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Gasoline particle emissions: real or artefact?

Particle Number Measurements of Gasoline Emissions: Genuine or Artefact?

Zurich 2001

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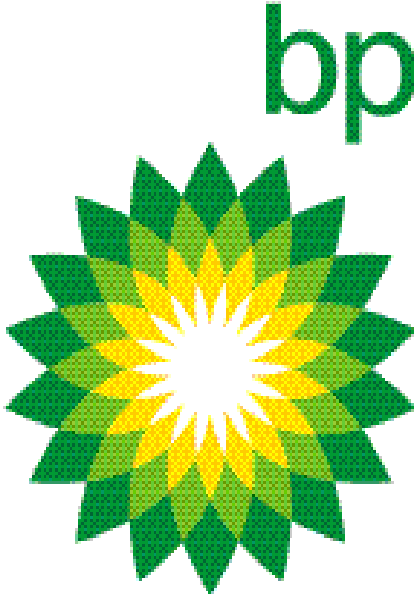


Background

- High particle number emissions from gasoline engines at high speed (120km/h) (SAE 982600)
- In house work on gas powered vehicles: high particle number emissions at high speed
- High numbers of nano-particles (sub 7nm) from a GDi vehicle at 120km/h (but not 100 km/h) (SAE 1999-01-3530)
- Literature (SAE 1999-01-1461) suggesting artefact formation in sampling system

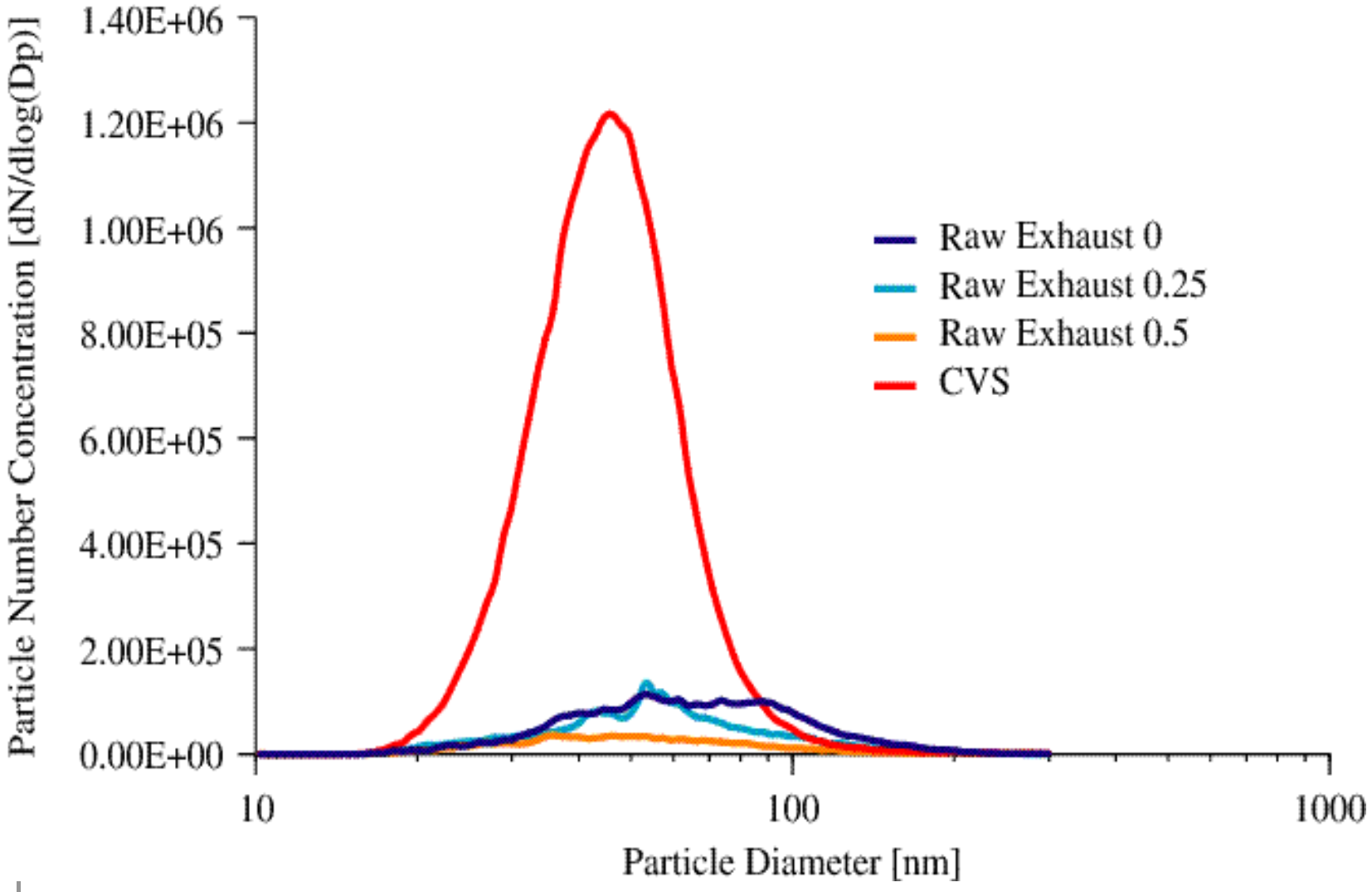
Aims of programme

- Indication that these small particles may have a common source
  - sampling system
  - lubricant
- Programme designed to address the latter: two lubricants of extreme composition (mineral oil vs synthetic) to investigate nature of gasoline particles
  - some preliminary testing on raw exhaust

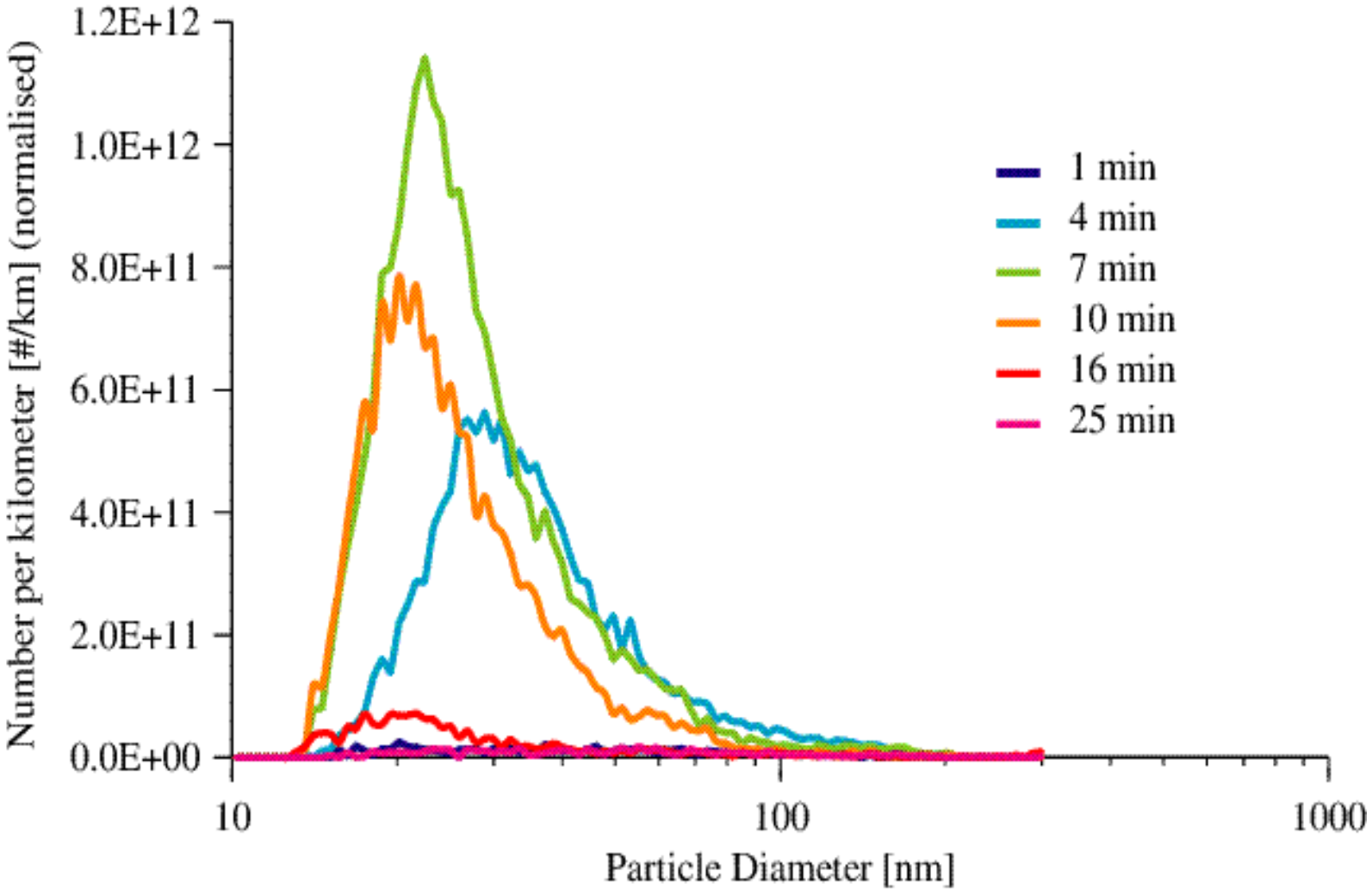
Test programme

- Vehicles
  - V1 – 1995, 5 valve/cylinder 1781cc - TWC
  - V2 – 1996, 2 valve/cylinder 1361cc - TWC
- Fuel
  - Representative of EN228 (1996)
- Lubricants
  - L1 – poly-alpha olefin; fully synthetic
  - L2 – standard mineral oil
- Particle measurement – SMPS/UPM

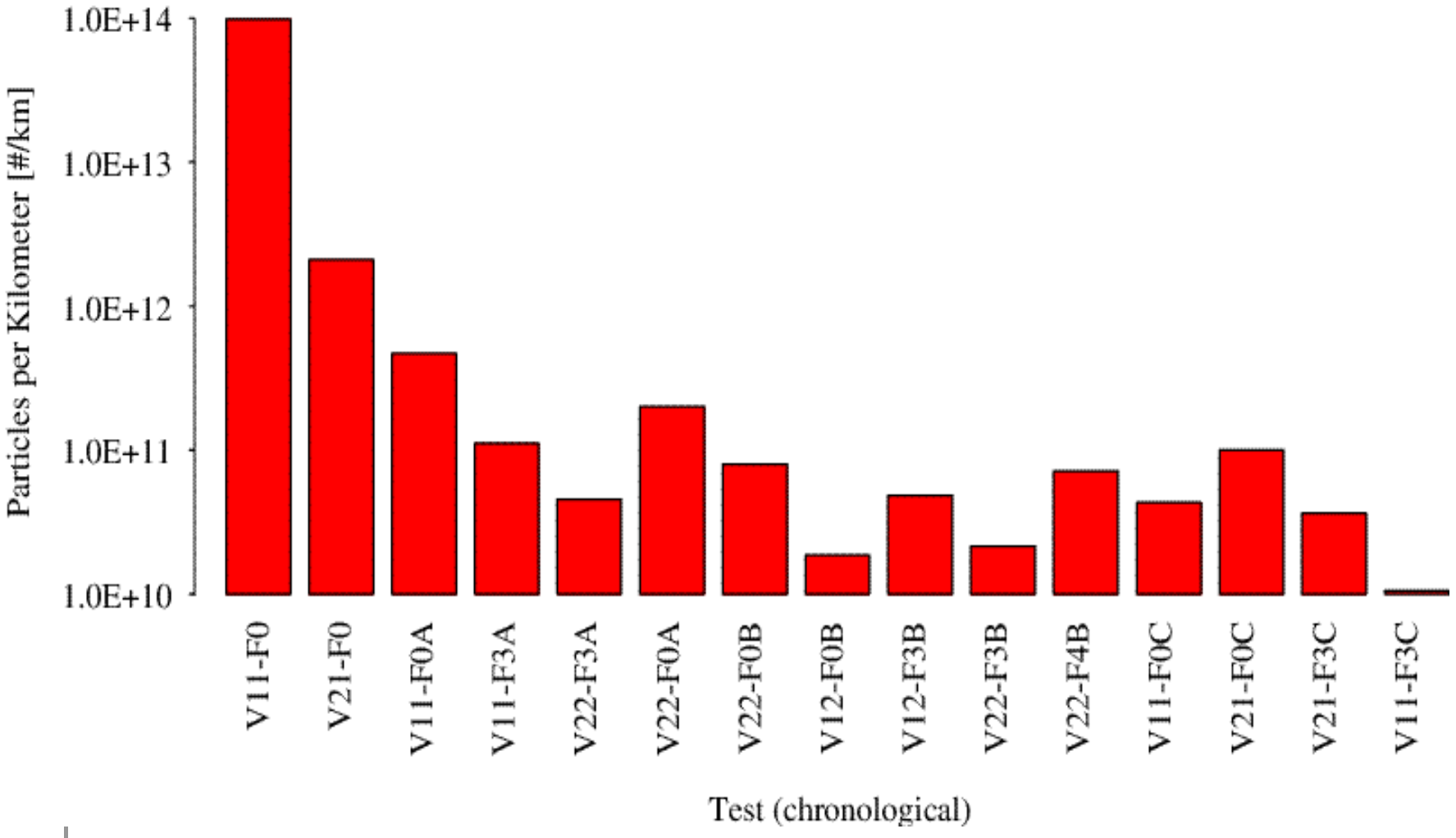
Tests on raw exhaust



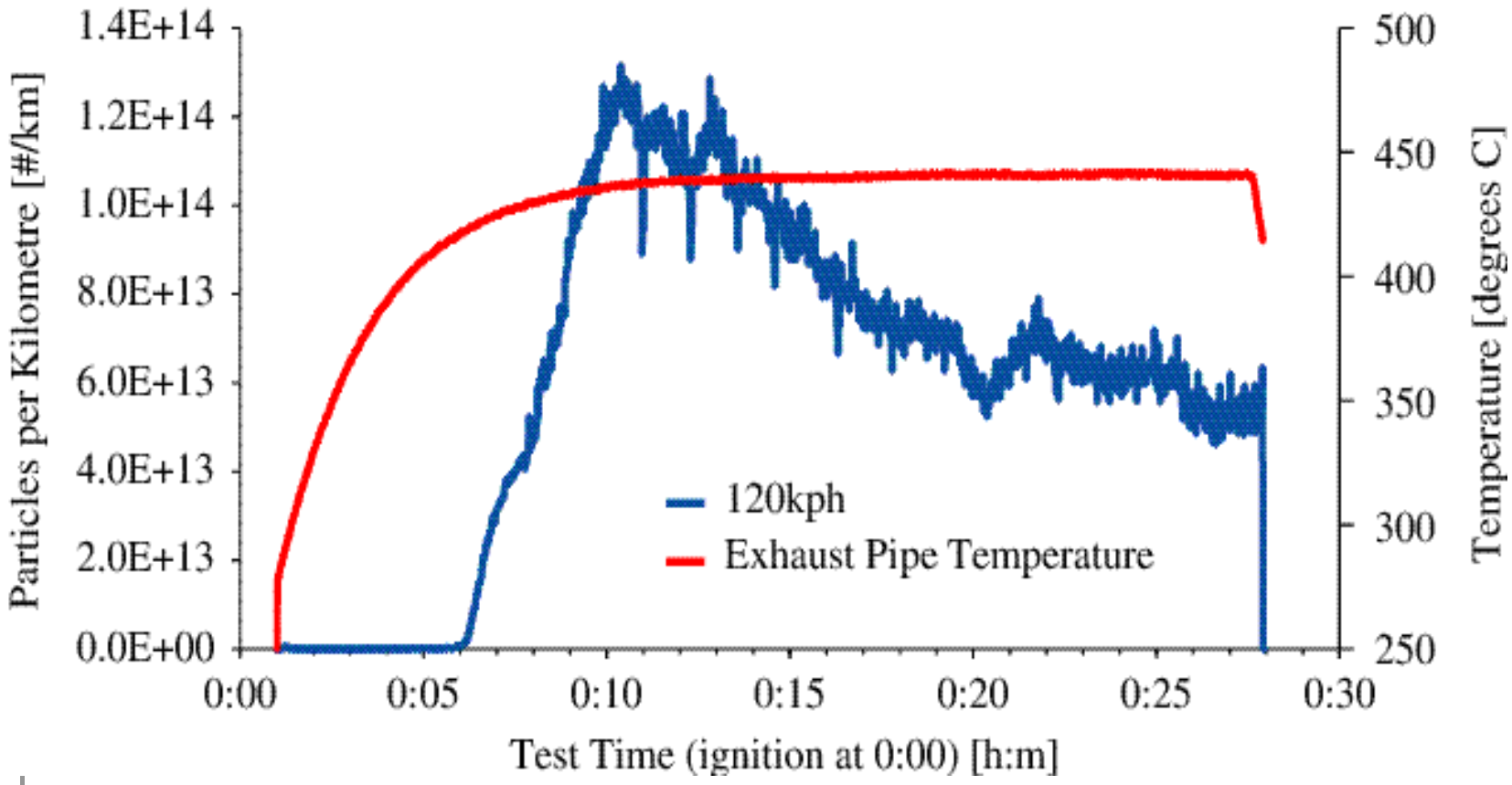
Stabilisation of furnace



Chronological order of testing



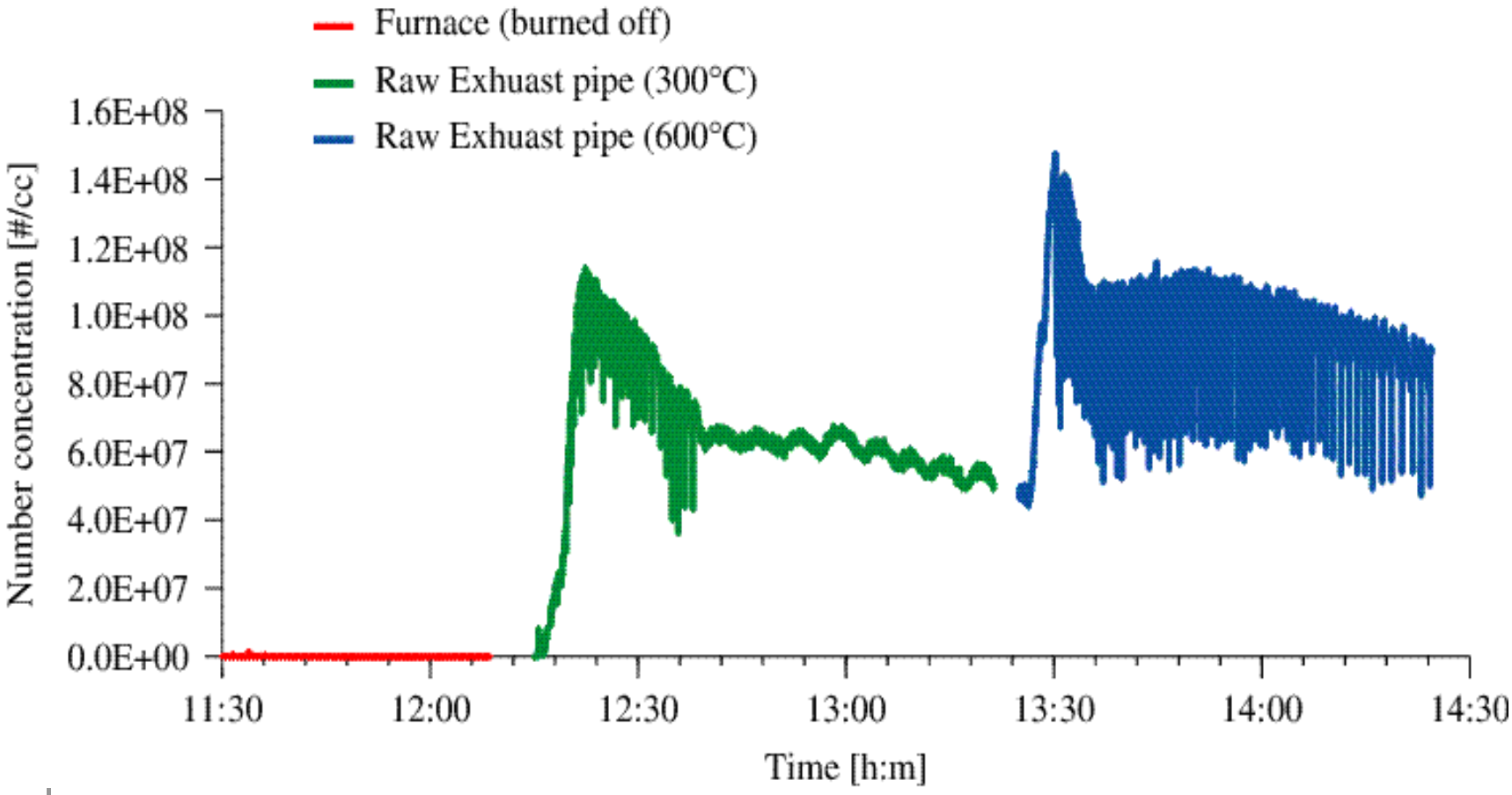
Particle emissions and exhaust-pipe temperature



Implications

- Data so far implied:
  - particles are seen in the sampling system that are not present in the exhaust
  - continual running at high speed was ‘clearing’ the system of particles
  - material appeared to be laid down on surfaces at cooler conditions with particle release appearing to be temperature related
- To test this last hypothesis, a section of old raw exhaust pipe was heated in the clean furnace

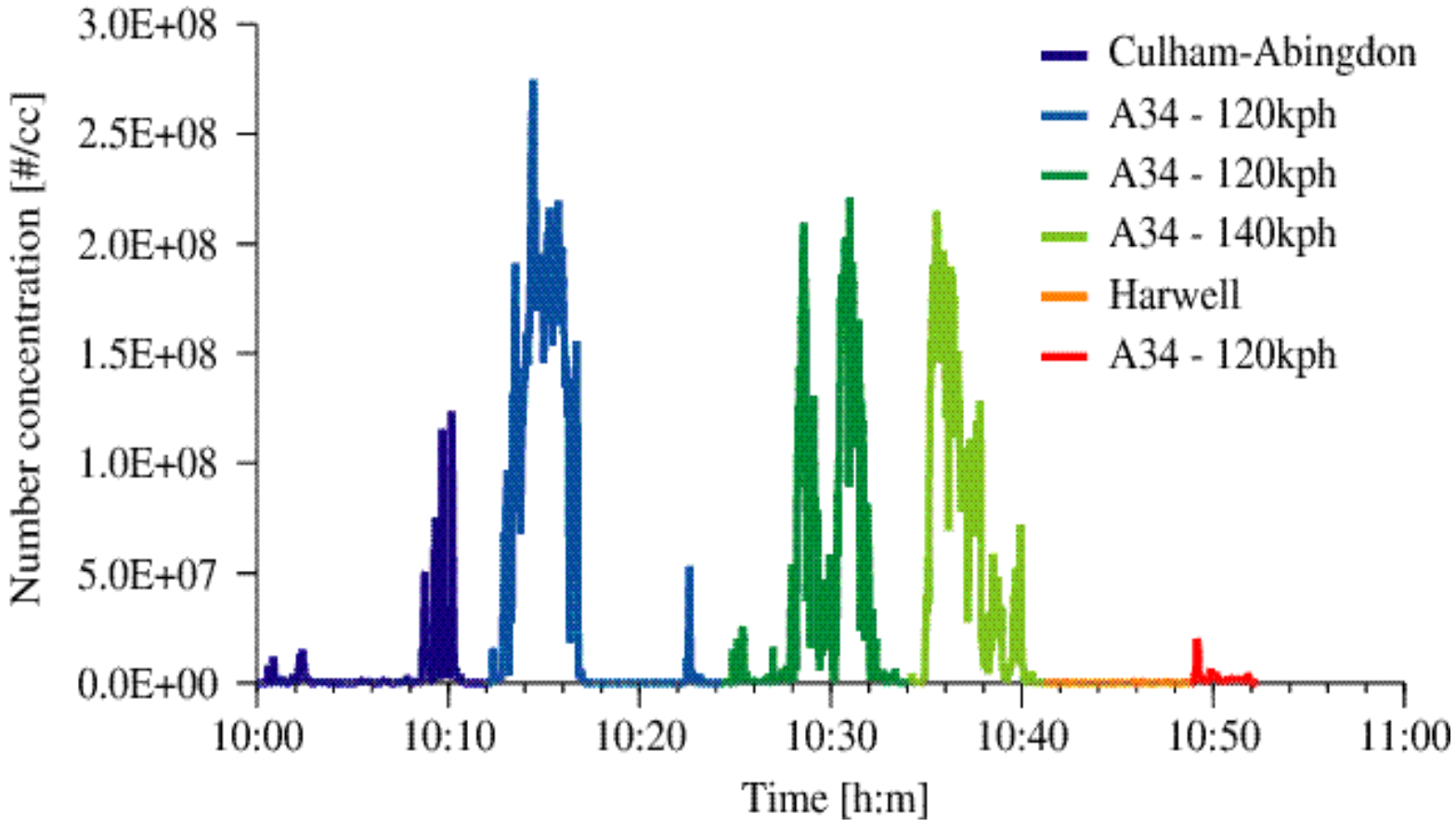
Tests on raw exhaust pipe



Summarising ...

- There now appeared to be enough information to suggest that not only is material laid down on cold sampling surfaces but also on the vehicle exhaust system itself
- Release of deposited material is related directly to temperature
- Temperature would be directly related to speed; this could be checked by on-road measurement

On-road tests



Conclusions (1)

- High concentrations of small particles have been measured from gasoline vehicles operating at high speeds
- These particles have been shown to be strongly linked to the temperature of both the exhaust and sampling system
- Material emitted from the engine is deposited on cool surfaces and released as particles as the temperature profile increases

Conclusions (2)

- Sustained periods of high temperature will ‘clean’ the system and reduce the number concentration to that measured at low speed
- Subsequent operation at progressively higher speeds will result in further release of deposited material
- The measurement of particle numbers is strongly dependent on the pre-history of both vehicle and sampling system
- There are serious implications for the measurement of gasoline particle emissions from vehicles operating on a chassis dynamometer