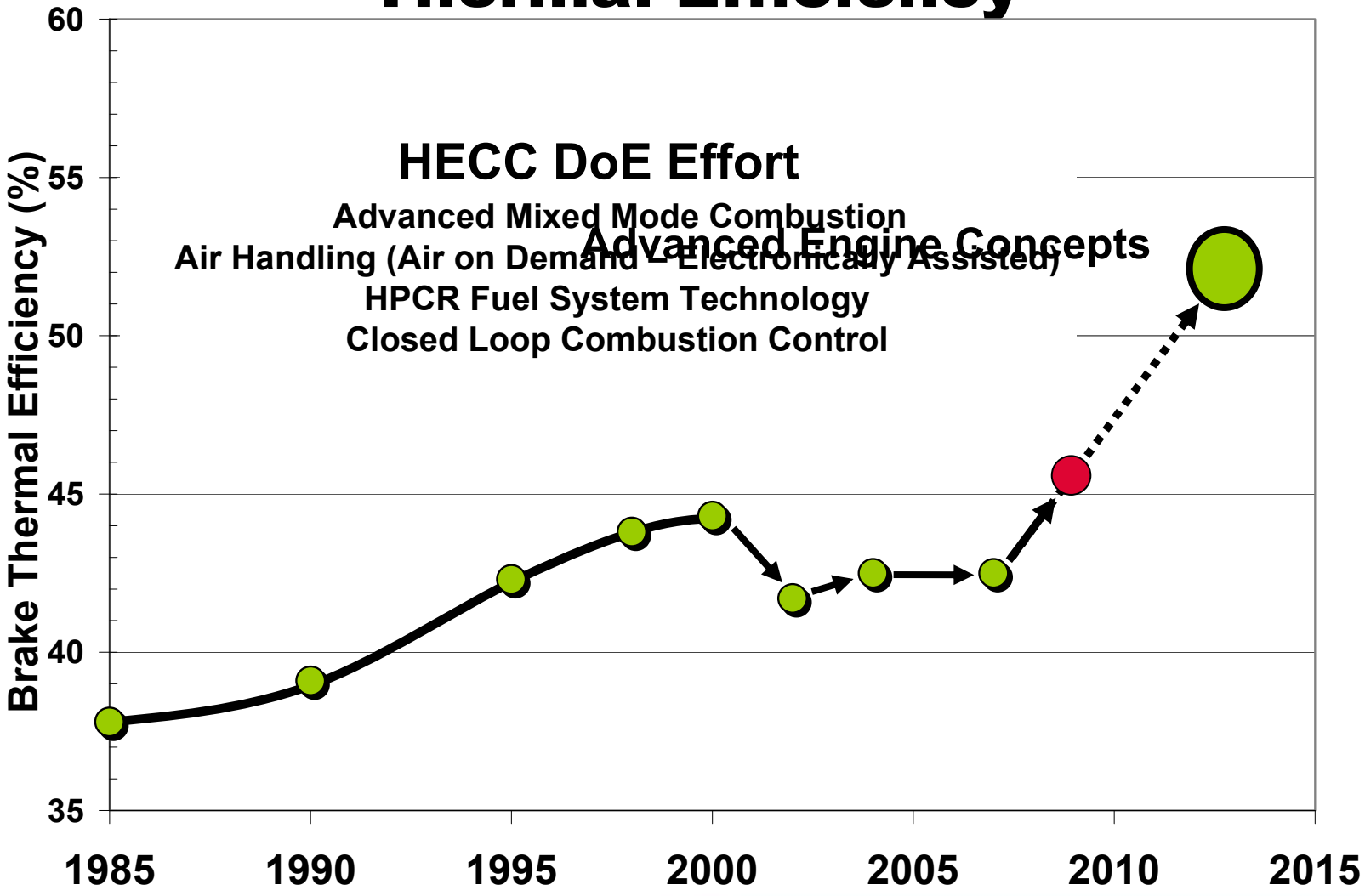
Integration of Diesel Engine Technology to Meet US EPA 2010 Emissions with Improved Thermal Efficiency

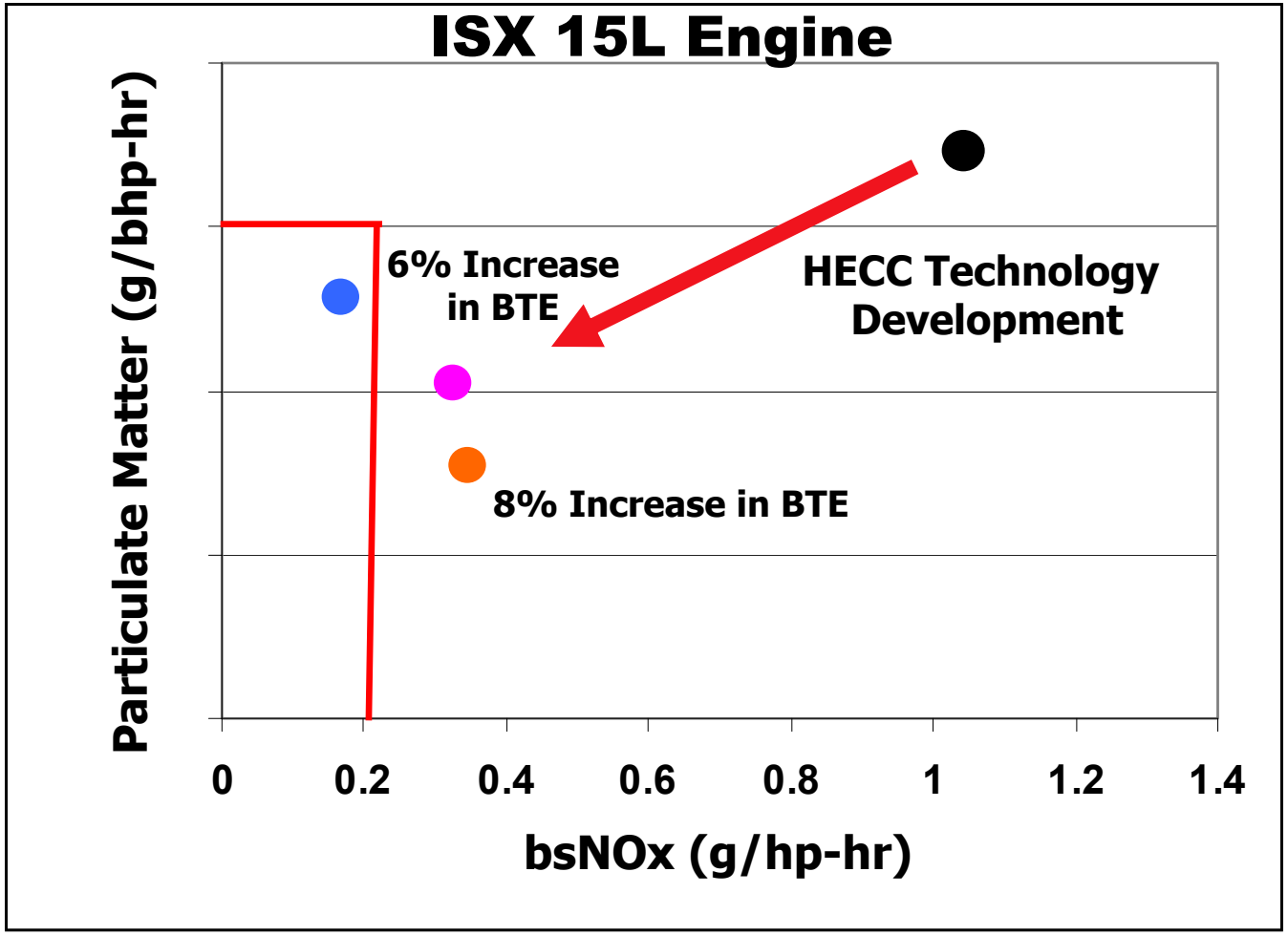
Donald Stanton
Research and Technology
Cummins Inc.

August 14, 2007 – DEER Conference

Historical Perspective of HD Brake Thermal Efficiency



Meeting 2010 Steady State Emissions



2010 Transient Emissions Compliance While Maintaining High on Remains a Challenge

ISX Technology Roadmap for Efficiency Improvement

Variable Valve Actuation

Fuel System

Advanced LTC

Variable Intake

Controls

Integration of Cummins Business Component Technologies in a Cost Effective Manner

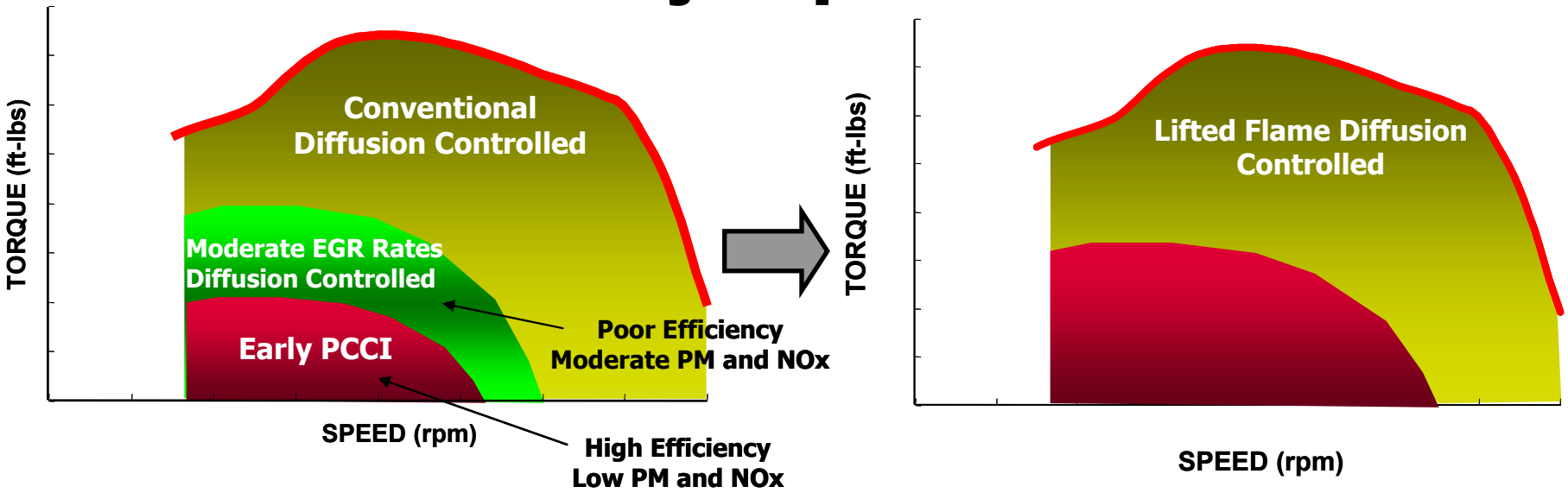
EGR Loop

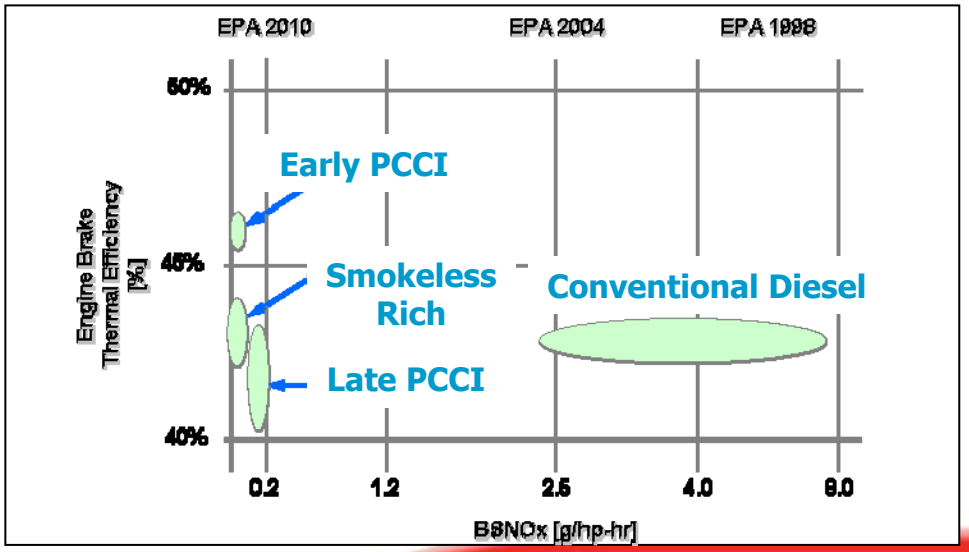
Electrically Driven Components

Turbo Technology

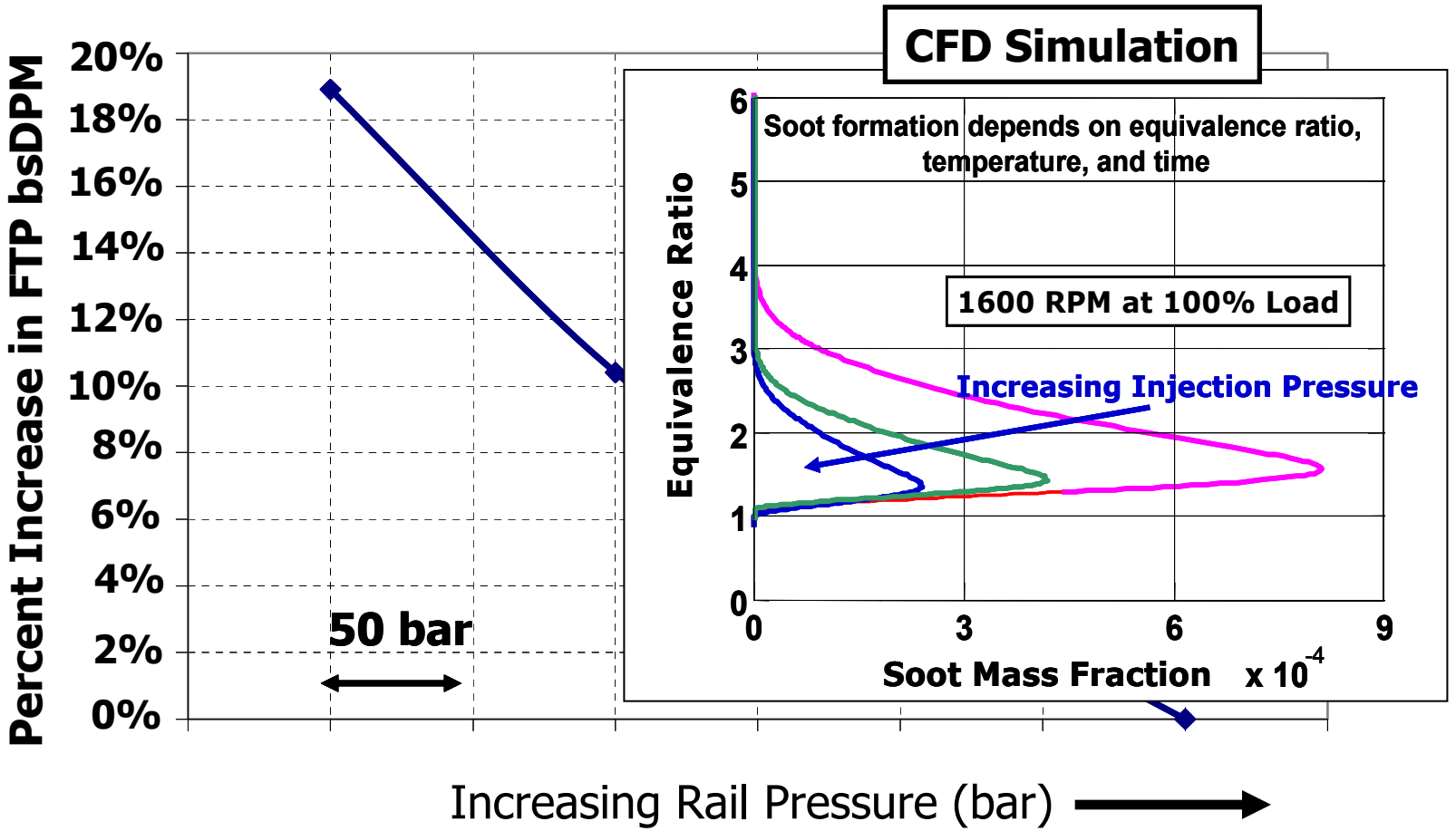
Aftertreatment

Combustion Strategy for Fuel Economy Improvements

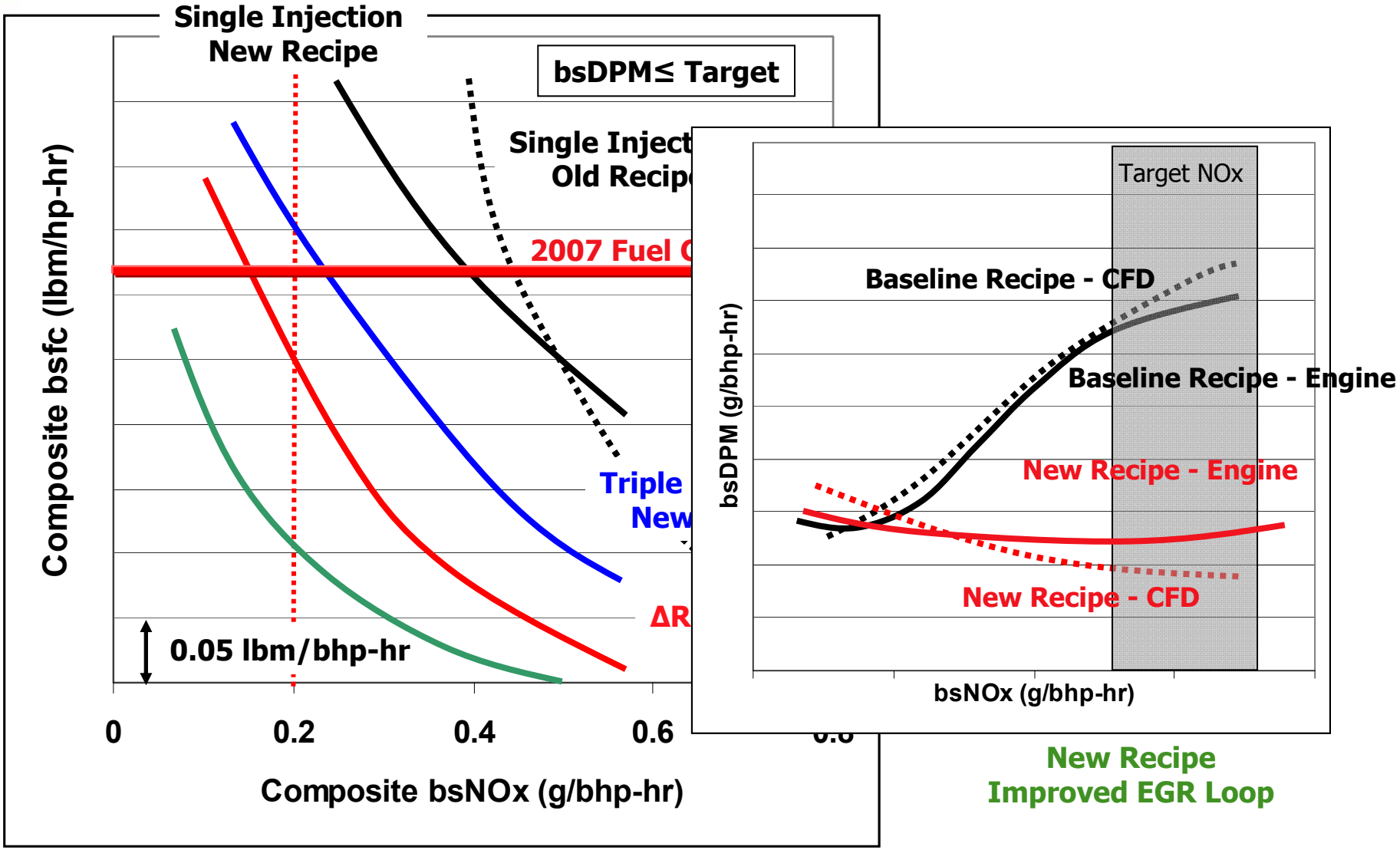




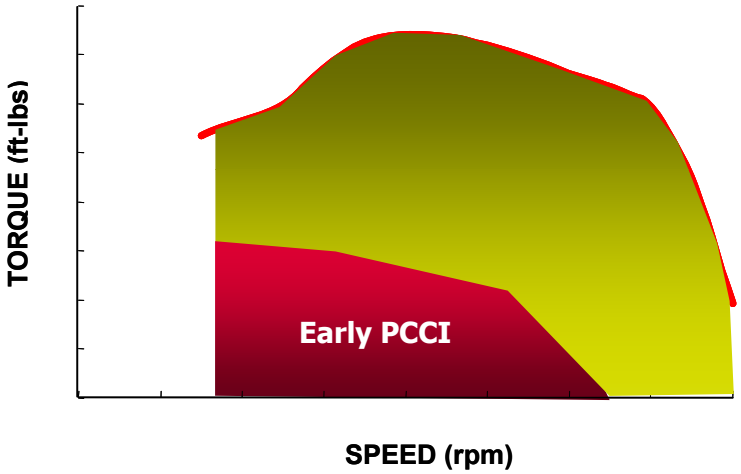
Impact of Injection Pressure on Transient Particulate Matter

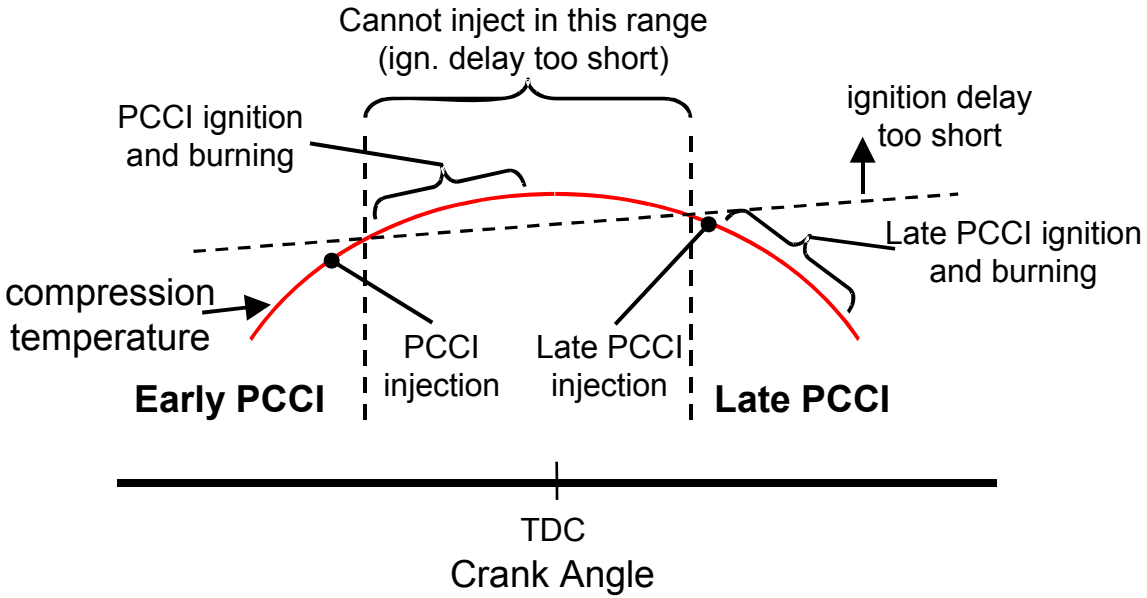


Combustion Recipe Development



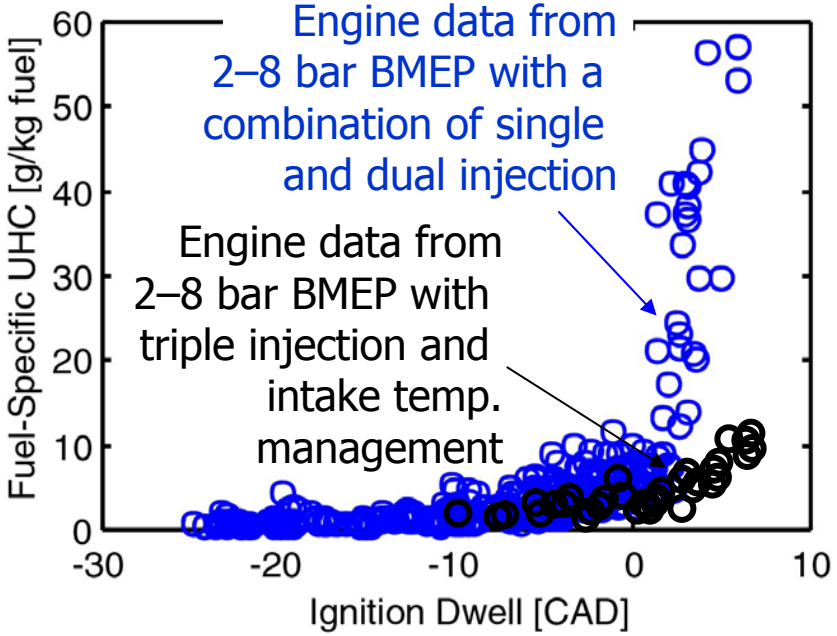
Extending the Range of Early PCCI

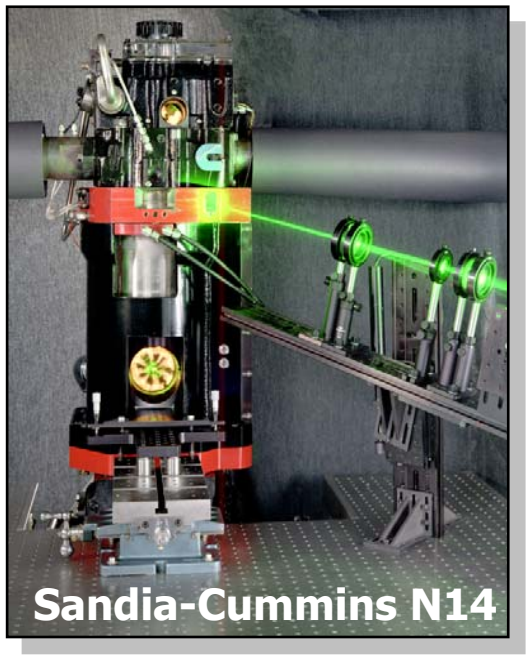




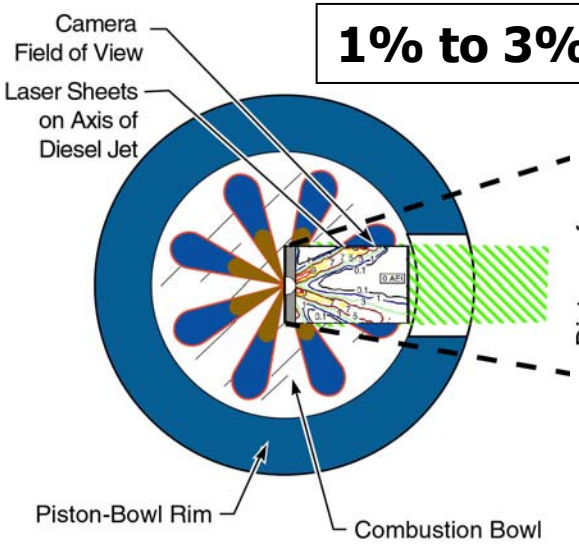
Mode	Advantages	Disadvantages
Early PCCI	- Good stability - Good fuel consumption	- High peak cyl. pressure - Limited BMEP - Noise - Higher cooled EGR rates
Late PCCI	- Low peak cyl. pressure - High BMEP capability (20 bar) - Low noise	- Narrow stability range - Higher fuel consumption - Needs combustion sensor

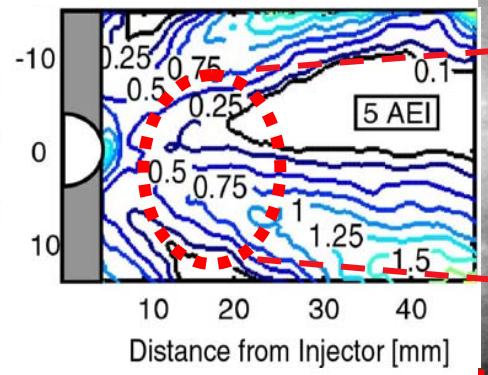
Reducing HC and CO for Early PCCI Efficiency Improvement



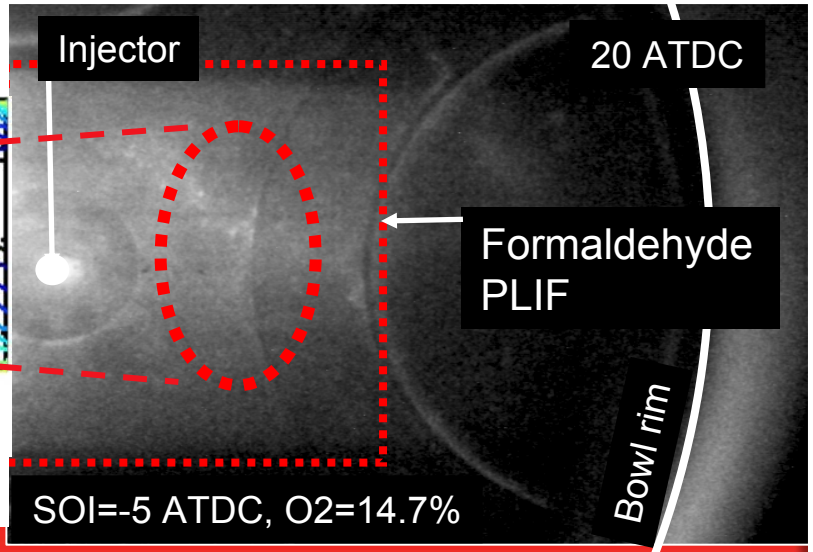


1% to 3% bsfc reduction





Equivalence Ratio Contours



Images Courtesy of Mark Musculus - SNL

ISX Technology Roadmap for Efficiency Improvement

Variable Valve Actuation

Fuel System

Advanced LTC

Variable Intake Swirl

Controls

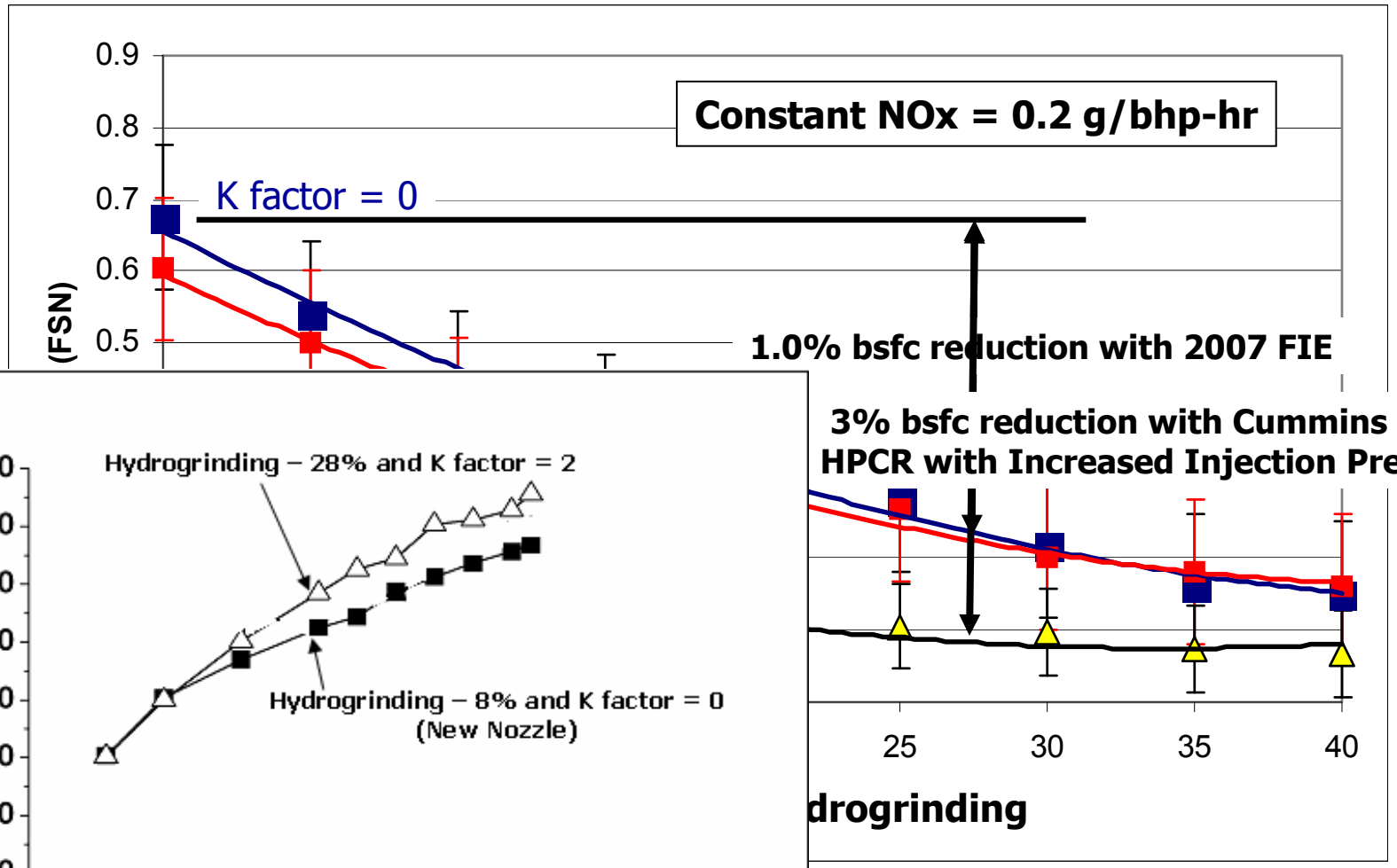
EGR Loop

Electrically Driven Components

Turbo Technology

Aftertreatment

Impact of Nozzle Configuration at High Injection Pressures



ISX Technology Roadmap for Efficiency Improvement

Variable Valve Actuation

Fuel System

Advanced LTC

Variable Intake Swirl

Controls

EGR Loop

Electrically Driven Components

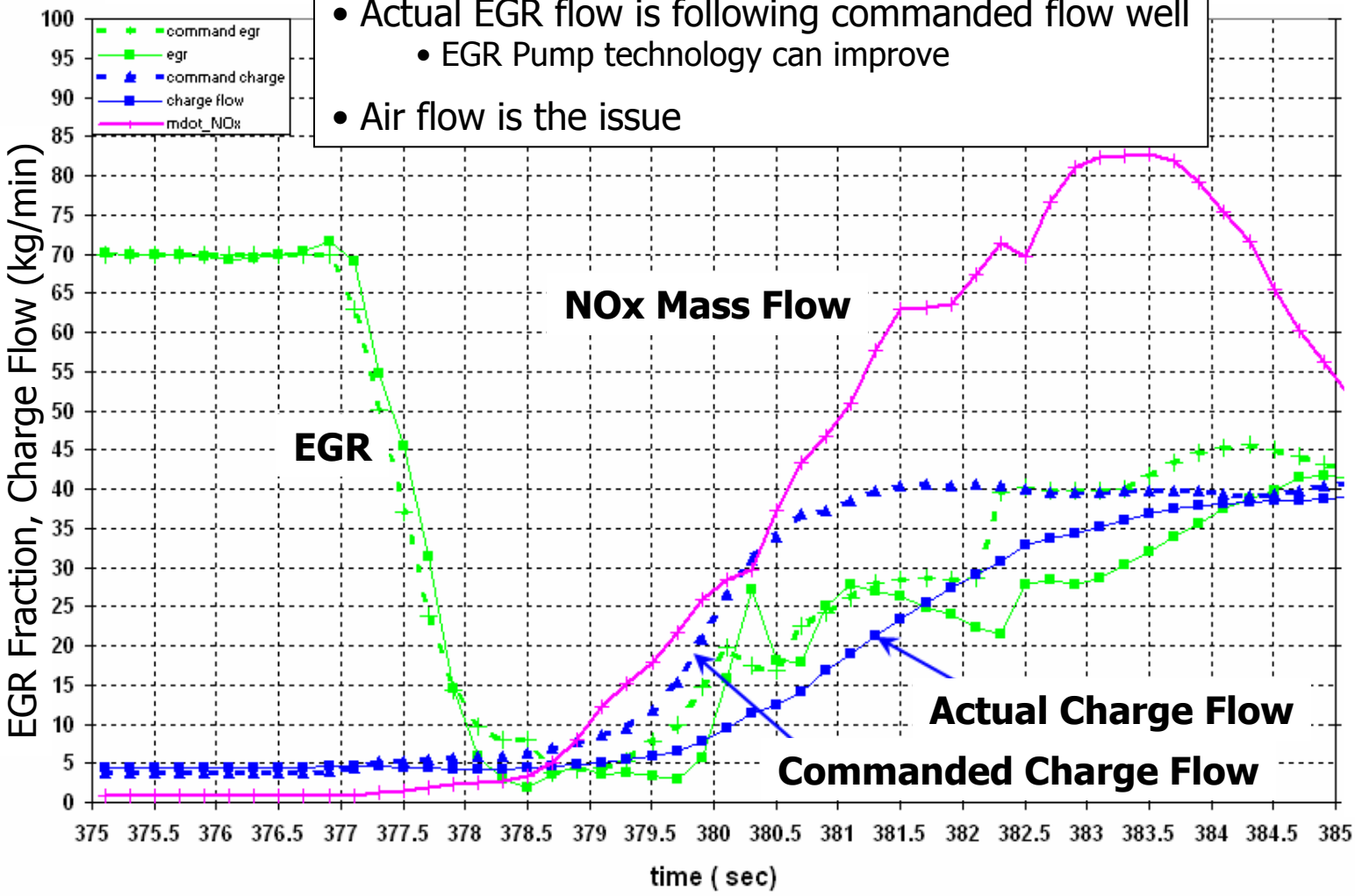
Turbo Technology

Aftertreatment

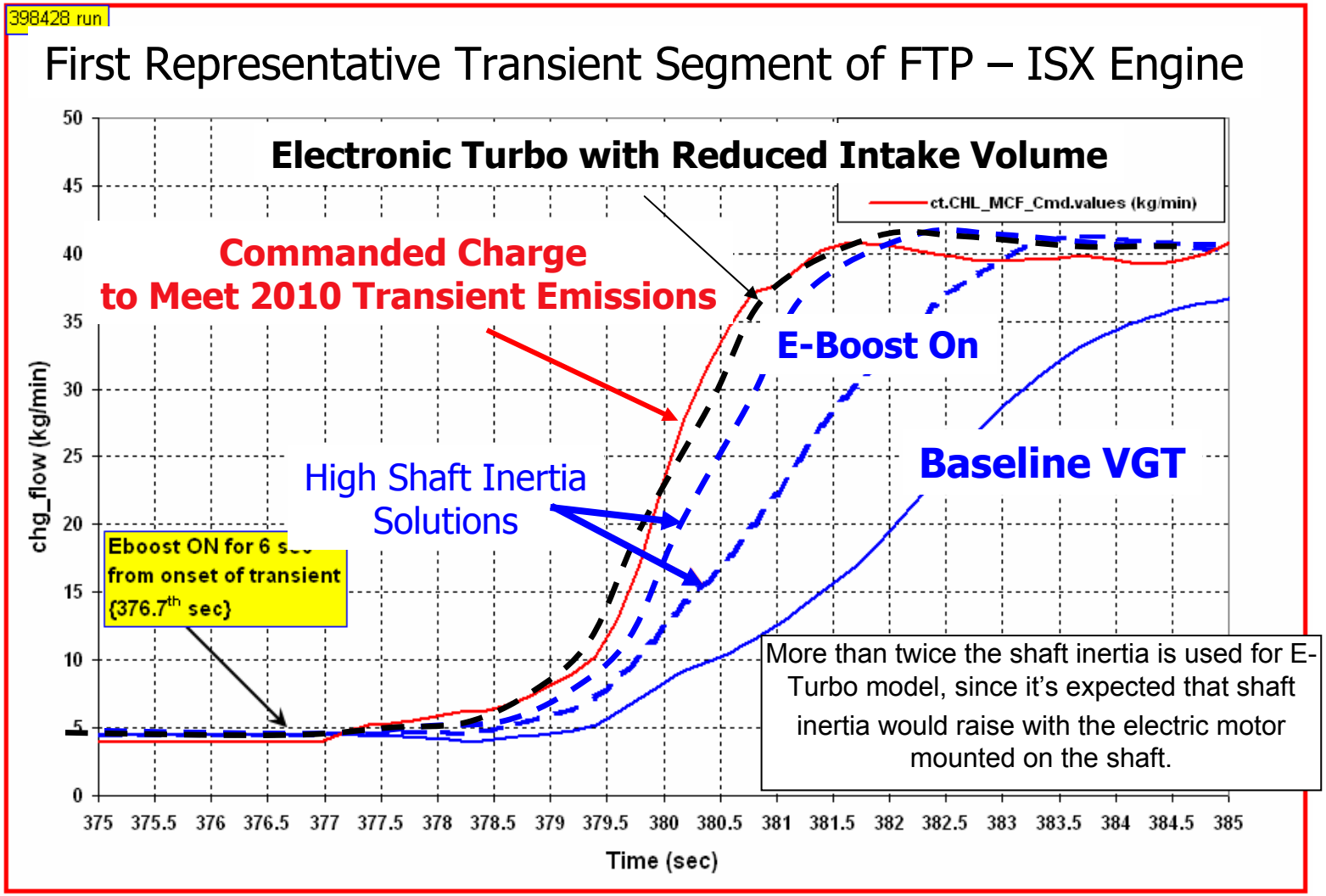
Improving Transient Air Flow

First Representative Transient Segment of FTP – ISX Engine

- Actual EGR flow is following commanded flow well
  - EGR Pump technology can improve
- Air flow is the issue



Electric Turbo – VGT Transient Air Handling Simulation



ISX Technology Roadmap for Efficiency Improvement

Variable Valve Actuation

Fuel System

Advanced LTC

Variable Intake Swirl

Controls

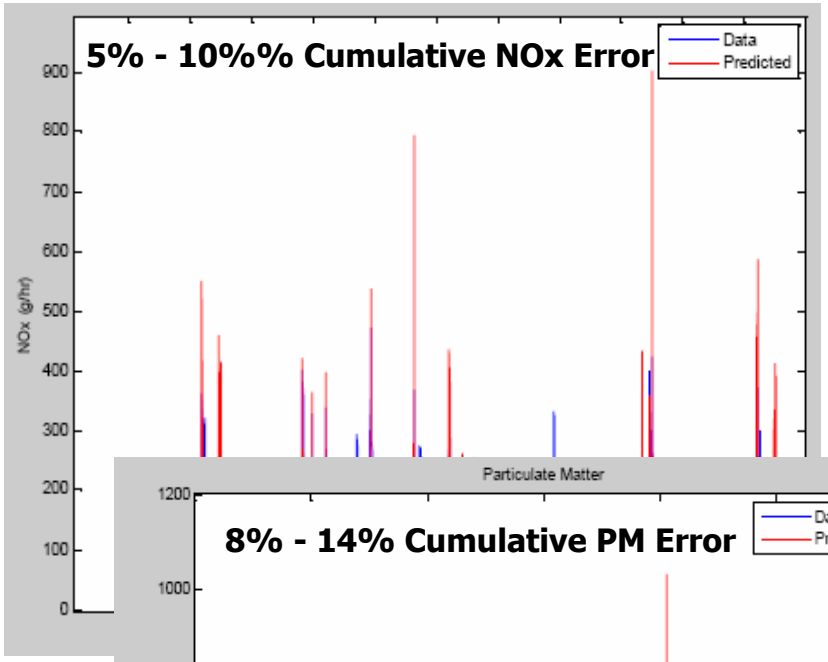
EGR Loop

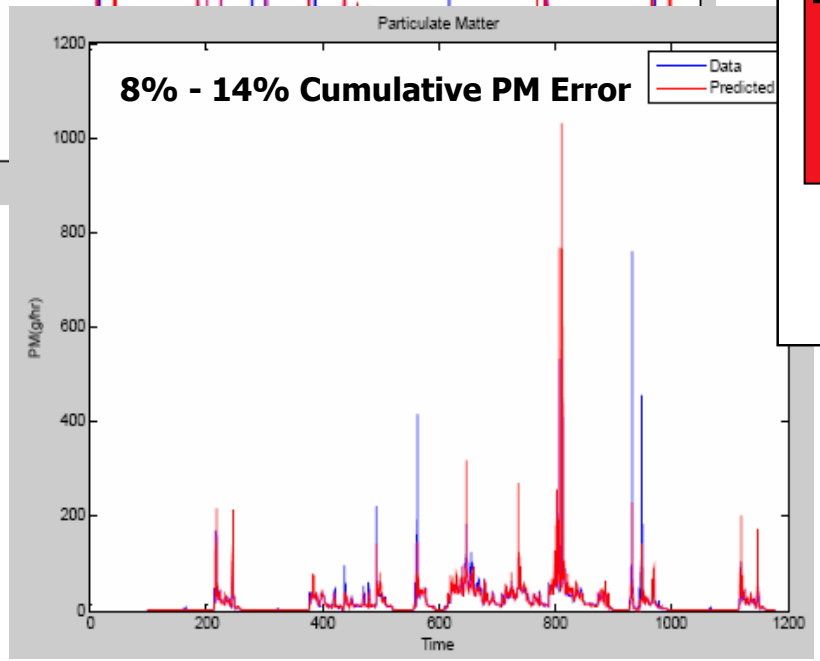
Electrically Driven Components

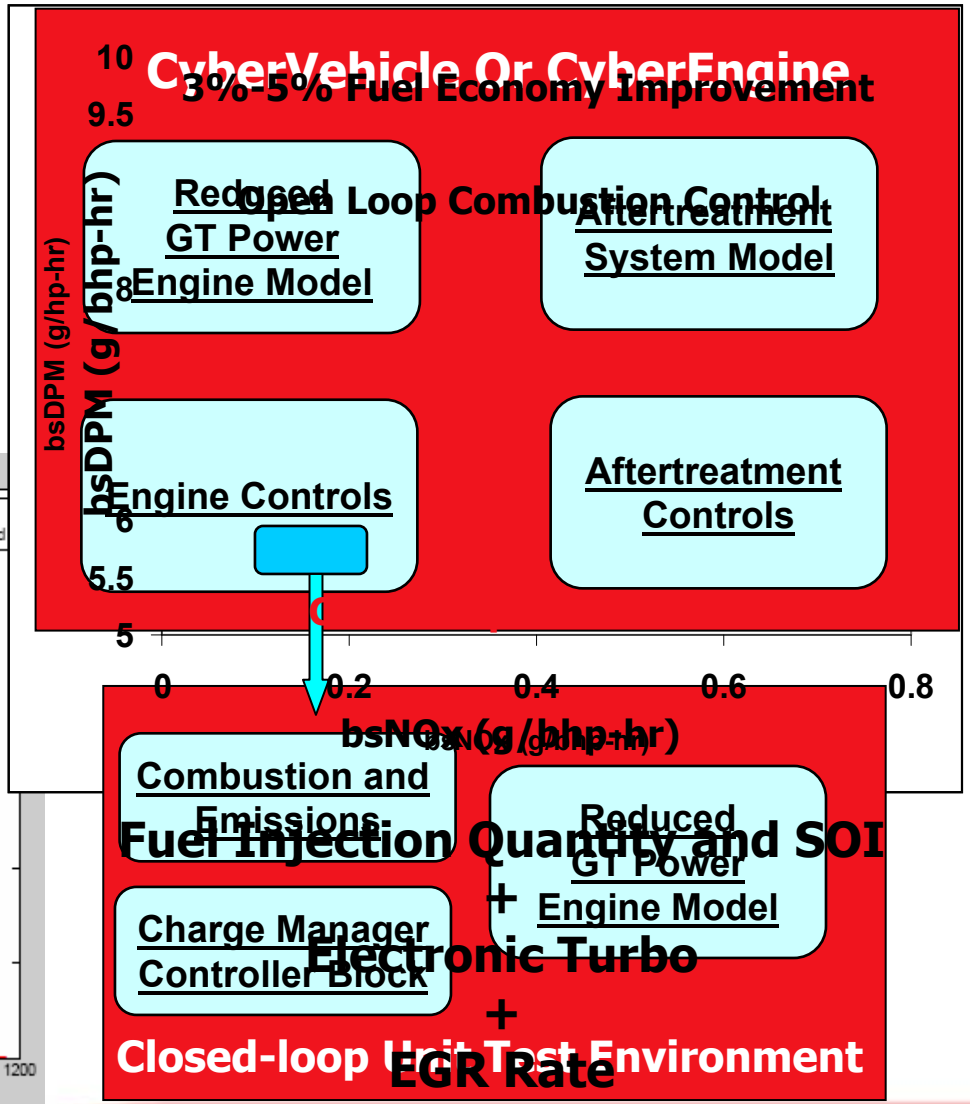
Turbo Technology

Aftertreatment

Controls Development for Transient Emissions







HD Brake Thermal Efficiency Accomplishments