Enhanced thermal and gas flow performance in a three-way catalytic converter through use of insulation within the ceramic monolith

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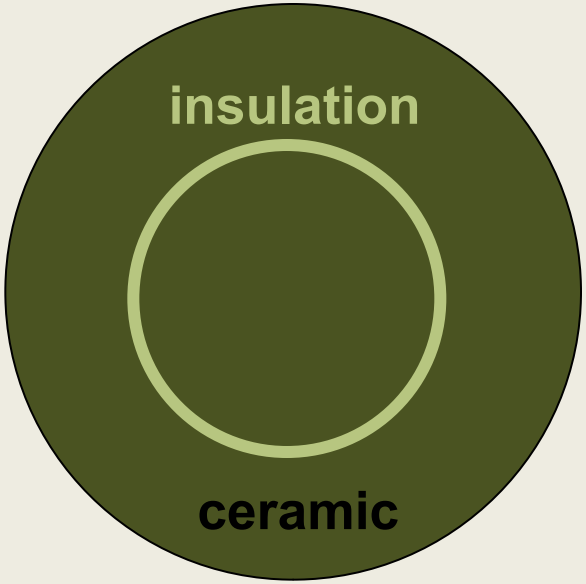
Multi-Chamber Catalytic Converter (MCCC)

- MCCC inserts an insulation layer within the standard ceramic monolith
- Influences thermal flows between the inner and outer zones of monolith

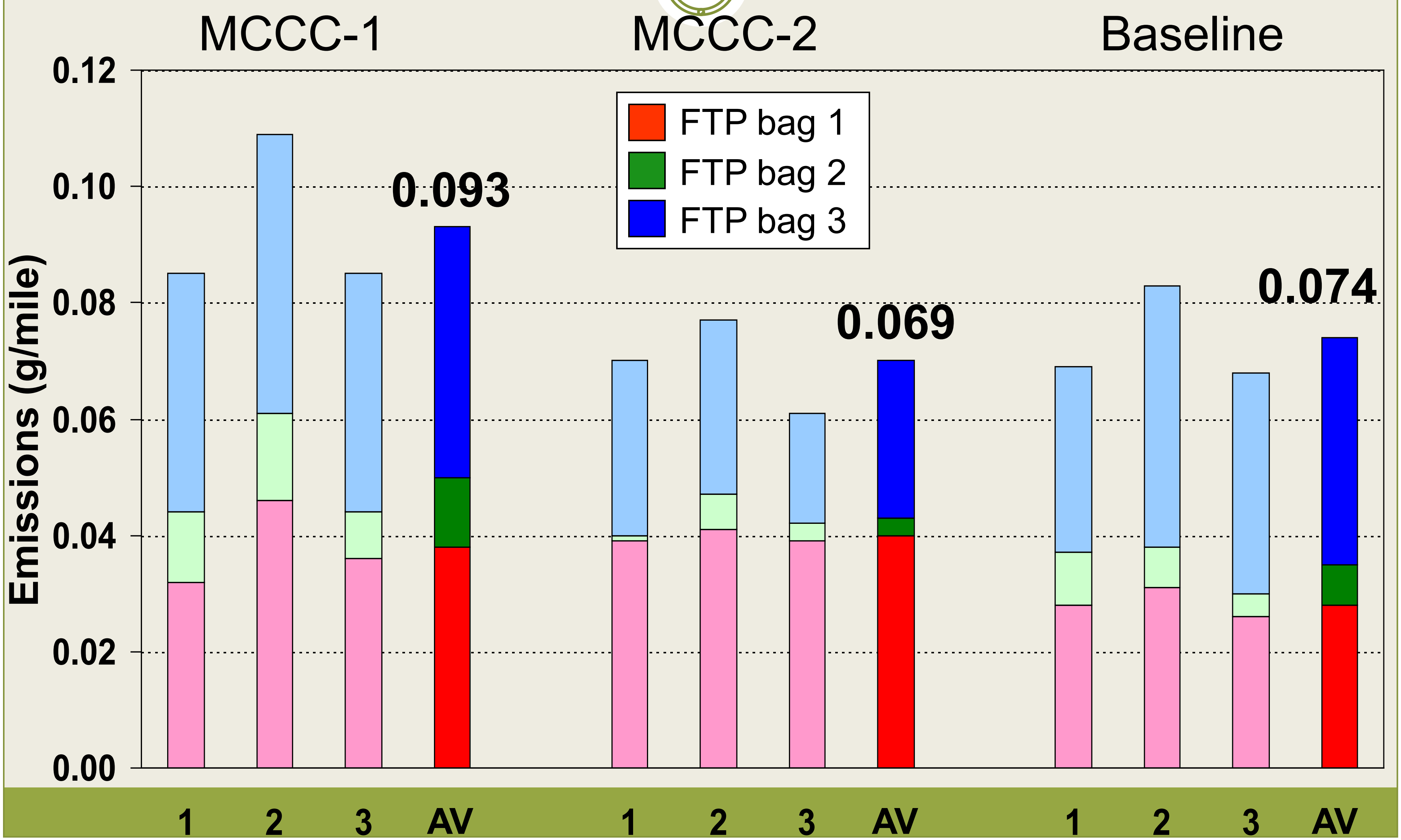


- Results in better thermal management
- Impacts distribution of exhaust gas across the face of the monolith

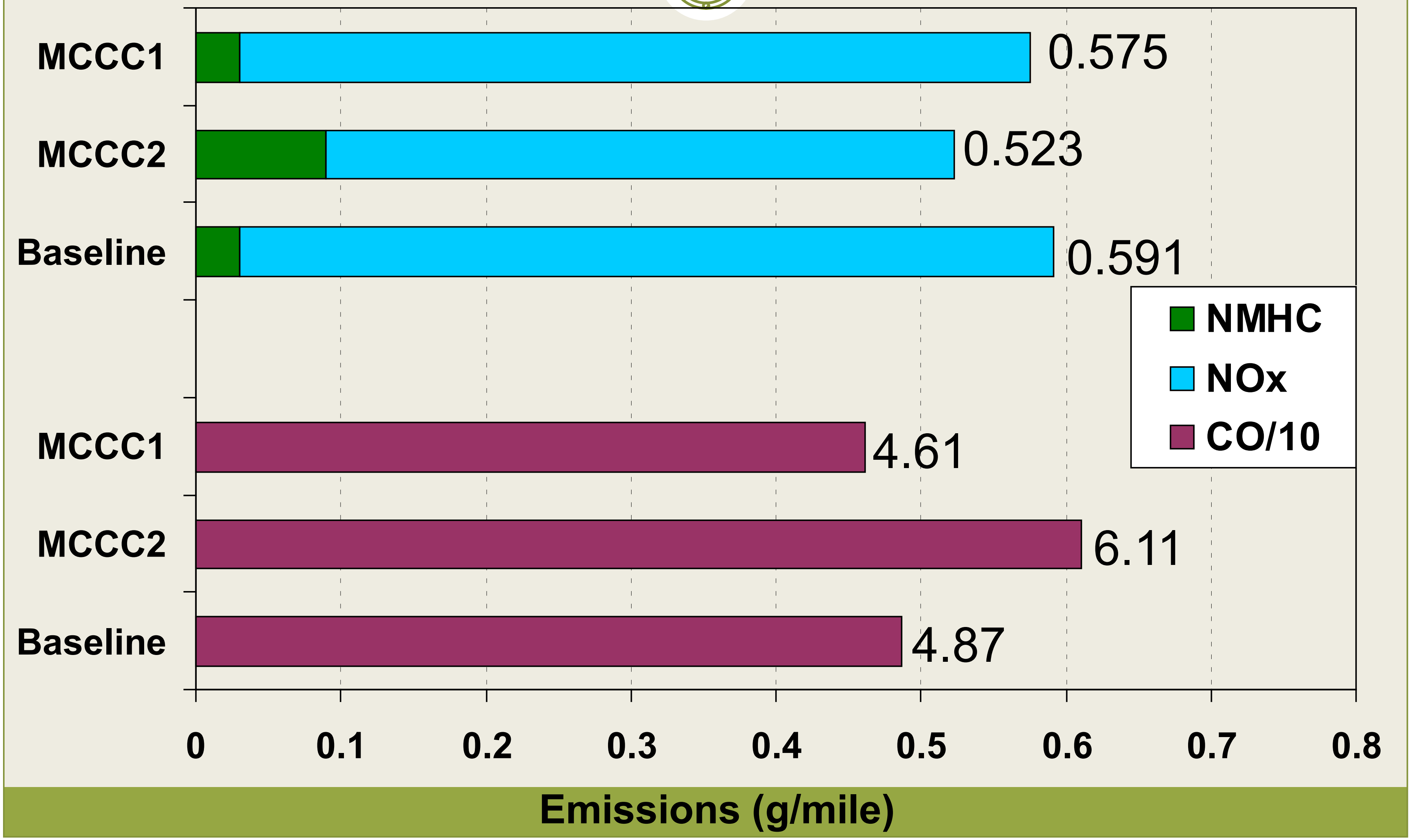
OEM Proof of Concept Testing

- Ford Edge Duratec 3.5L testbed
  - **Baseline (standard Ford part)**
    - 900/2.5 CPSI front monolith
    - 400/6.5 CPSI rear monolith
  - **MCCC-1 (PGM reduction)**
    - 900 CPSI front monolith (5% shorter, -25% PGM)
    - 400 CPSI rear monolith (5% shorter, -25% PGM)
  - **MCCC-2 (900 CPSI monolith replacement)**
    - 400/6.5 CPSI front monolith (-5% PGM)
    - 400 CPSI rear monolith (5% shorter, -9% PGM)
  - All aged to 100,000 miles, 3 tests per prototype

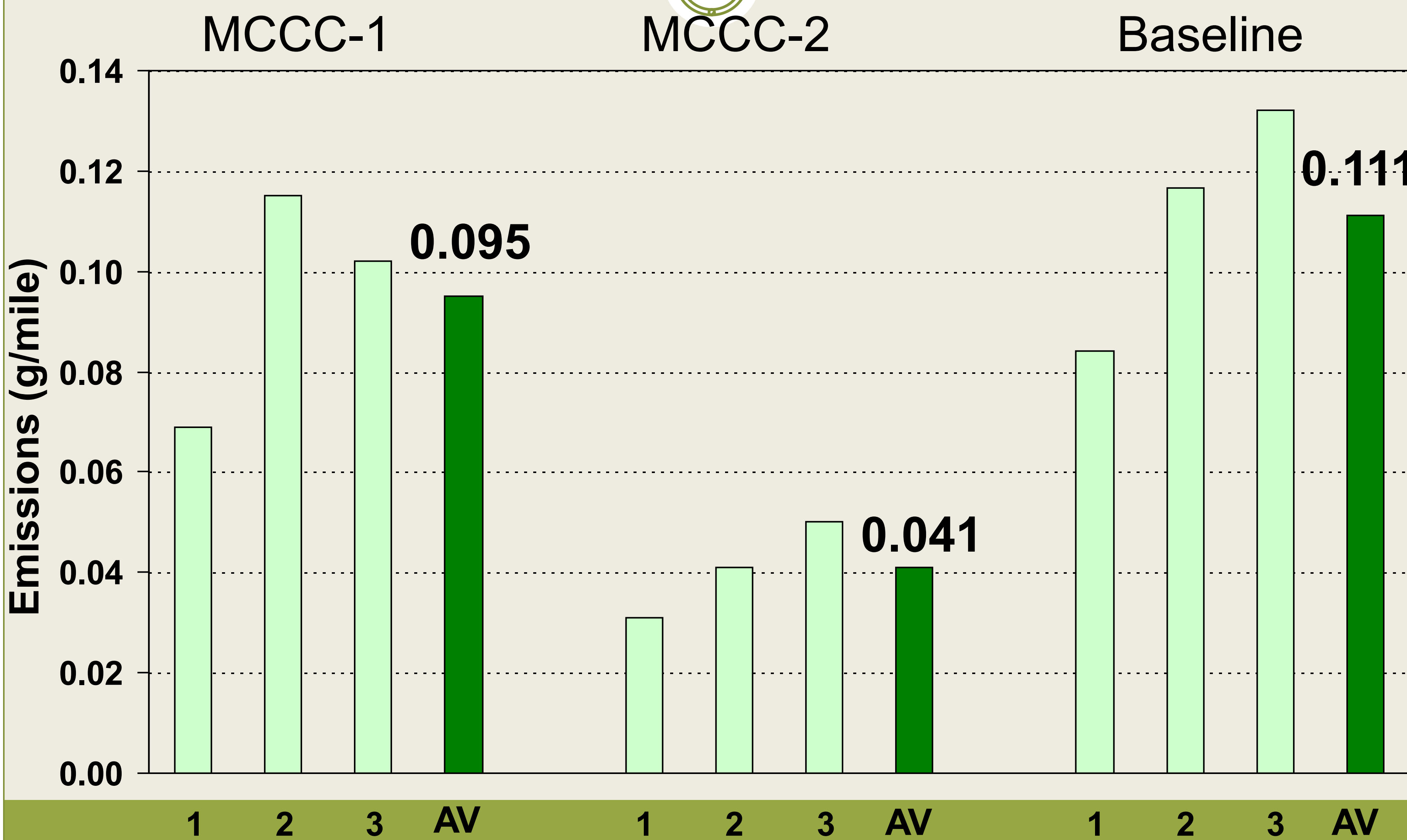
OEM Proof-of-Concept Testing
FTP NOx Bag Emissions



OEM Proof-of-Concept Testing
US06 Emissions Data



OEM Proof-of-Concept Testing HwyNOx Emissions Data

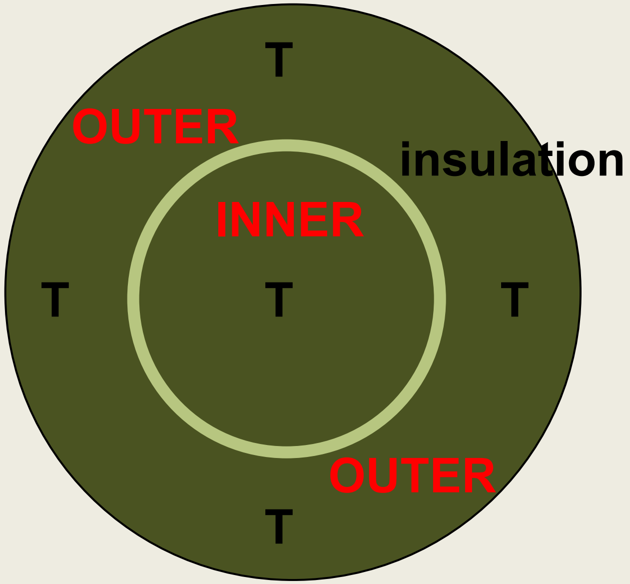


Emissions Testing Summary

- Ford Edge Duratec 3.5L testbed
  - **MCCC-1 (PGM reduction prototype)**
    - 5% shorter, -25% PGM
    - Slightly better emissions across the board
  - **MCCC-2 (900 CPSI monolith replacement)**
    - 400 CPSI front monolith, -6% PGM
    - Slightly higher hydrocarbon and CO emissions
    - Major NOx reduction (-10% FTP, -23% US06, -63% HwyNOx)

Thermal Management Testing

- **MCCC design goals:**
  - **Improve light-off performance within inner zone**
  - **Improve heat retention within outer zone**

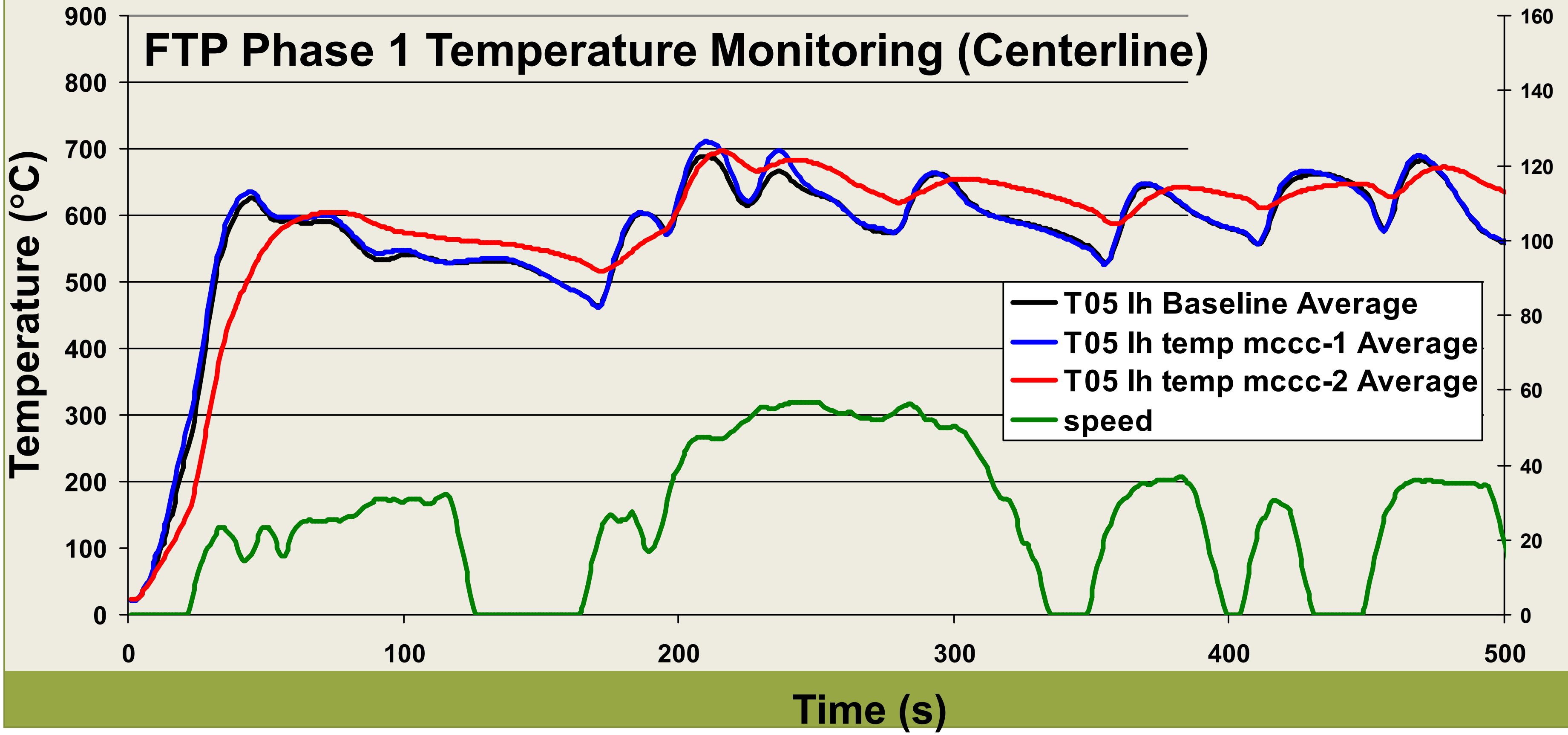


T – Thermocouple position

- **Temperature monitoring carried out within each zone**
- **5 thermocouples were inserted into the monolith**
- **1 T/C on the centerline (in the inner zone) and 4 T/Cs in the outer zone**

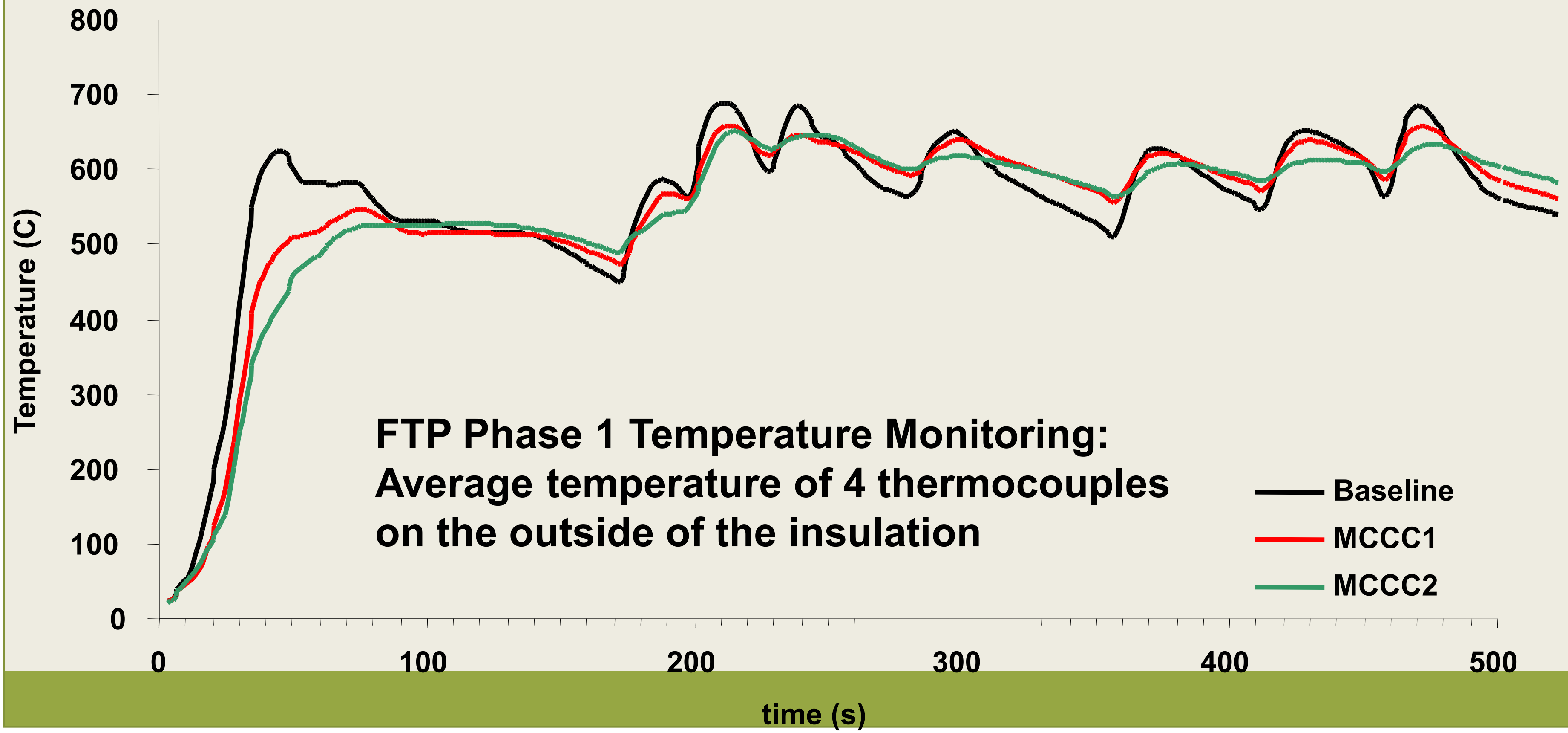
Thermal Management Testing
Inner Zone Temperature Profiles

- 900/400 MCCC-1 exhibits marginally faster light-off
- 400/400 MCCC-2 exhibits superior heat retention



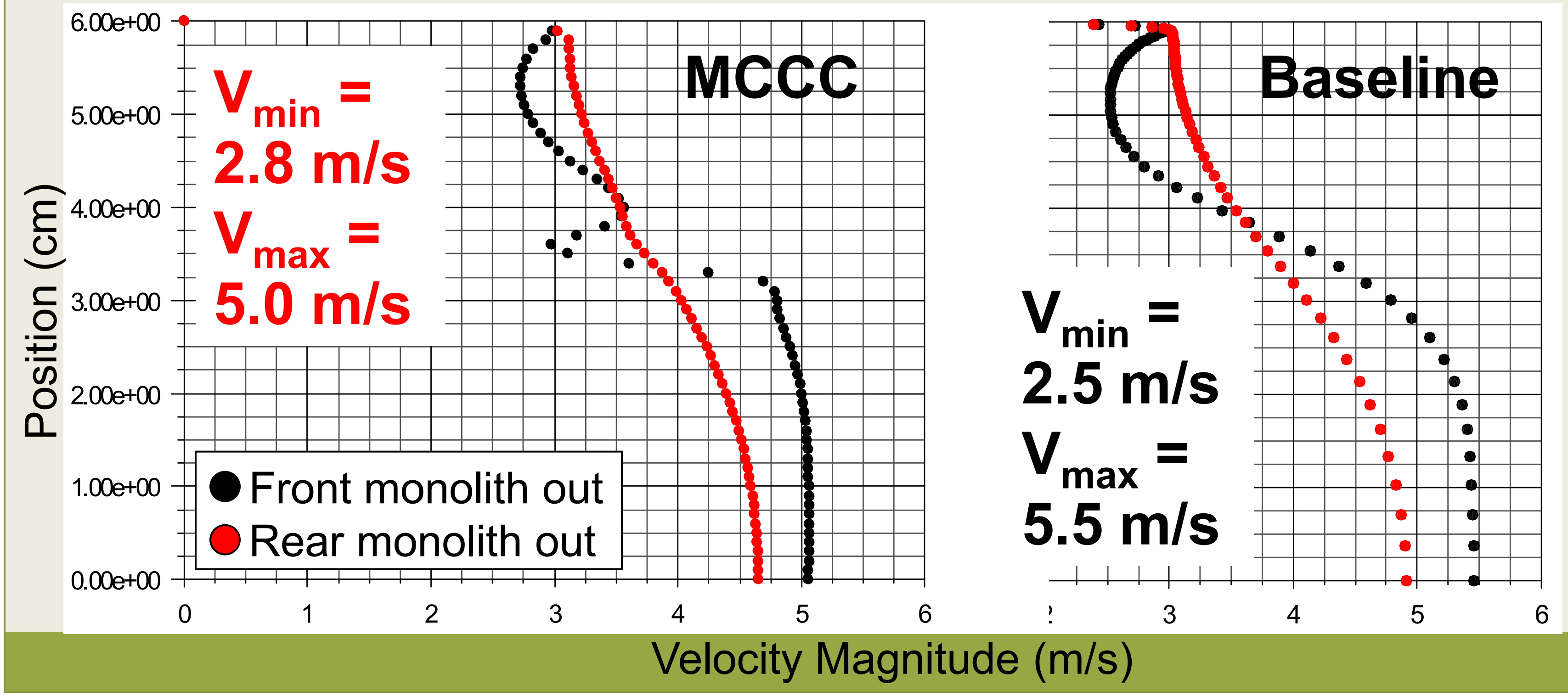
Thermal Management Testing
Outer Zone Temperature Profiles

- Outer zone of MCCC monolith acts as a heat sink during idle and stop – enhancing heat retention
- Helps overall emissions – particularly NOx

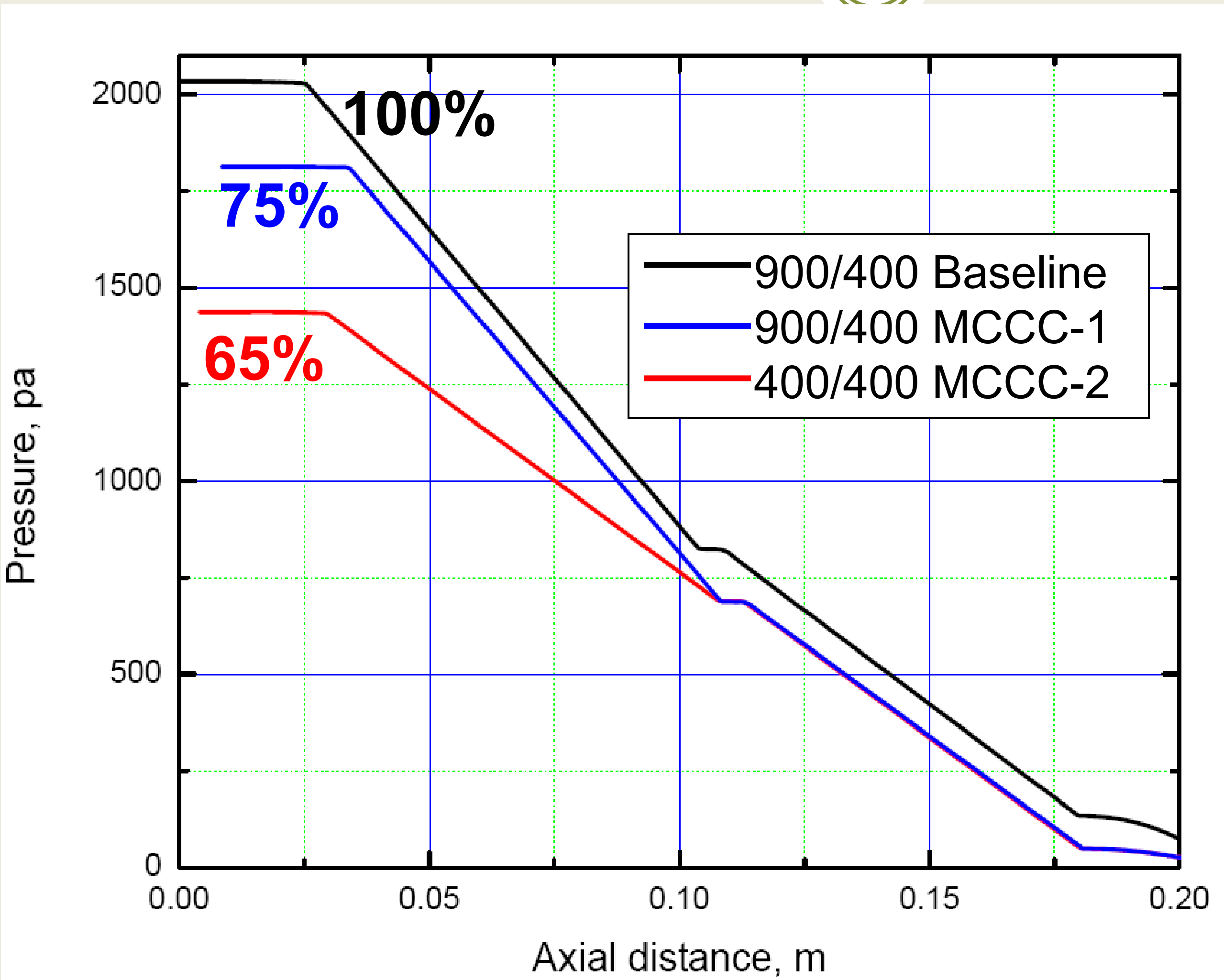


Improved Exhaust Gas Distribution

- Effects velocity distribution across monolith face
- Reduces backpressure – improves fuel economy
- Flattens residence time distribution thereby improving catalytic conversion efficiency



CFD Modeling Supports Lower Backpressure



- CFD modeling
- Static Pressure
- Fluent 12.1
- Medium Load

MCCC Conclusions

- Enhances thermal characteristics for catalytic converter monoliths
  - Continued emission reduction during idle and stops
- Lower backpressure through better exhaust gas distribution
  - Improved fuel economy
- Uses shorter length monoliths and reduced PGM loadings
  - Cost savings
- Improves emission performance (particularly NOx)
  - 400/400 MCCC emission performance matches standard 900/400
- Cost competitive with current catalytic converter technology

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