Light – Duty Passenger Car Project

APBF-DEC-JCAP-CAFE Meeting
Washington, October 9-10, 2002

Review of the APBF-DEC Light-Duty Demonstrator Program

Dean Tomazic

FEV Engine Technology, Inc.
Auburn Hills, Michigan, USA

Outline

1. Project Objective
2. Vehicle Specifications
3. Engine Specifications
4. Emission Control System
5. Bypass System and Strategy
6. Initial Results
7. Summary

Light – Duty Passenger Car Project

Project Objective

- Determine the influence of diesel fuel composition on the ability of NOx adsorber catalyst technology in conjunction with DPF's, to achieve stringent emission levels with a minimal fuel economy impact.

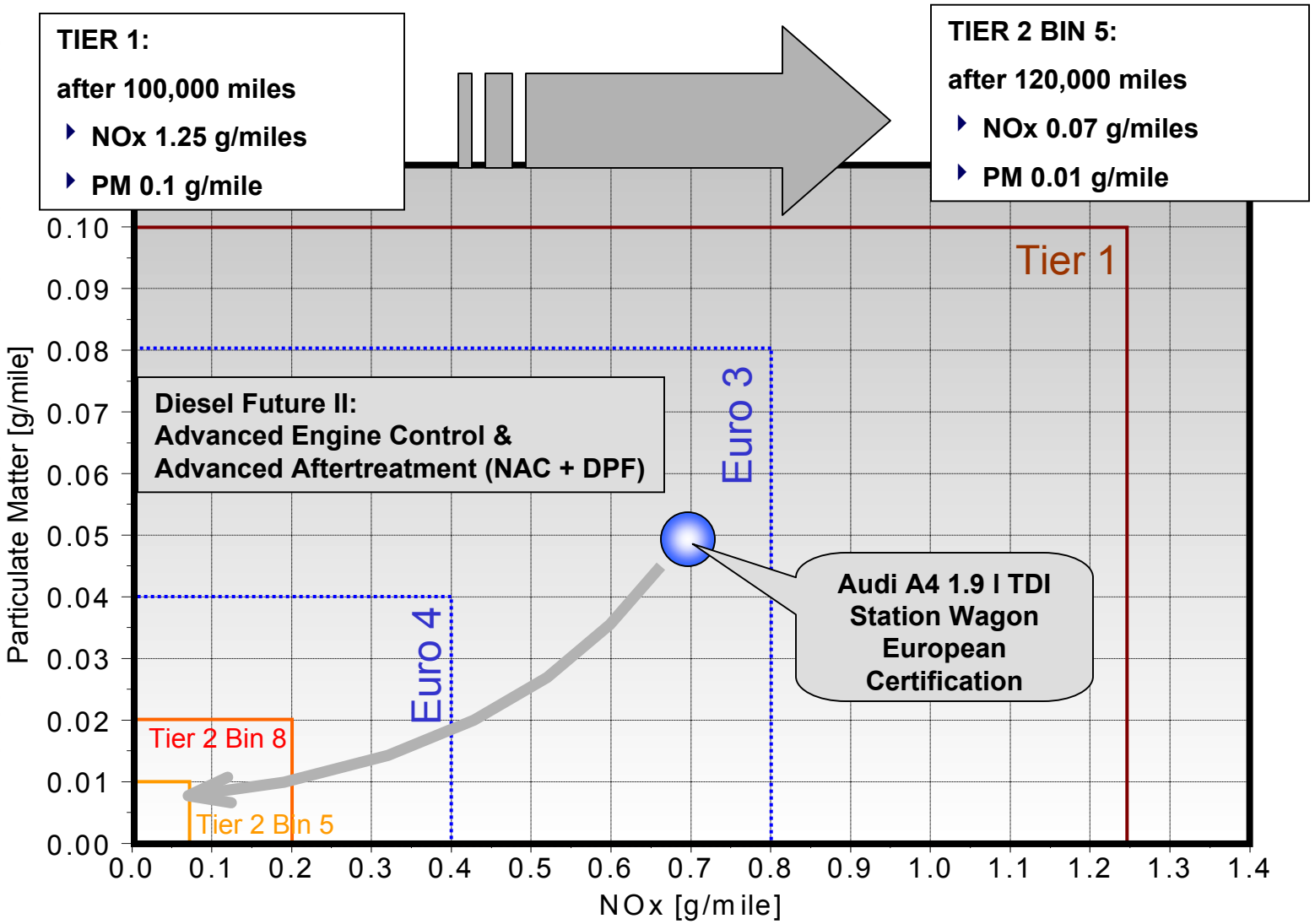
Project Goals

- Achieve Tier 2, Bin 5 tailpipe emission levels (0.07 gNOx/mi and 0.01 gPM/mi)
- Meet Tier 2, Bin 5 HC and CO emission standards
- Minimize fuel economy penalty

FEV

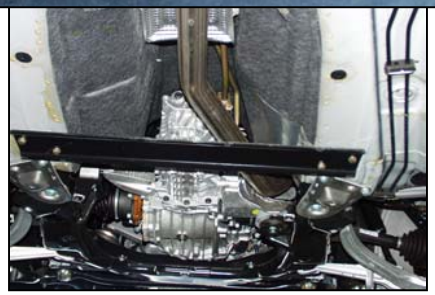
Light – Duty Passenger Car Project

Program Goals



Light – Duty Passenger Car Project

Vehicle Specifications



Audi A4 Avant
1.9L TDI

Light – Duty Passenger Car Project

Vehicle Specifications

Specifications	
Vehicle Mass:	1590 kg
Transmission:	5-Speed Manual
Total Length:	4544 mm
Total Height:	1429 mm
Total Width:	1766 mm
Air Drag Coefficient:	$c_w = 0.3$
Gear-Ratios:	1: 3.50
	2: 1.84
	3: 1.16
	4: 0.84
	5: 0.68
	Axle: 3.89

Light – Duty Passenger Car Project

Engine Specifications

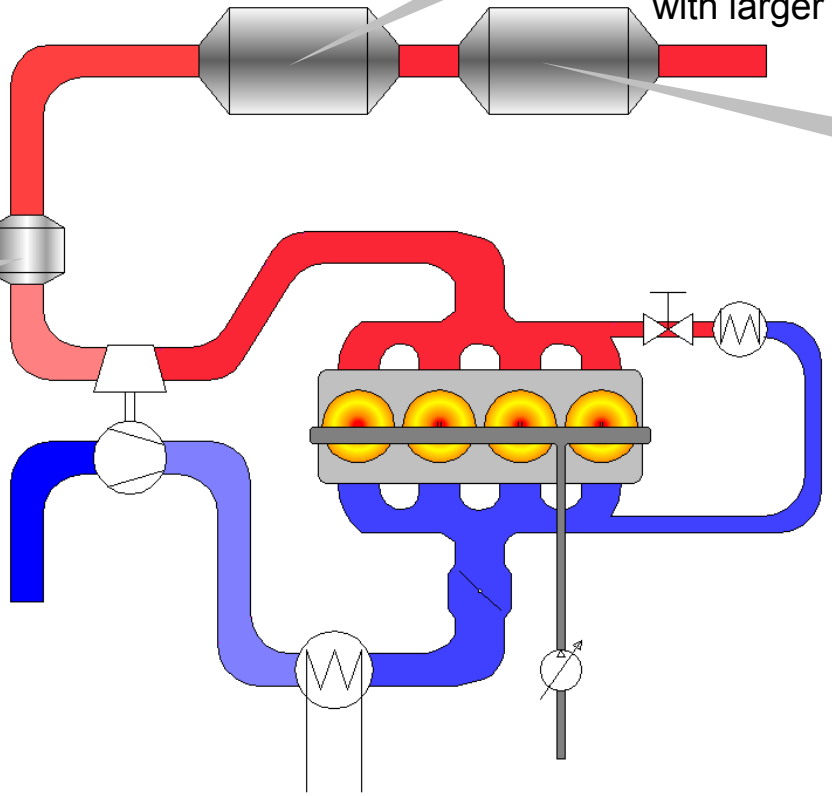
Specifications

Arrangement:	In-Line 4-Cylinder
Displacement:	1.9 L
Rated Power:	100 KW @ 4000 rpm
Max. Torque:	330 Nm
Bore/Stroke:	79.5/95.5 mm
Turbocharger:	Garrett GT 17 V
Injection System:	Bosch Common Rail, 2nd Generation
Valves:	2 x Intake / 2 x Exhaust
Compression Ratio:	18.2 : 1

FEV

Light – Duty Passenger Car Project

Emission Control System



NAC →
Optimized effectiveness for lowest possible temperatures. Clean up catalyst for breakthrough control with larger post injection quantities

CDPF →
Optimized for lower soot ignition temperature with lowest backpressure penalty

Pre-Cat →
Increase temperature during:
- Warm-up
- DPF Regeneration
- Desulfurization

Light – Duty Passenger Car Project

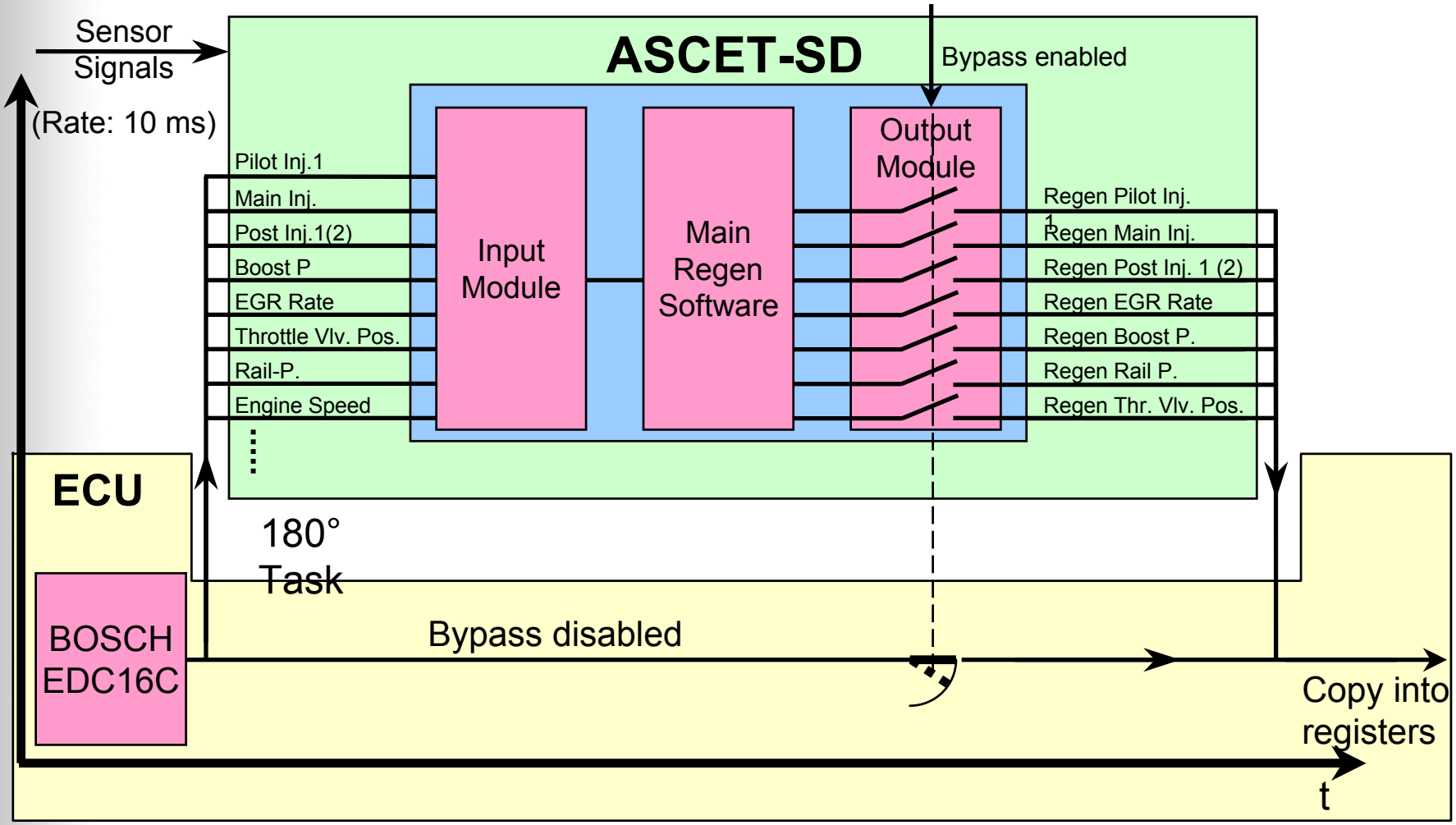
Emission Control System

Catalyst Specifications

		ECS A			ECS B		
		Pre-Catalyst [Warmup & NAC]	Under Body NAC	CDPF	Pre-Catalyst [NAC only]	Under Body NAC	CDPF
Volume	[L]	1.34	2.5	2.5	1.34	2.5	2.5
Cross-section	-	Round	Round	Round	Round	Round	Round
Diameter	[in]	4.16	5.66	5.66	4.16	5.66	5.66
Length	[in]	6	6	6	6	6	6
Substrate Material	-	Cordierite	Cordierite	SiC	Cordierite	Cordierite	SiC
Wall Thickness	[mil]	4.5	5.5	14	4.5	5.5	14
Cell Density	[cpsi]	400	350	200	400	350	200
Cell Geometry	-	Square	Square	Square	Square	Square	Square

Light – Duty Passenger Car Project

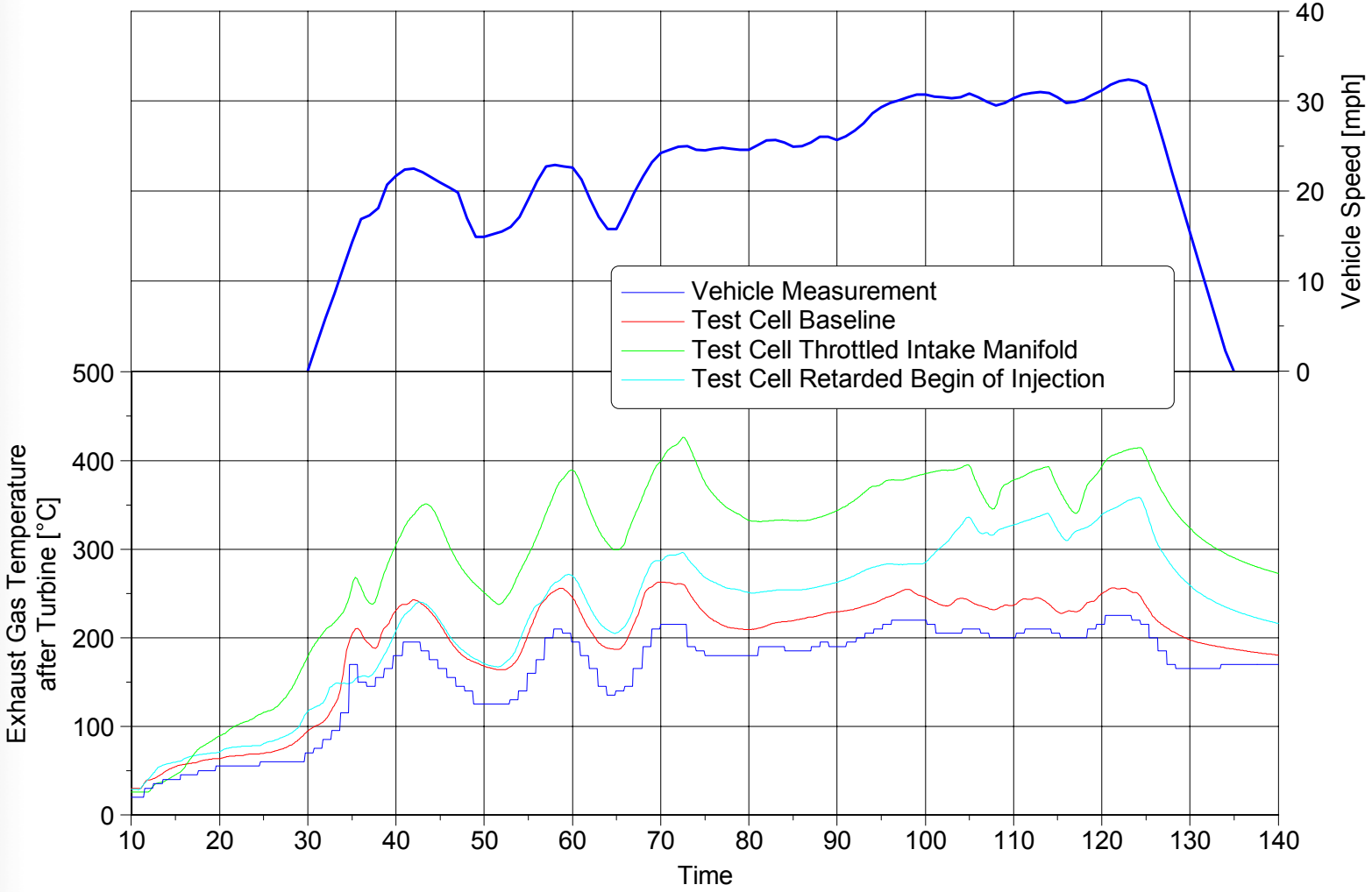
Bypass System and Strategy



Light – Duty Passenger Car Project

Initial Results

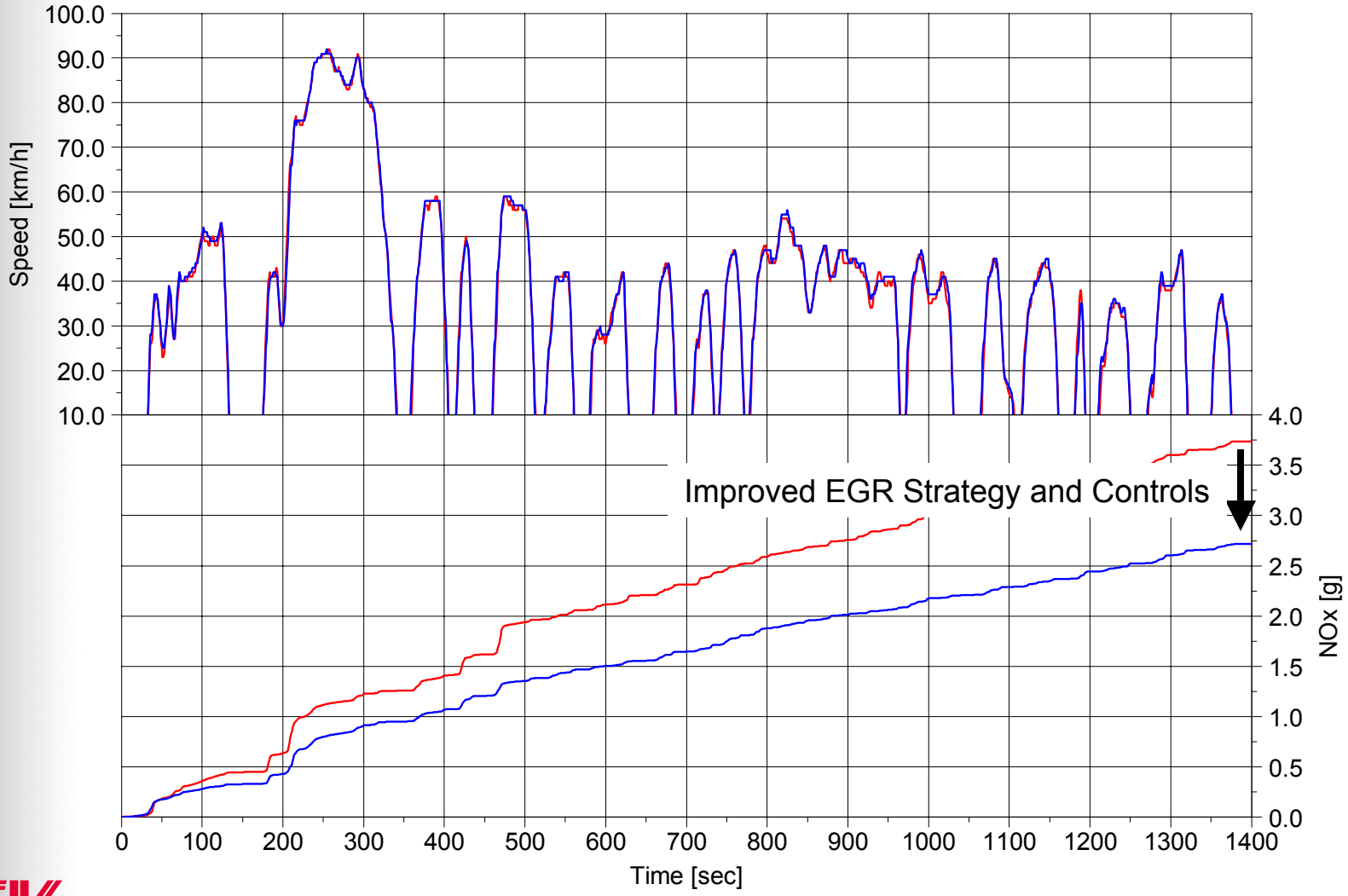
Rapid Warm Up Results



Light – Duty Passenger Car Project

Initial Results

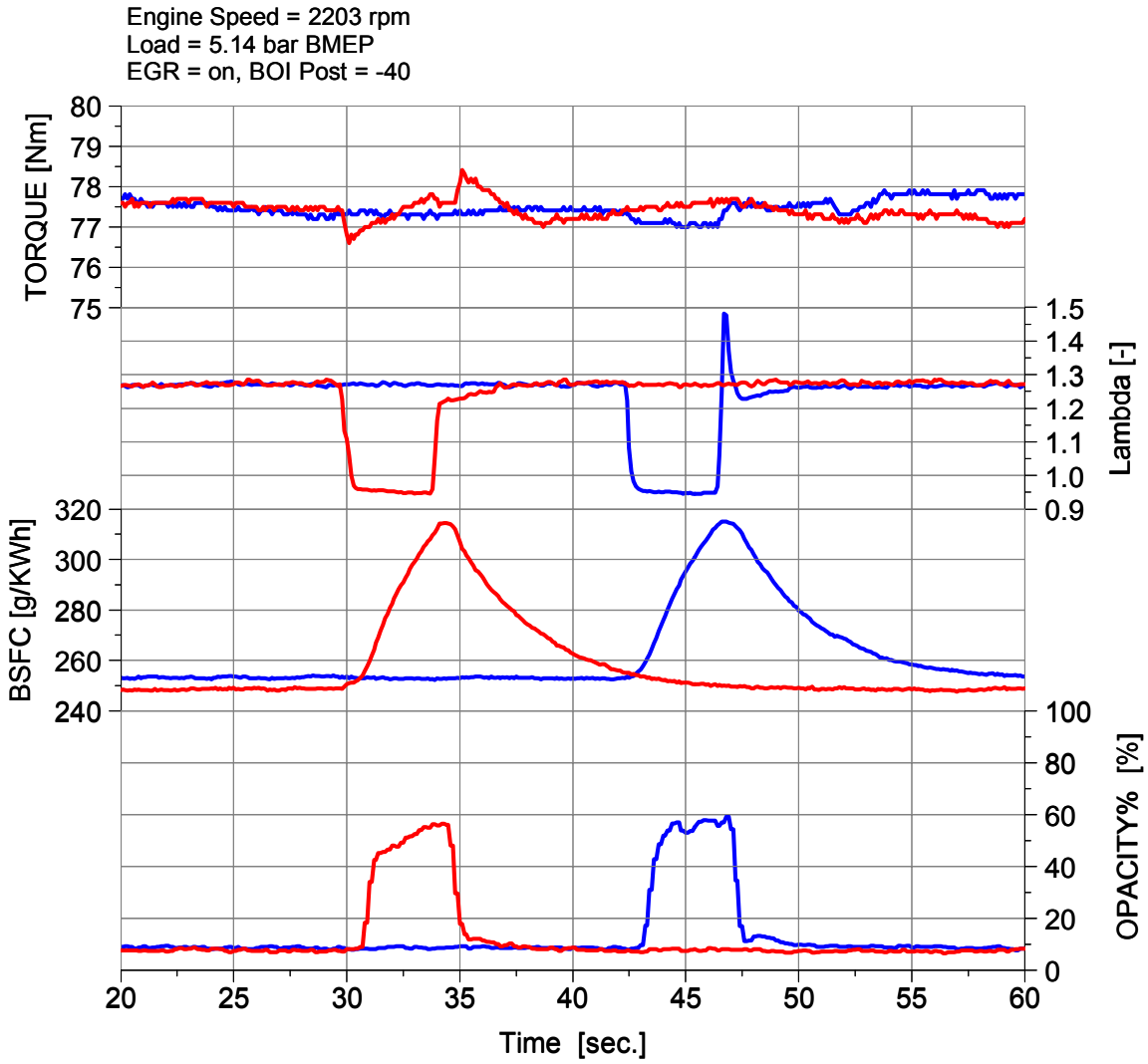
Vehicle Engine Out Emission Results



Light – Duty Passenger Car Project

Initial Results

Improvement in Regeneration Strategy



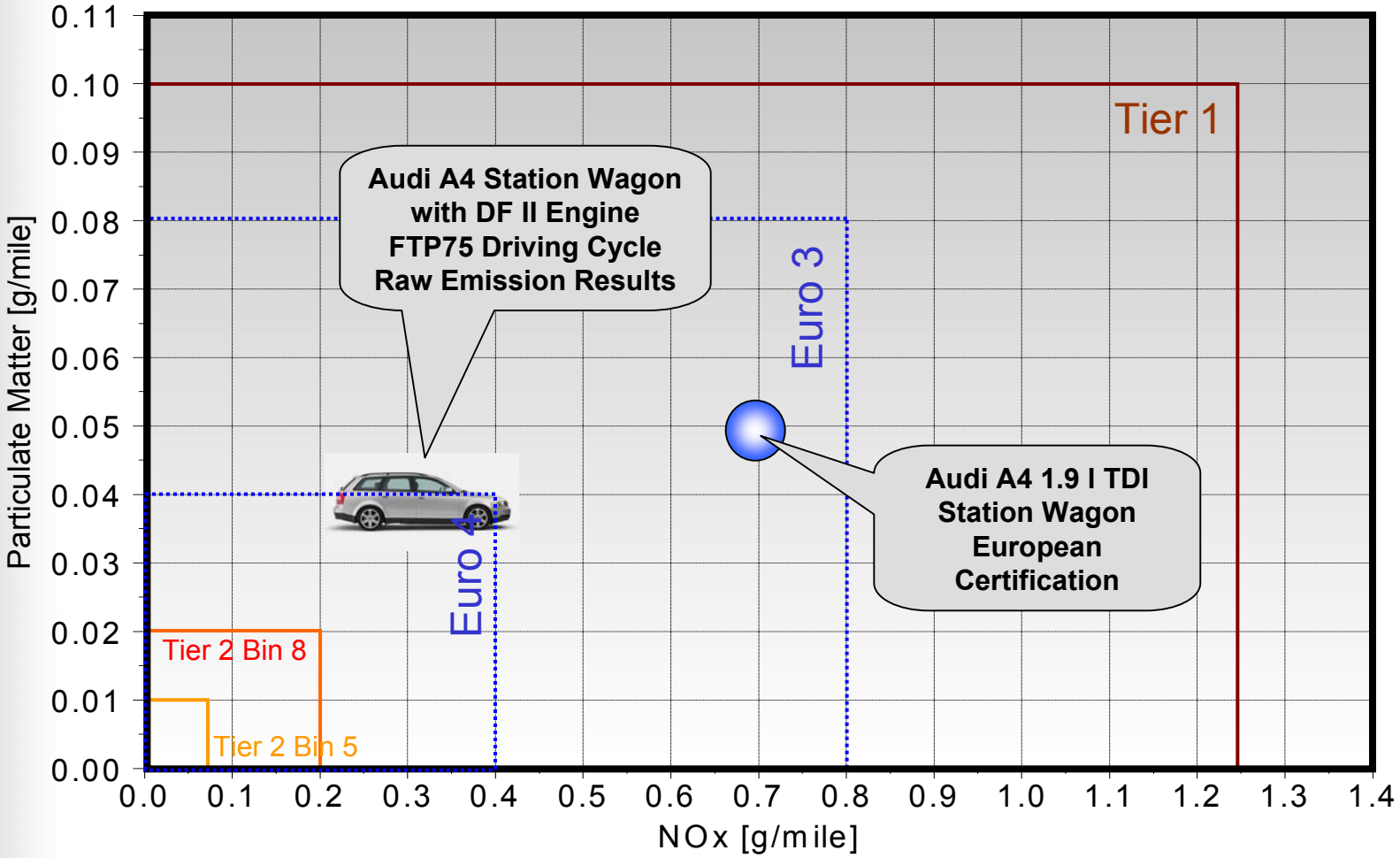
Initial Results Utilizing EGR, Throttle and Post-injection

Optimized Strategy with Closed Loop λ Control

Light – Duty Passenger Car Project

Initial Results

Current Vehicle Engine Out Emission Status



Light – Duty Passenger Car Project

Summary

- First task of the program accomplished
- Vehicle engine out emissions close to targeted numbers
- With current engine out emissions about
  - 80% NOx conversion efficiency
  - 85% PM filter efficiency of
  - ECS required
- Regeneration strategies will be refined during the program
- Further optimization for vehicle operation required

Light – Duty Passenger Car Project

Participating Companies/Organizations

Automobile:
Ford
GM
DaimlerChrysler
Toyota

Engines:
EMA
Caterpillar
Detroit Diesel
Cummins
John Deere
Mack Trucks
International Truck & Engine

Government:
DOE
NREL
ORNL
EPA
CARB/SCAQMD

Technology:
Battelle

Emission Control:
MECA
Johnson Matthey
Delphi
3M
Engelhard
Siemens
Benteler
ArvinMeritor
Clean Diesel Tech.
Corning
Donaldson Co.
OMG
NGK
Rhodia
Tenneco Automotive

Energy/ Additives:
API
American Chemistry Council
NPRA
BP
Ethyl
ExxonMobil
Marathon Ashland
Pennzoil-Quaker State
Lubrizol
Equilon
Castrol
ChevronTexaco
Chevron Oronite
Ciba
Ergon
Valvoline
Motiva
Infineum

FEV