RDE Challenges for Instrument Manufacturers & Outlook on PEMS PN

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AECC Technical Seminar on Real-Driving Emissions (RDE)

Brussels, 29. April 2015

PEMS Applications

Off Road - Various | Light Duty | Heavy Duty

PEMS Development Timeline

AVL M.O.V.E PEMS

2010

2014

HORIBA
Automotive Test Systems

2014

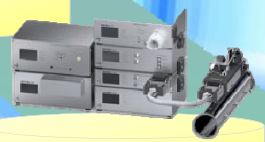
2014

2002

2004

2006

SEMTECH Product Development



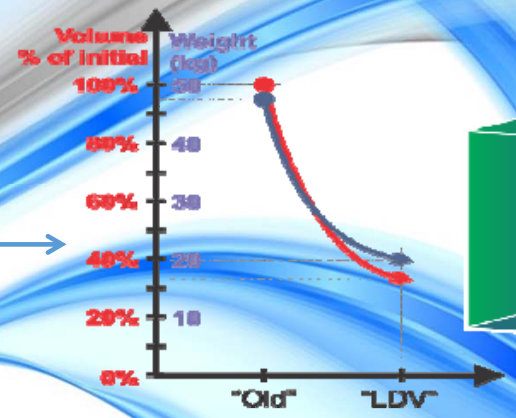
2011

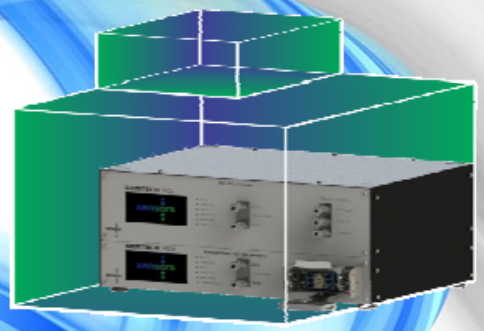
2014

RDE-LDV PEMS Criteria/ Challenges

KEY Features Include:

1. Regulatory Compliance
2. Size, Weight and Power
3. Ease-of-Use, Fast Installation
4. Reliability (MTBF, MTTR)
5. Automation of Tasks (e.g. Warm-up, Span, Linearity)
6. Flexibility (configuration, HD – LD, inside –outside)
7. Support (repair, data processing, test route design, etc.)
8. Integration with other devices, 3rd party equipment, test cells





RDE-LDV ANNEX IIIA

VERIFYING REAL DRIVING EMISSIONS

The following criteria are currently covered by the draft RDE-LDV procedures amending Regulation (EC) No 692/2008. For the last 4 years, this set of specifications has been a moving target making it difficult for R&D:

- Exhaust Flow Measurement
- GPS, ECU Connection, Auxiliary Components
- Vehicle speed

NOx (or NO and NO2), CO, CO2, THC

- Drift, Linearity, Accuracy, Precision, Noise, Zero Response, Rise Time, Span Response Drift
- Permissible Tolerances

PN

Outlook on PEMS PN

Dr. David Booker, Sensors, Inc.

Examples of PEMS PN Solutions

CPC Based Solutions

- Modular Heated Line (SS core)
- Primary Diluter (10-20:1
- Heated Catalyst (250-300 C)
- Secondary Diluter (50-100:1)
- Mixing CPC (n-Butanol)

Other Manufacturers Developing PN PEMS Solutions

HORIBA Automotive Test Systems

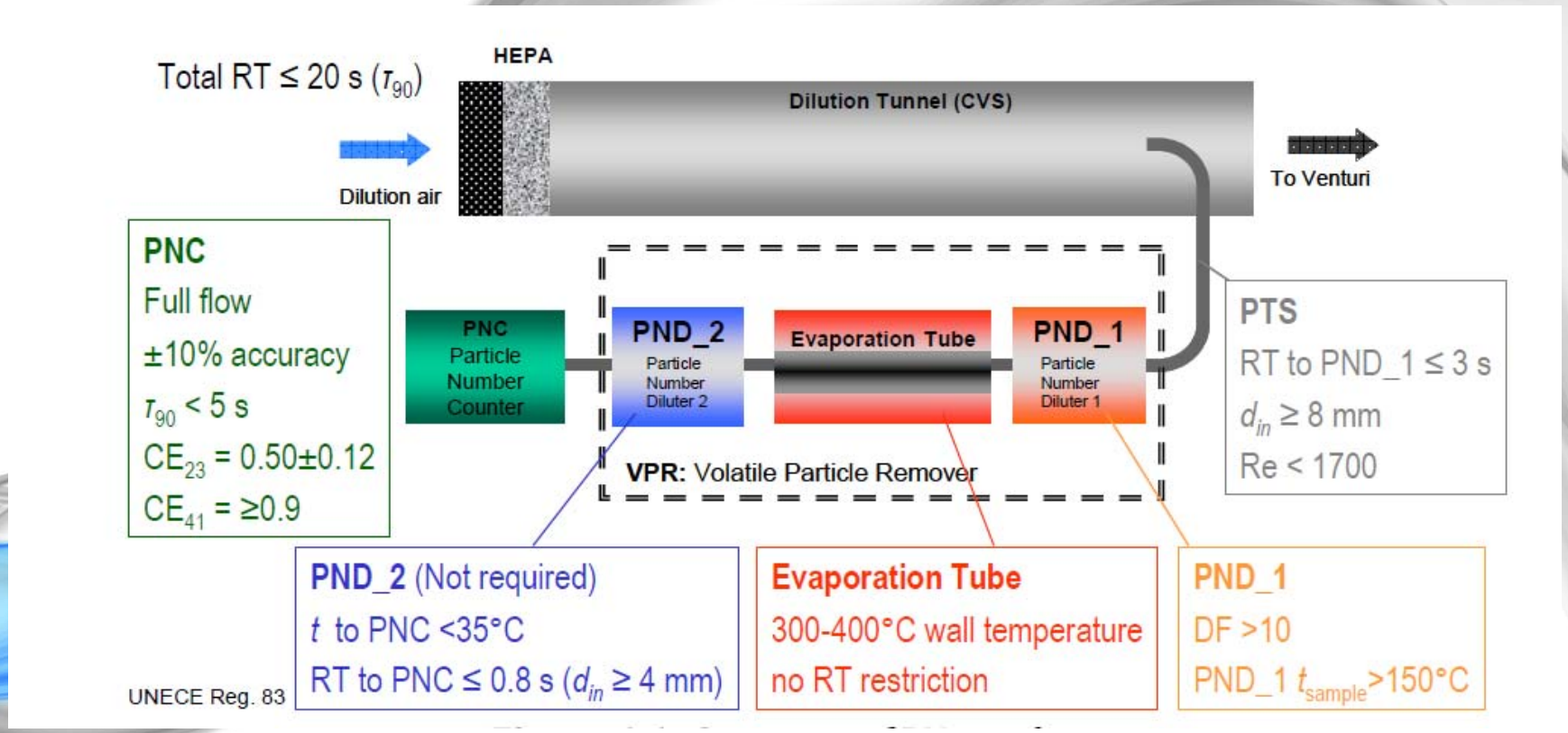
pegasor

AVL

Automotive Industry Products AIP MAHA

Diffusion Charge Systems

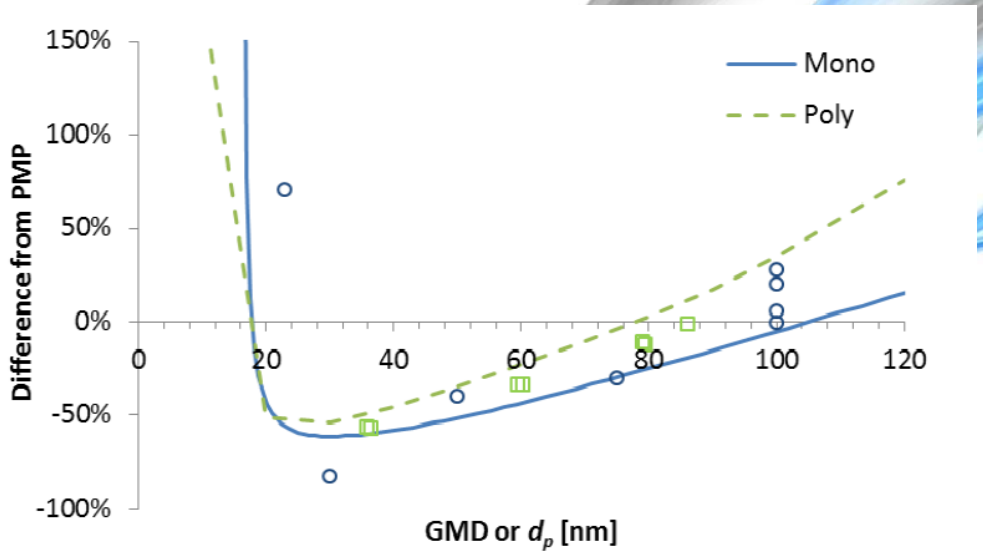
PN EU Regulation



Source - Feasibility study on the extension of the Real Driving Emissions (RDE) procedure to Particle Number (PN), JRC 2014

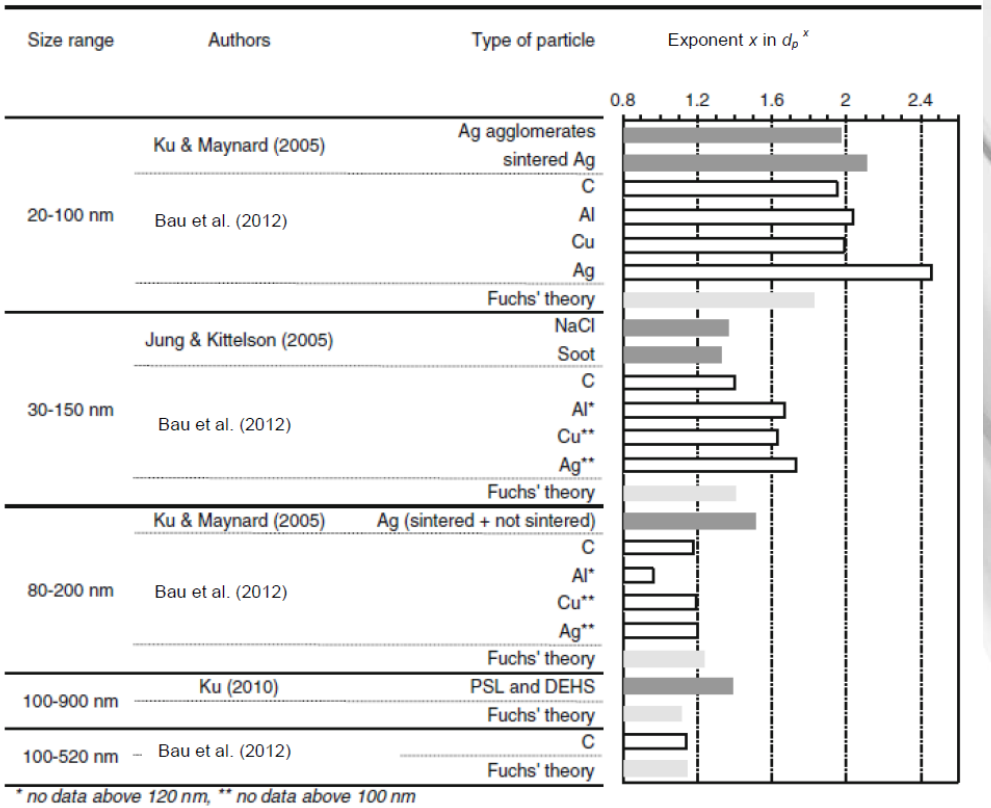
Technology: -Diffusion Chargers (DC) or Condensation Particle Counters (CPC)

- Particle Size - CPC dp^0 (CPC) or DC dp^1.4
- Morphology, Existing charge, Dielectric constant … etc



Source - Feasibility study on the extension of the Real Driving Emissions (RDE) procedure to Particle Number (PN), JRC 2014

Relationship between active surface area and particle size. From Bau et al. (2012).



SEMTECH PN PEMS (with CPC Module)

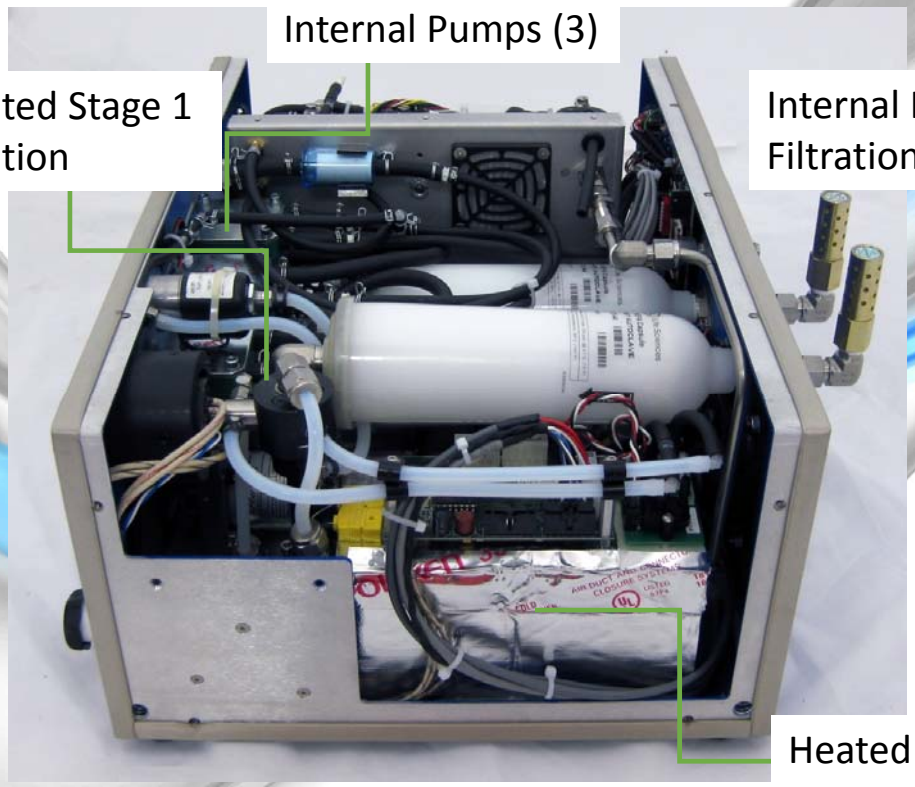
Specifications

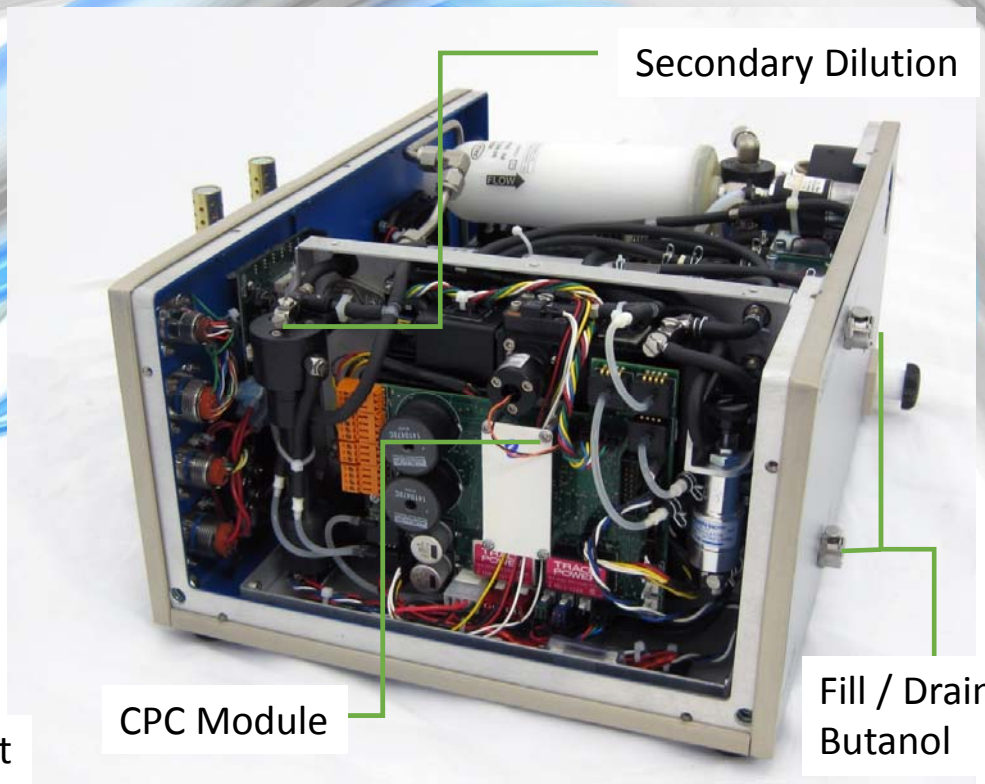
Power: 12 VDC, 200W
Size: W 430 x H 180 x D 310 mm
Weight: 15 kg

Key Components:

- Modular Heated Line (SS core)
- Primary Diluter (10-20:1
- Heated Catalyst (250-300 C)
- Secondary Diluter (50-100:1)
- Mixing CPC (n-Butanol)
- ECOSTAR and SEMTECH RDE/LDV compatible

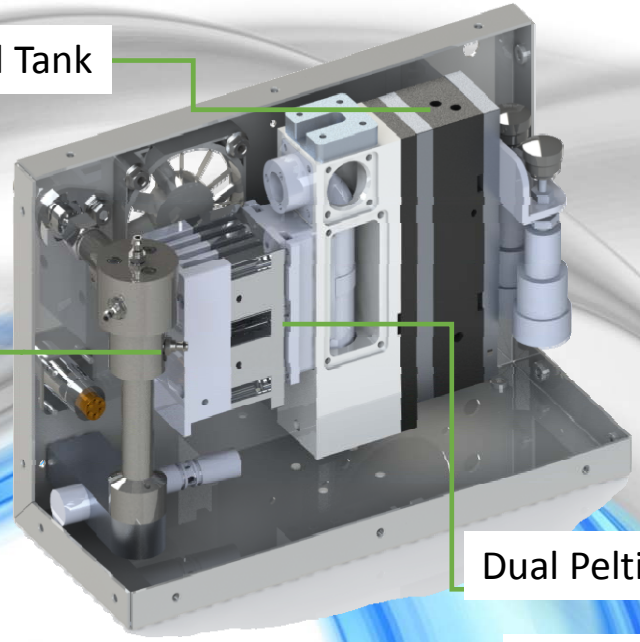
Integrated CPC Module

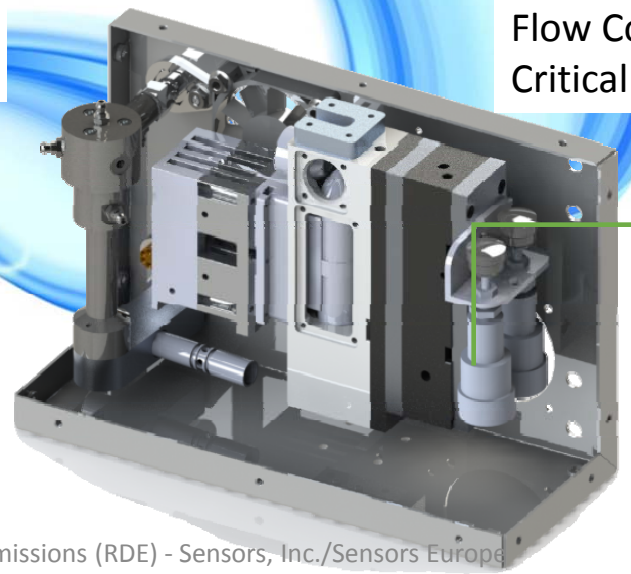




CPC Development

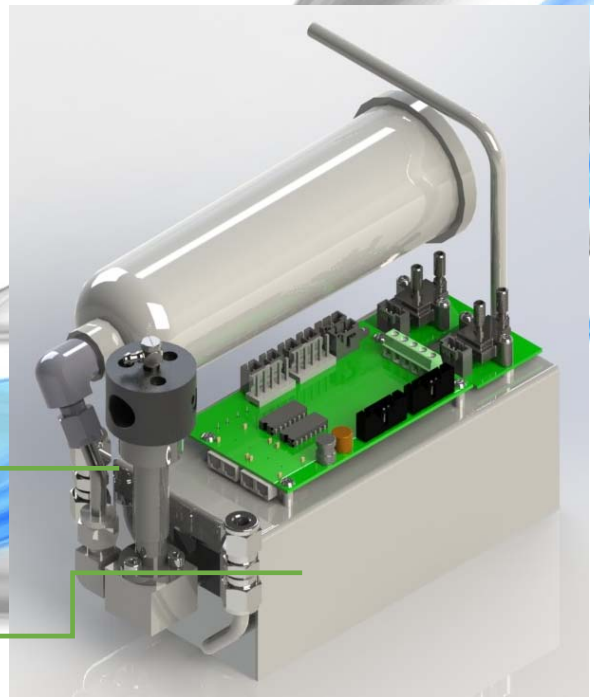
- Vibration and thermally stable
  - Dual Peltier Condenser cooler
- Small Butanol tank (<5 ml)
  - Exhaust controlled venting
  - No Butanol optics contamination
- Critical Flow for stable flow control
- Operates exclusively in single count mode





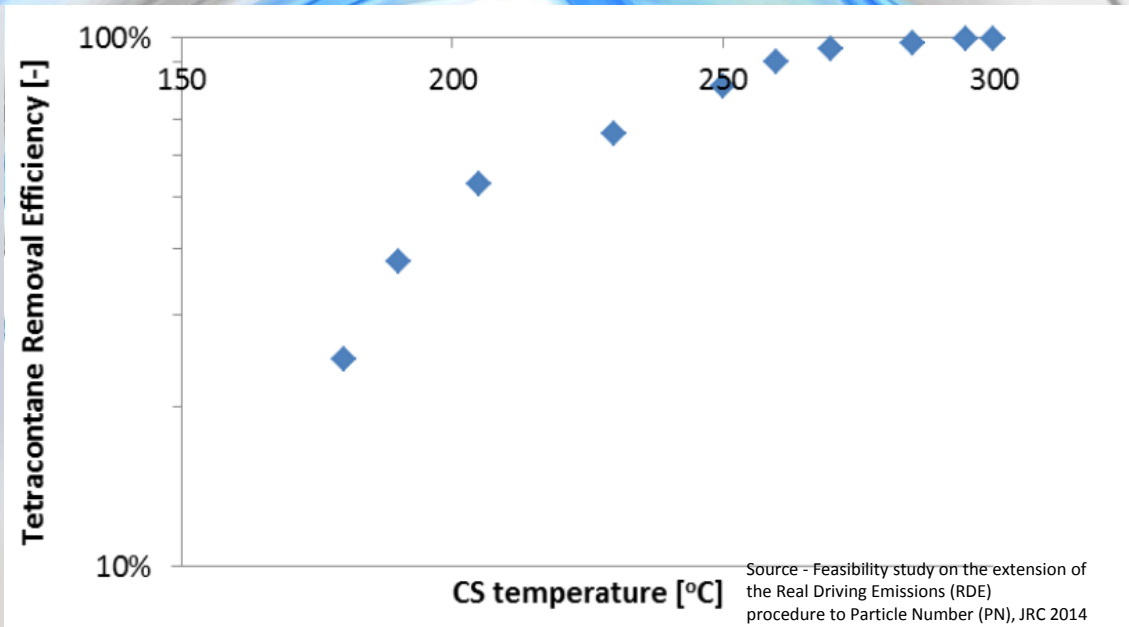
VPR-Catalyst – Experimental Verification

- PMP Specifications met, 67% penetration at 10 nm



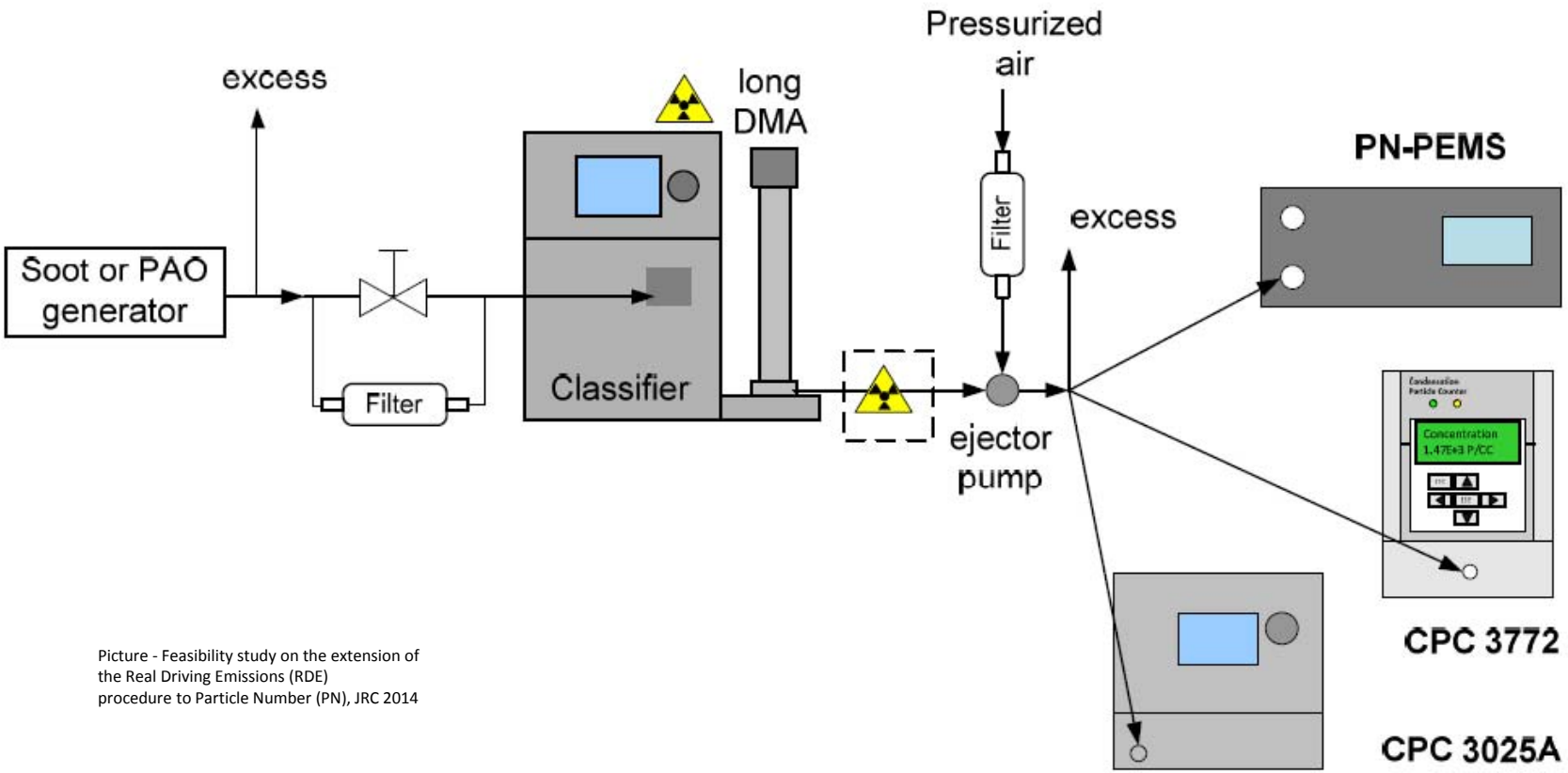
Stage 1 Heated Dilution
10-20:1

Heated Catalyst
250-300 C



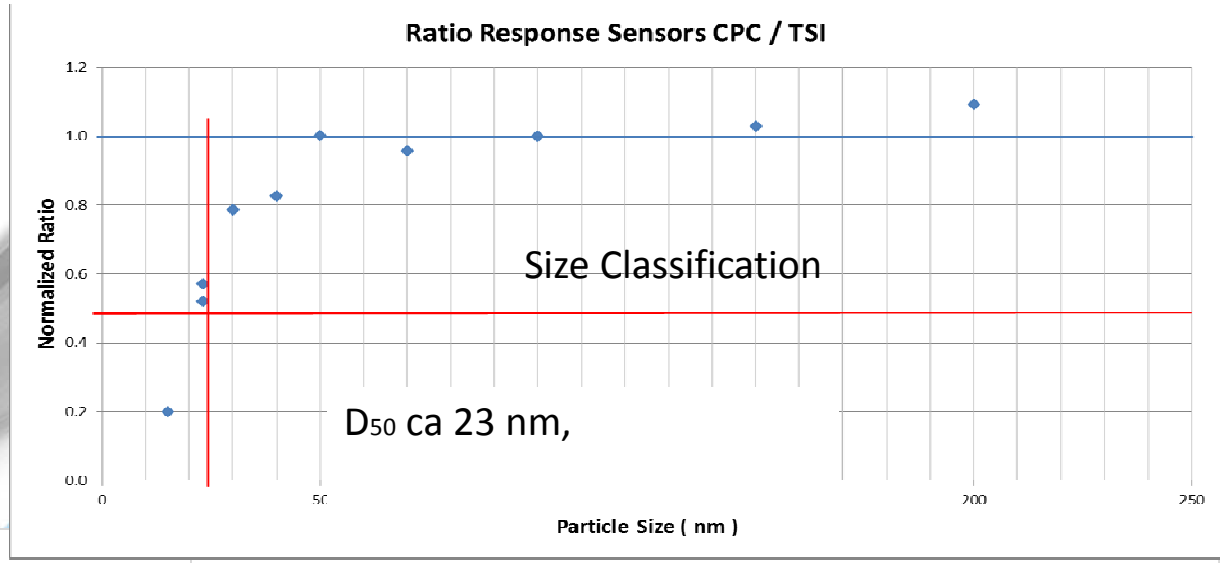
Source - Feasibility study on the extension of the Real Driving Emissions (RDE) procedure to Particle Number (PN), JRC 2014

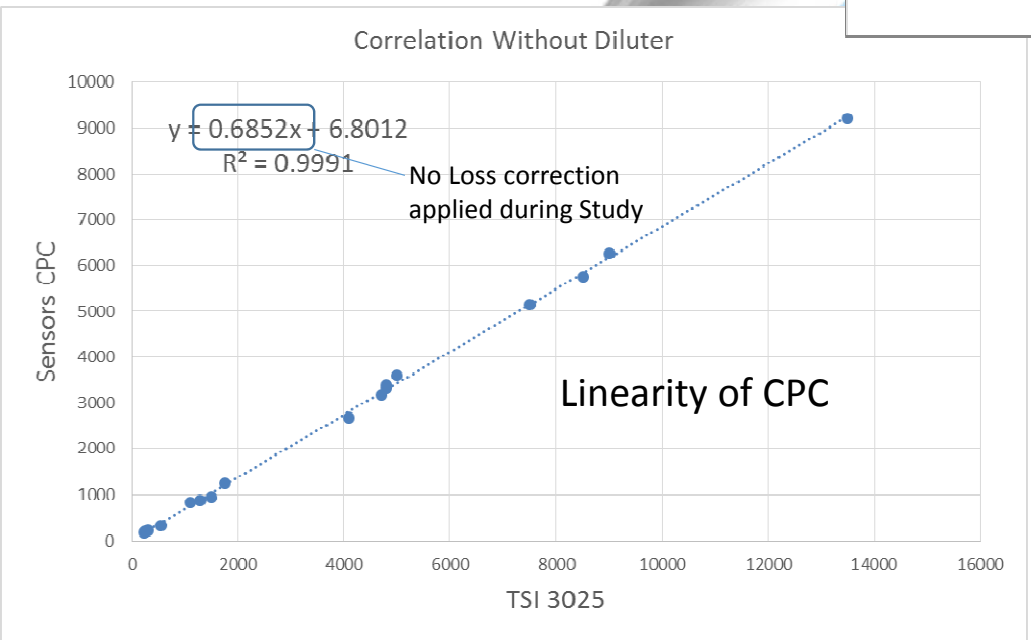
Laboratory Characterization Test Set-Up

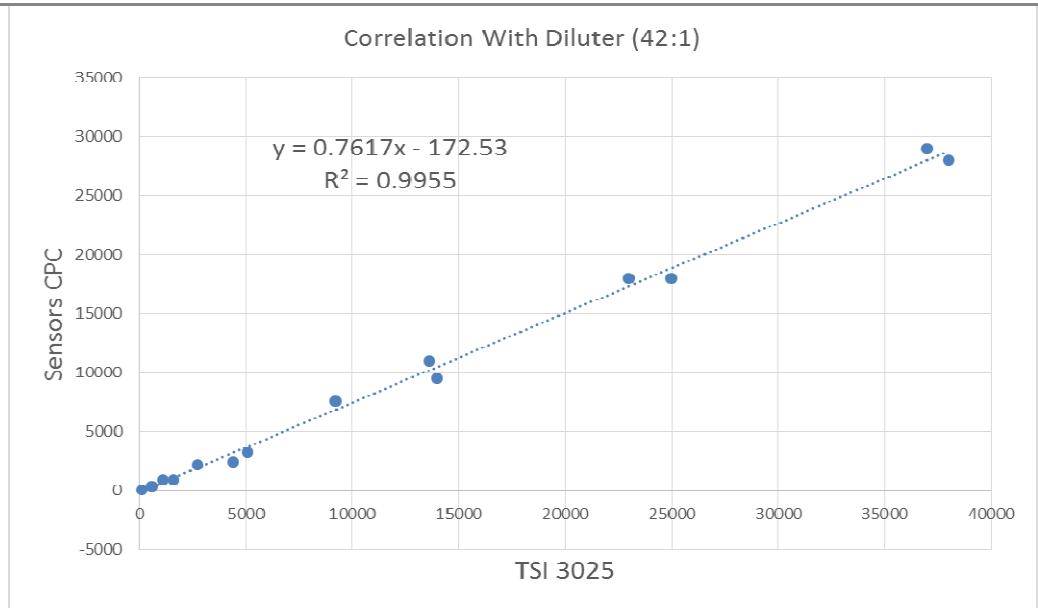


Picture - Feasibility study on the extension of the Real Driving Emissions (RDE) procedure to Particle Number (PN), JRC 2014

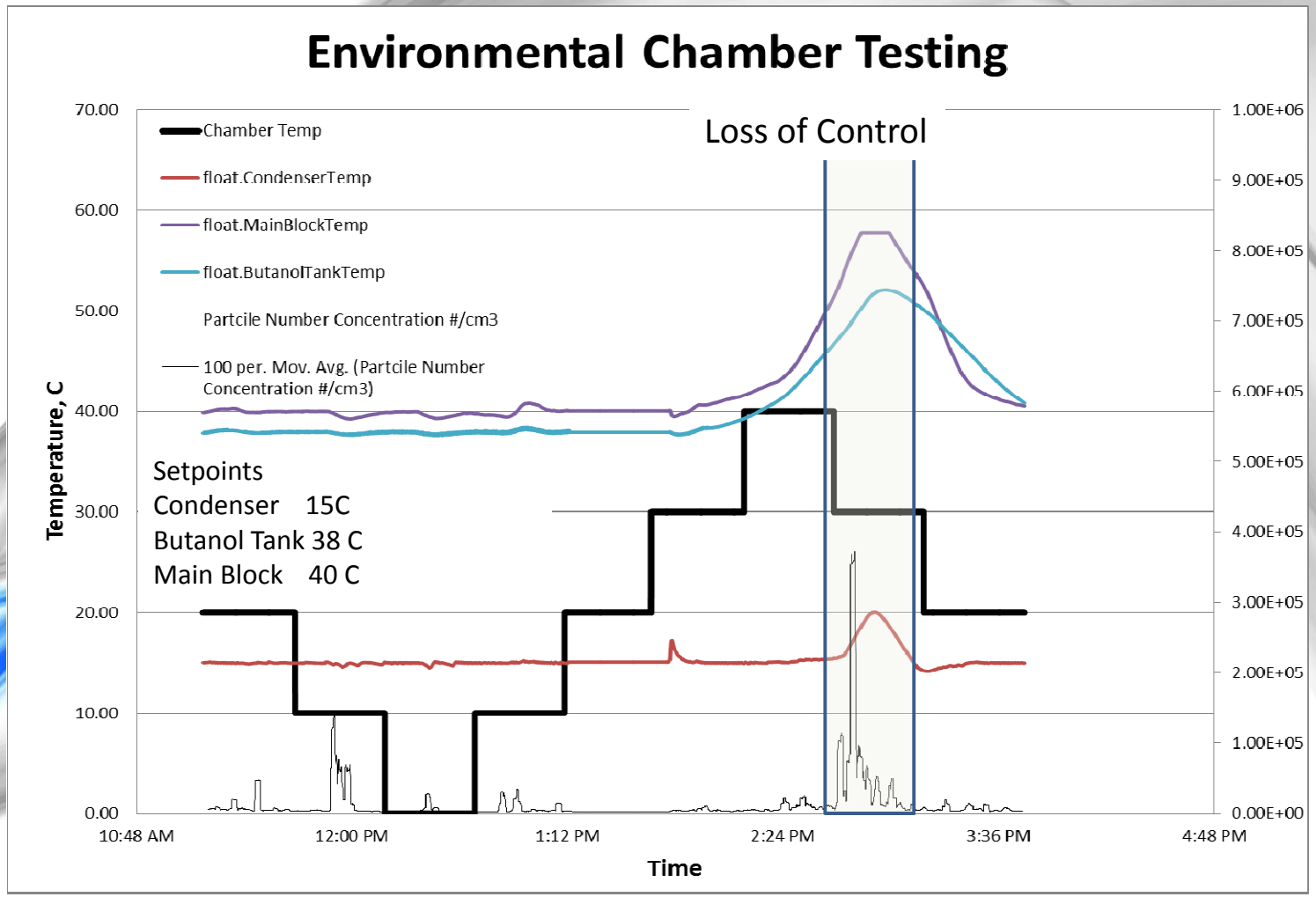
Aerosol Laboratory Evaluation







Environmental Chamber Testing (0-10-20-30-40-30-20 C)



Summary

Condenser, Butanol Tank and Main Chamber remain controlled over the temperature range 0 to 30 C

Action Item

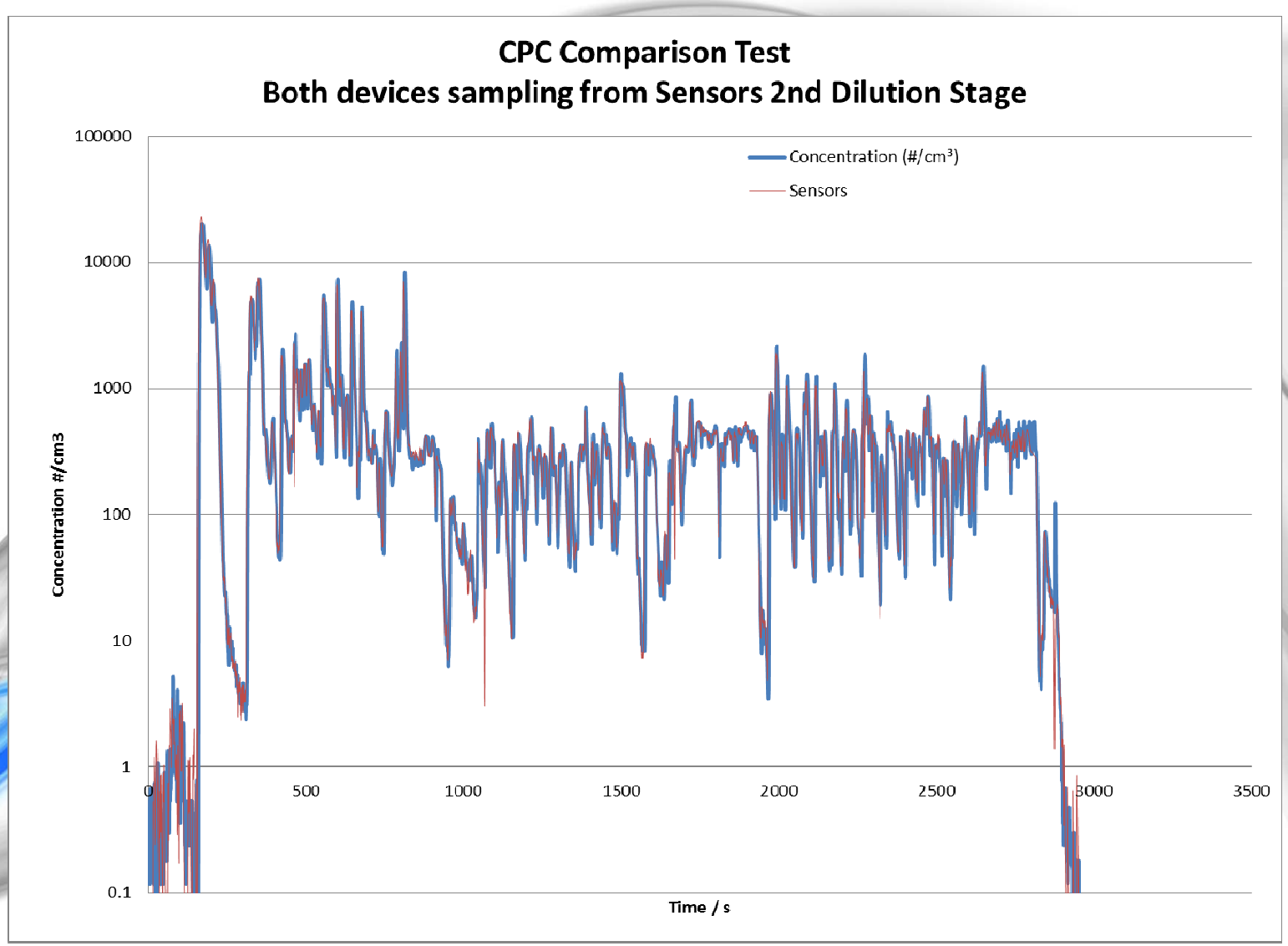
Additional cooling required to meet 40 C ambient specification

Dyno Testing

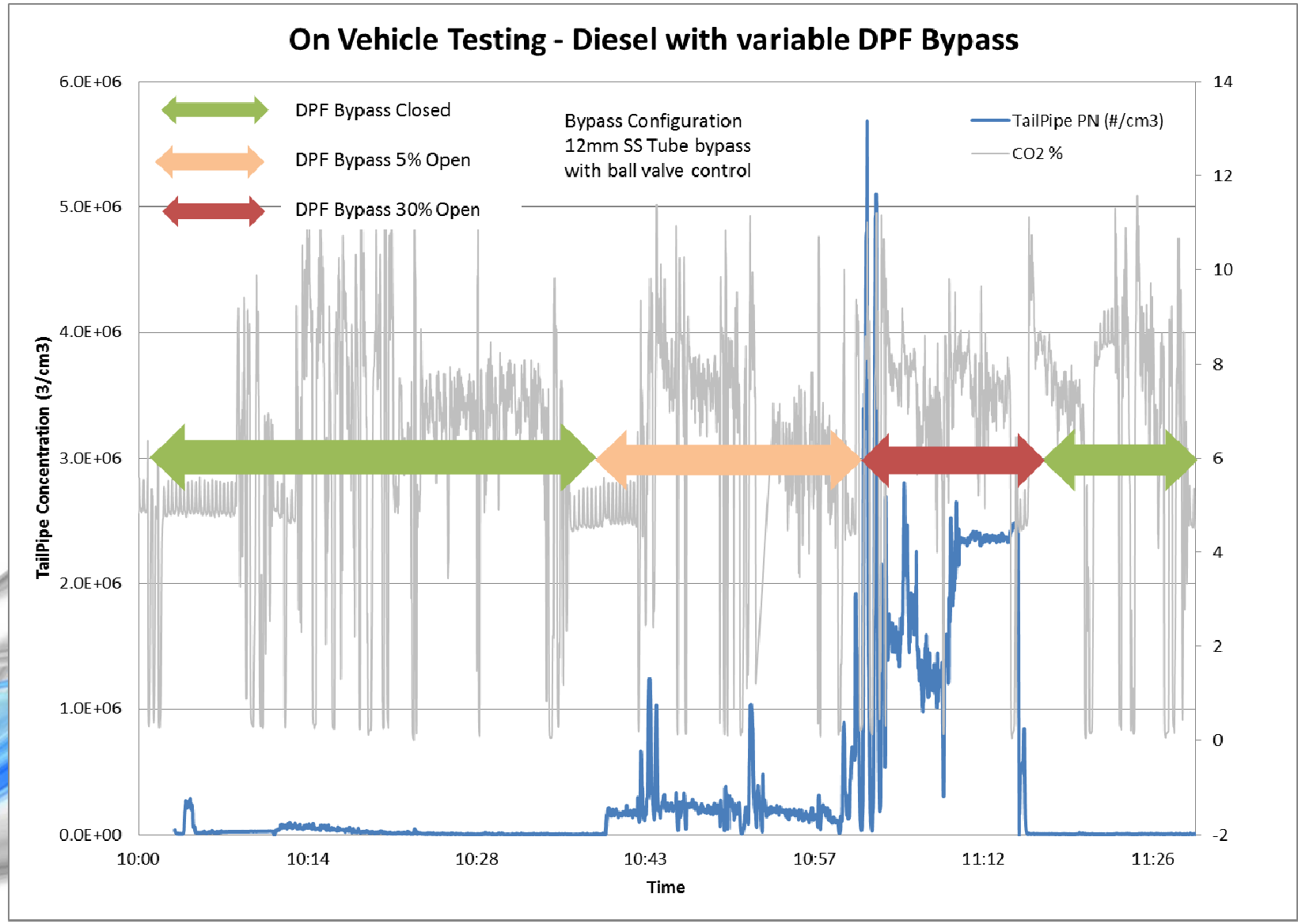
Data obtained at JRC ISPRA

CPC Evaluation:

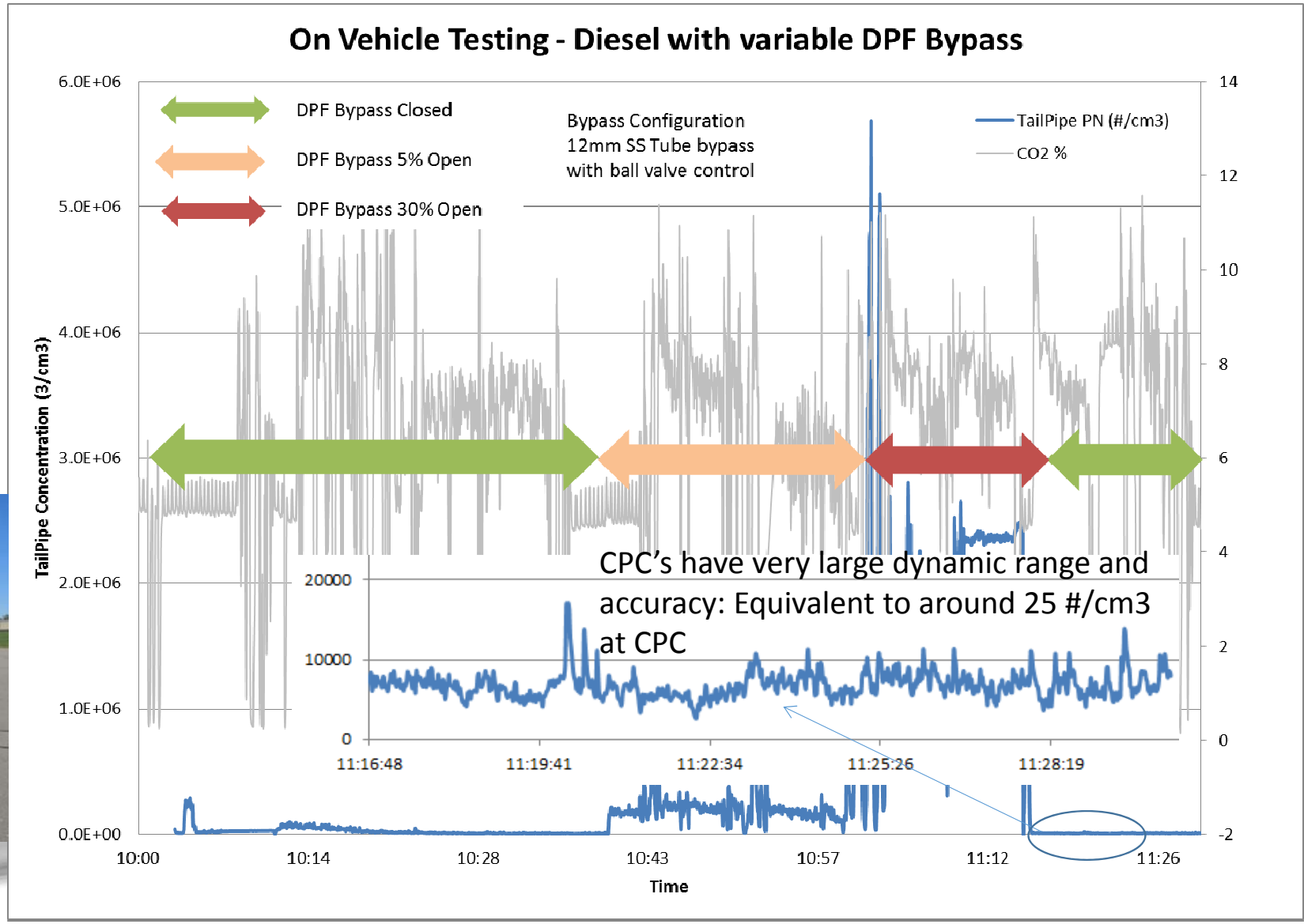
Exhaust of CPN module measured simultaneously by TSI CPC and Sensors CPC during chassis dyno testing



On Vehicle Testing



On Vehicle Testing



Observations – Against PMP Calibration Protocol

• Absolute losses are on the order of 25%.	Correction factor applied re PMP
• d50 should increase slightly (ca 30nm), because when the penetration is normalized to 1, the d23nm goes >50% and to match PNP systems	Will add diffusion screen
• Heated line introduces some losses (10% at 100 nm 40% at 15 nm).	Will investigate further
• Polydisperse checks showed a good agreement with a simulated PMP system for GMDs between 35 and 80nm.	No action required
• No observable deterioration in performance during on-vehicle testing	Testing continues
• PMP Correlation testing (fuel, vehicle, cycle etc)	On-going
• Increase cooling in high Ambient temperature conditions to enable 0-40 C operation specification	Will investigate further

Thank You

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