

Emissions from the European Light Duty Diesel Vehicle During DPF Regeneration Events

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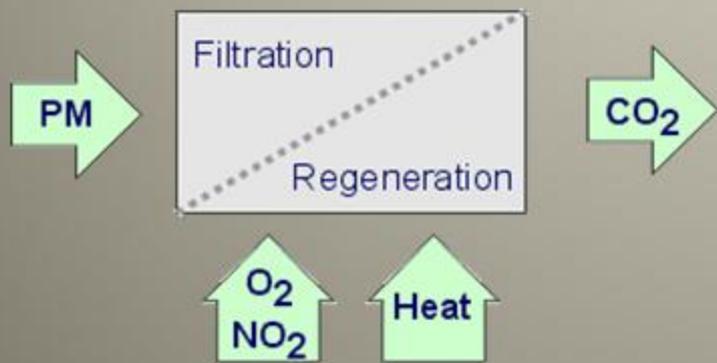
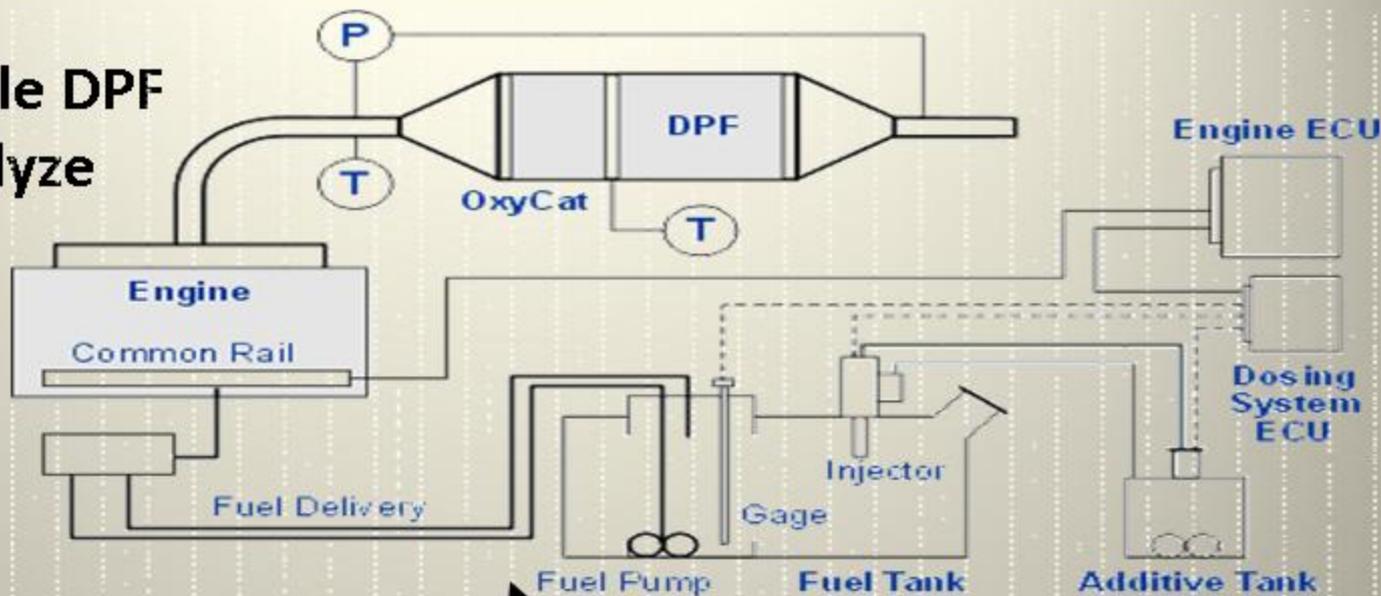


Outline of Presentation

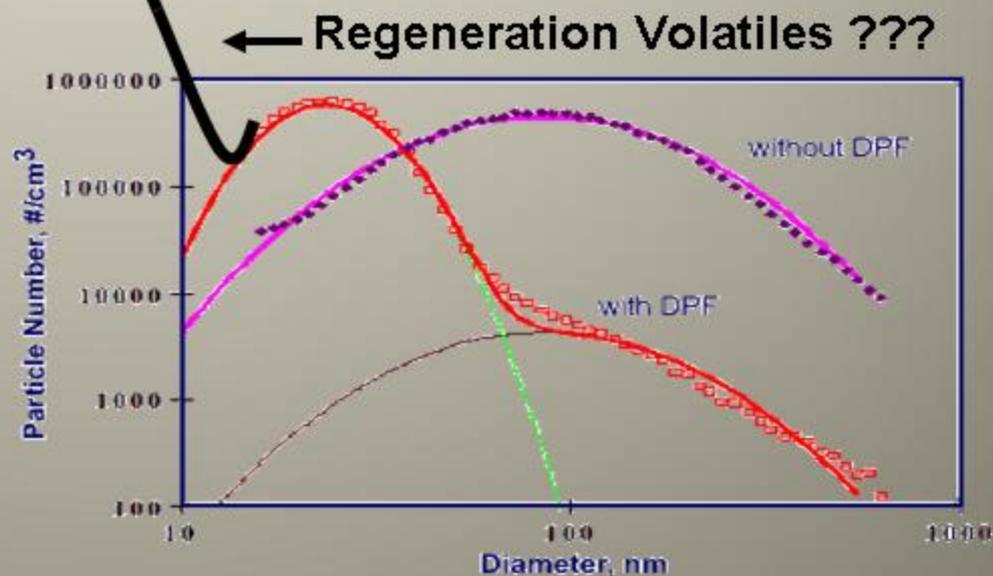
- **DPF's have to be regenerated periodically.**
- **The Golden Vehicle, GV, is regenerated when a DPF pressure drop occurs.**
- **An exhaust exotherm starts the catalytic regeneration process for the present vehicle.**
- **What are the characteristics of DPF regeneration?**
- **What are the changes in regulated emissions?**
- **What are the changes in unregulated emissions?**

The Golden Vehicle and the Testing Setup

Golden Vehicle DPF Actively Catalyze With Cerium

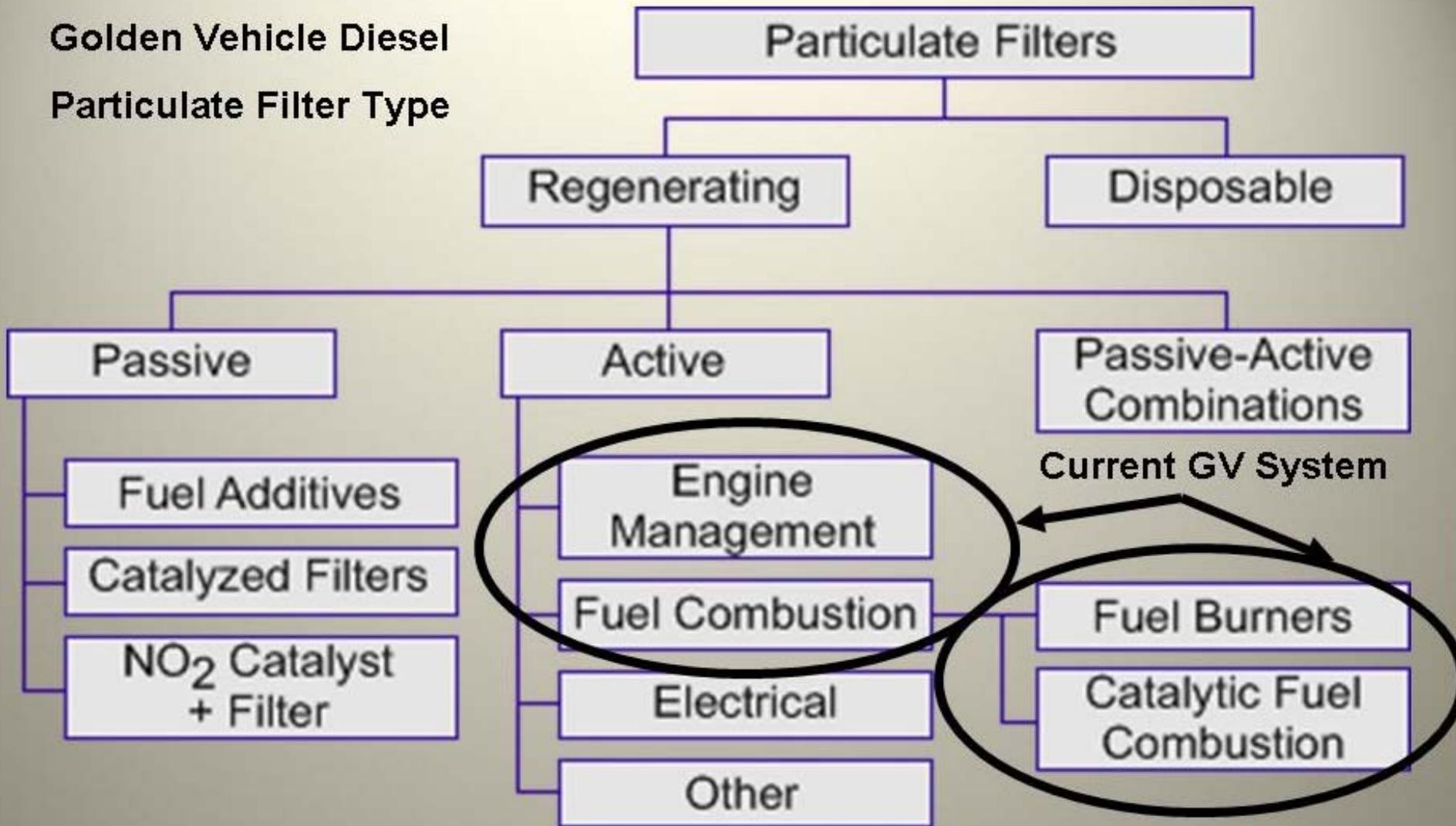


Ideal Performance

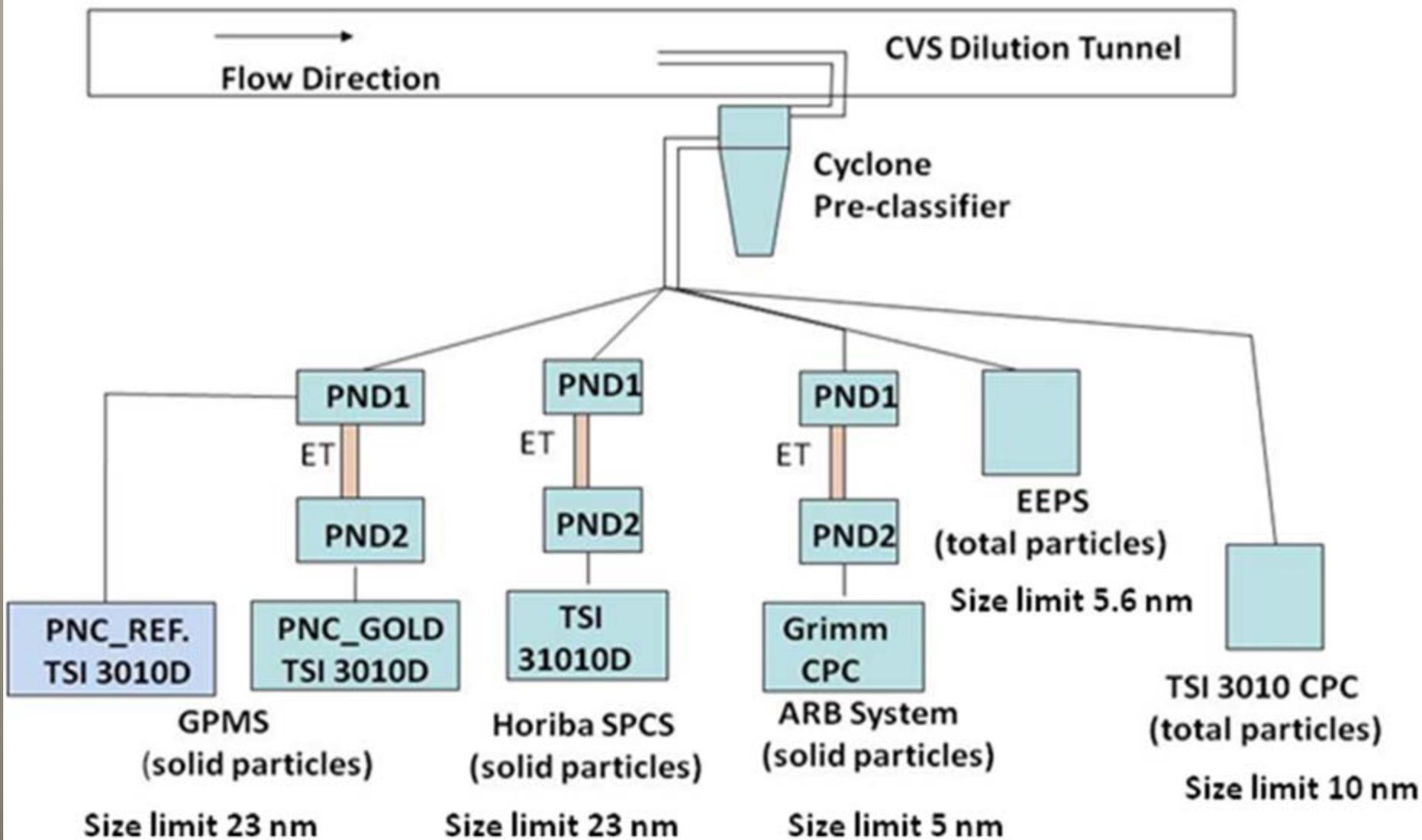


Experimental Performance

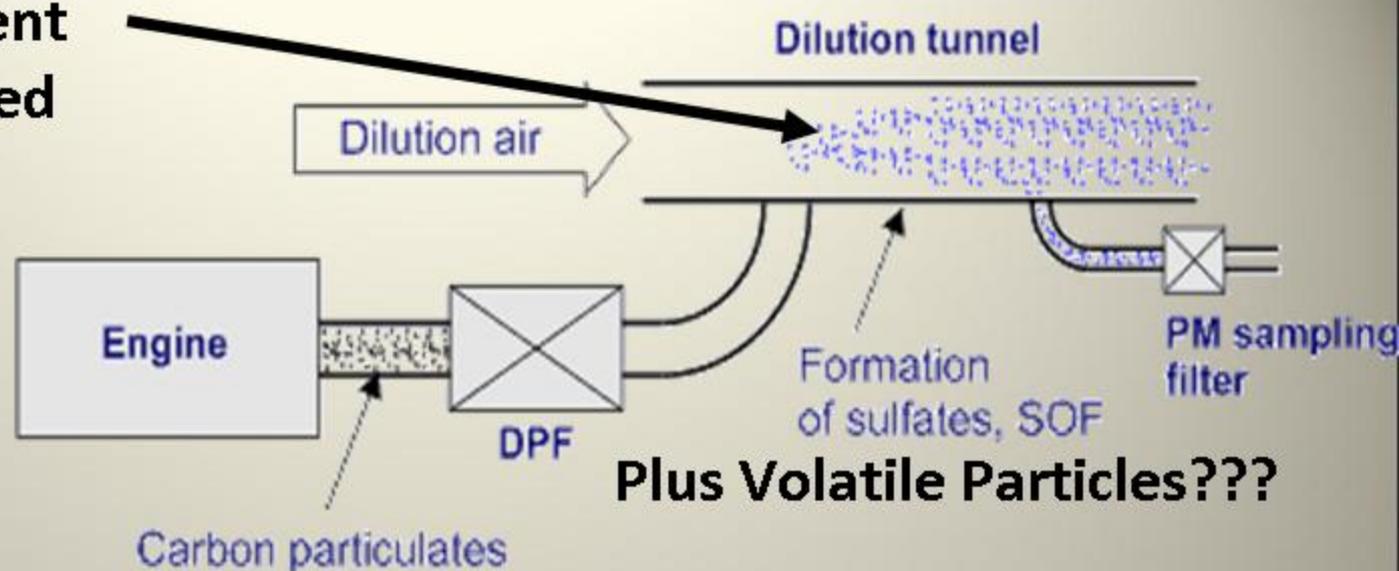
Golden Vehicle Diesel
Particulate Filter Type



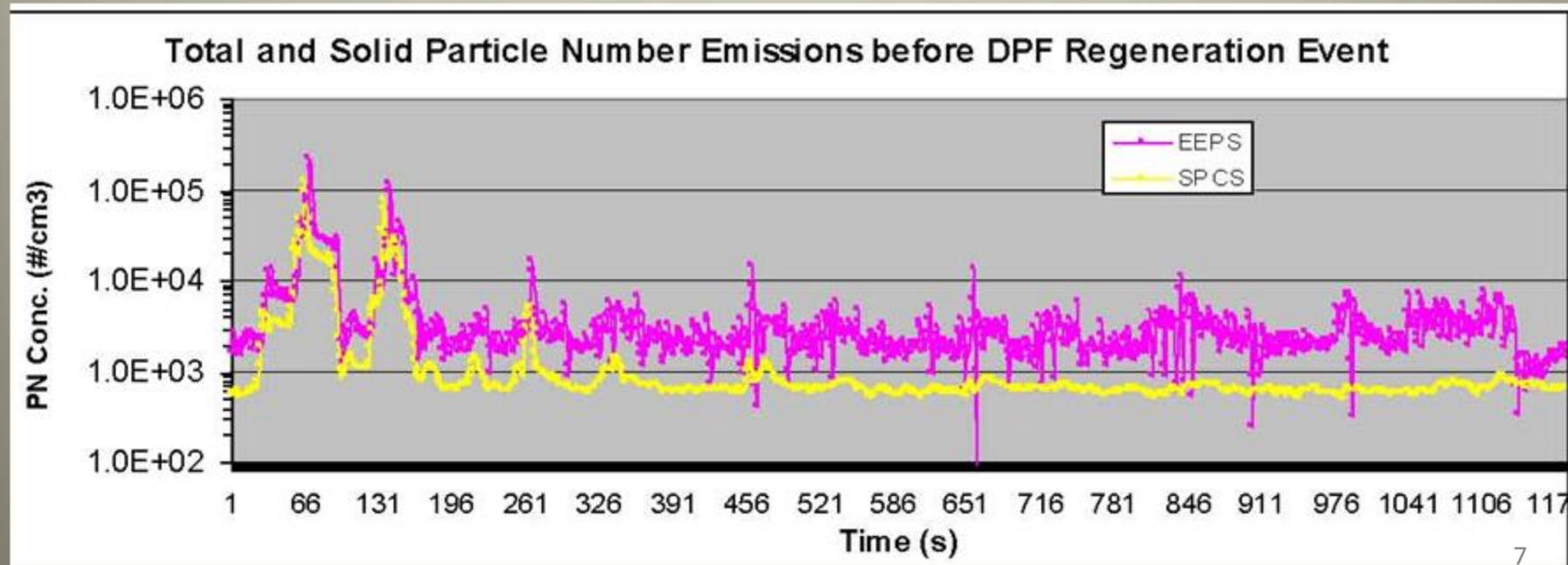
Schematic of Particle Number Measurement Setup



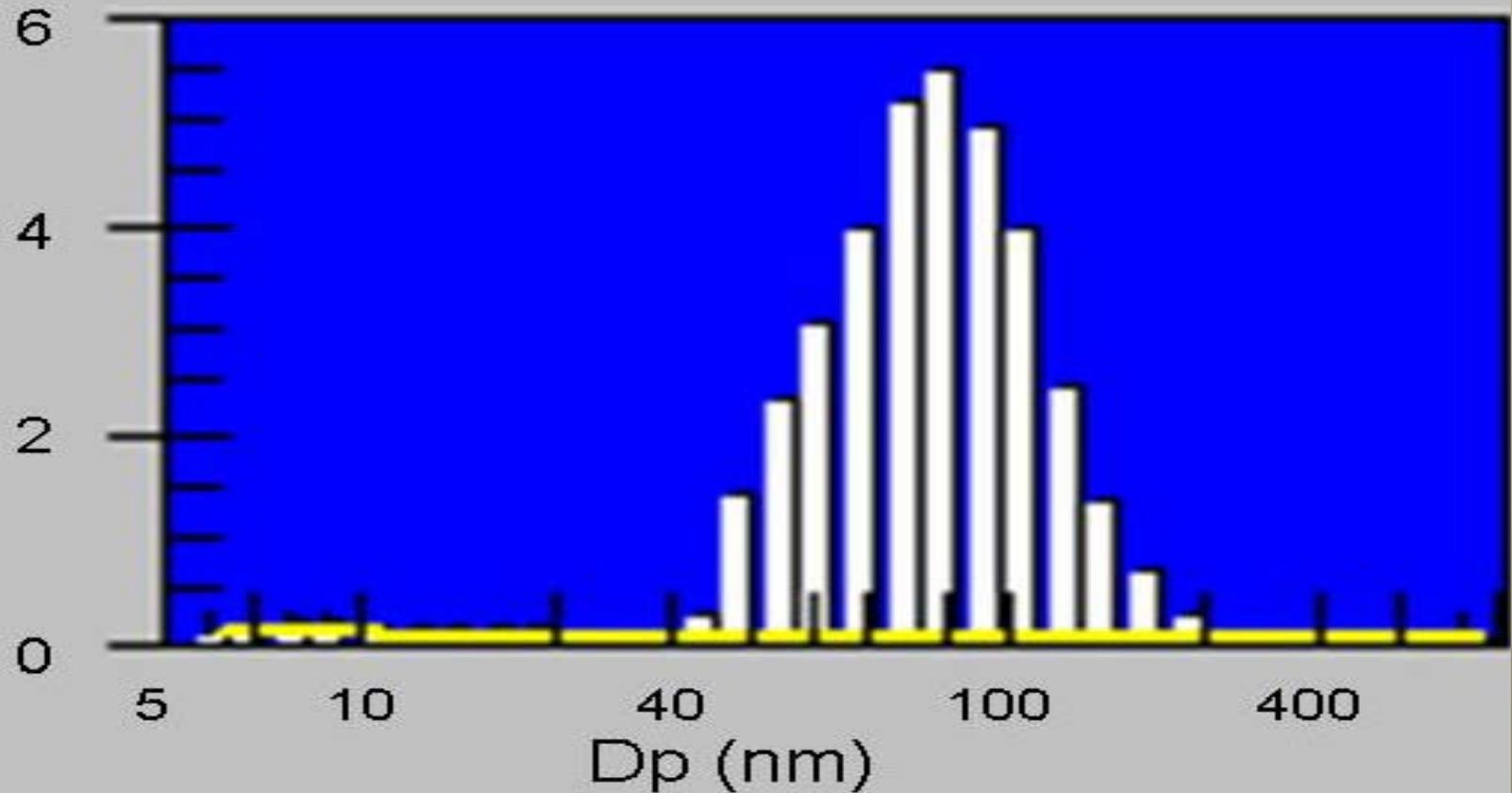
A new and different problem associated with DPFs



Typical NEDC Cycle Results without a Regeneration Event



Concentration (dN #/cm³ × 10³)

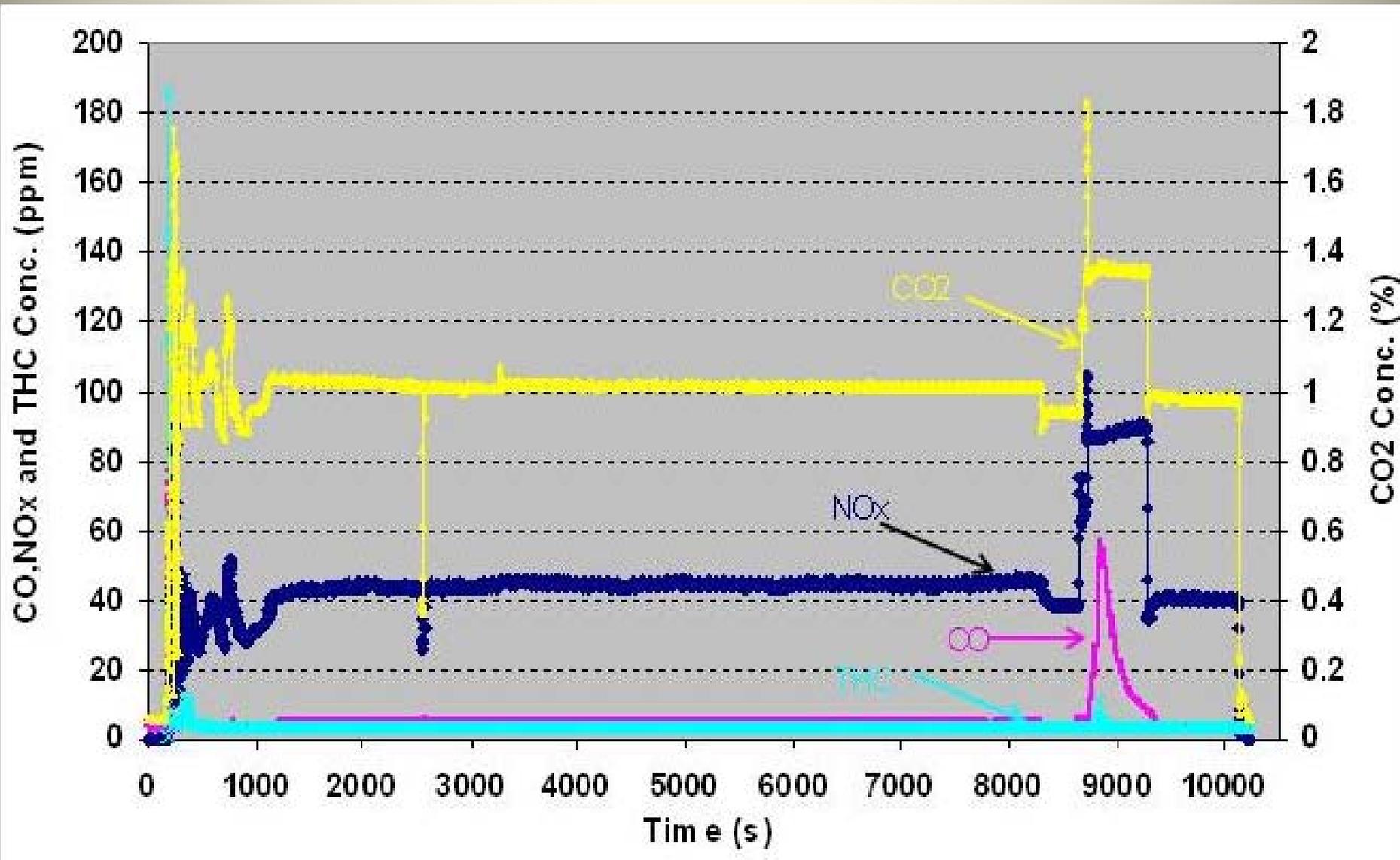


Solid particle size distribution during cold start of a normal NEDC cycle. Note: Very few very small particles < 10 nm

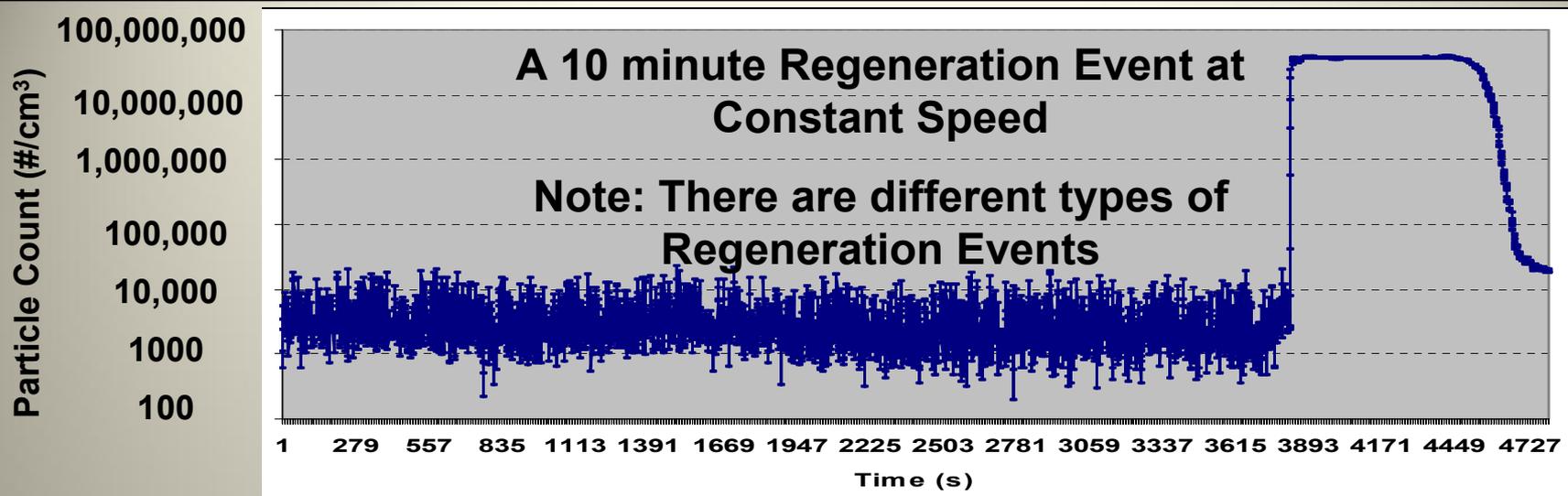
Testing during DPF Regeneration

Some notes on ARB regeneration experiences

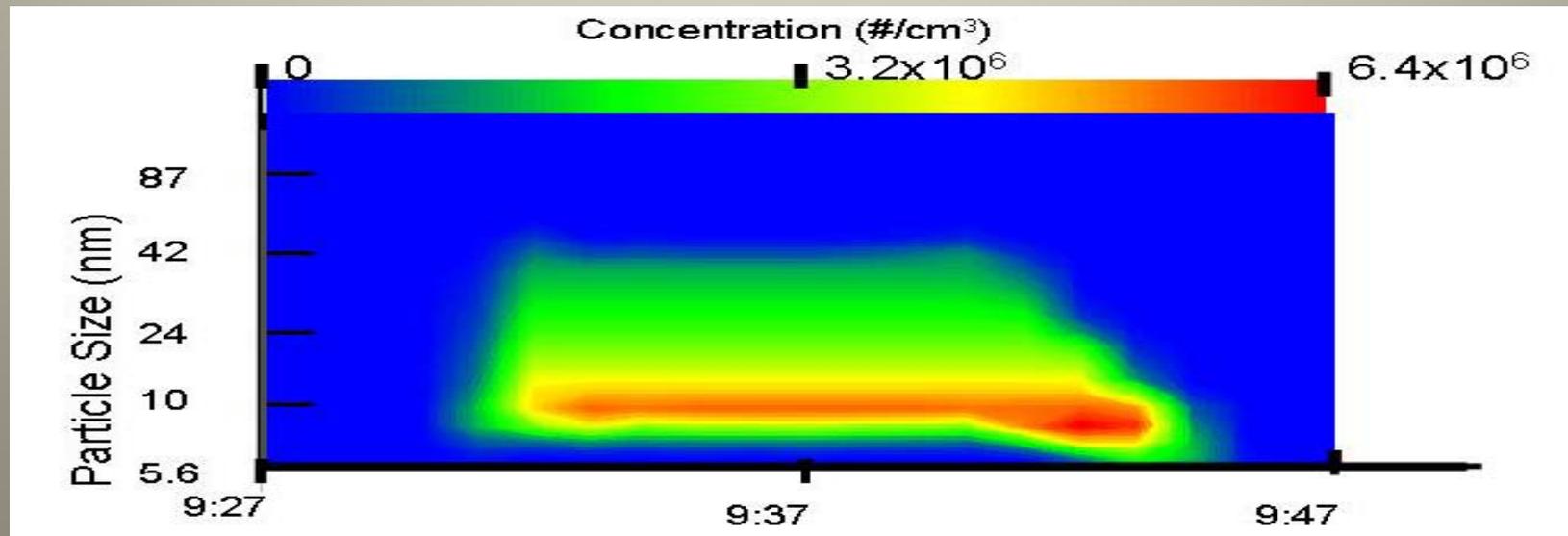
- Regeneration is determined by DPF pressure drop and aggressive driving conditions.**
- Once regeneration is started, it can be terminated by stopping the vehicle.**
- During CARB testing three regeneration events occurred. Two regenerations occurred during constant speed tests, and one regeneration was distributed between three NEDC cycles and two constant speed tests.**
- It is possible that the starting and stopping of regeneration may change the characteristics of the regeneration event.**



Gaseous emissions from DPF regeneration during a constant speed test

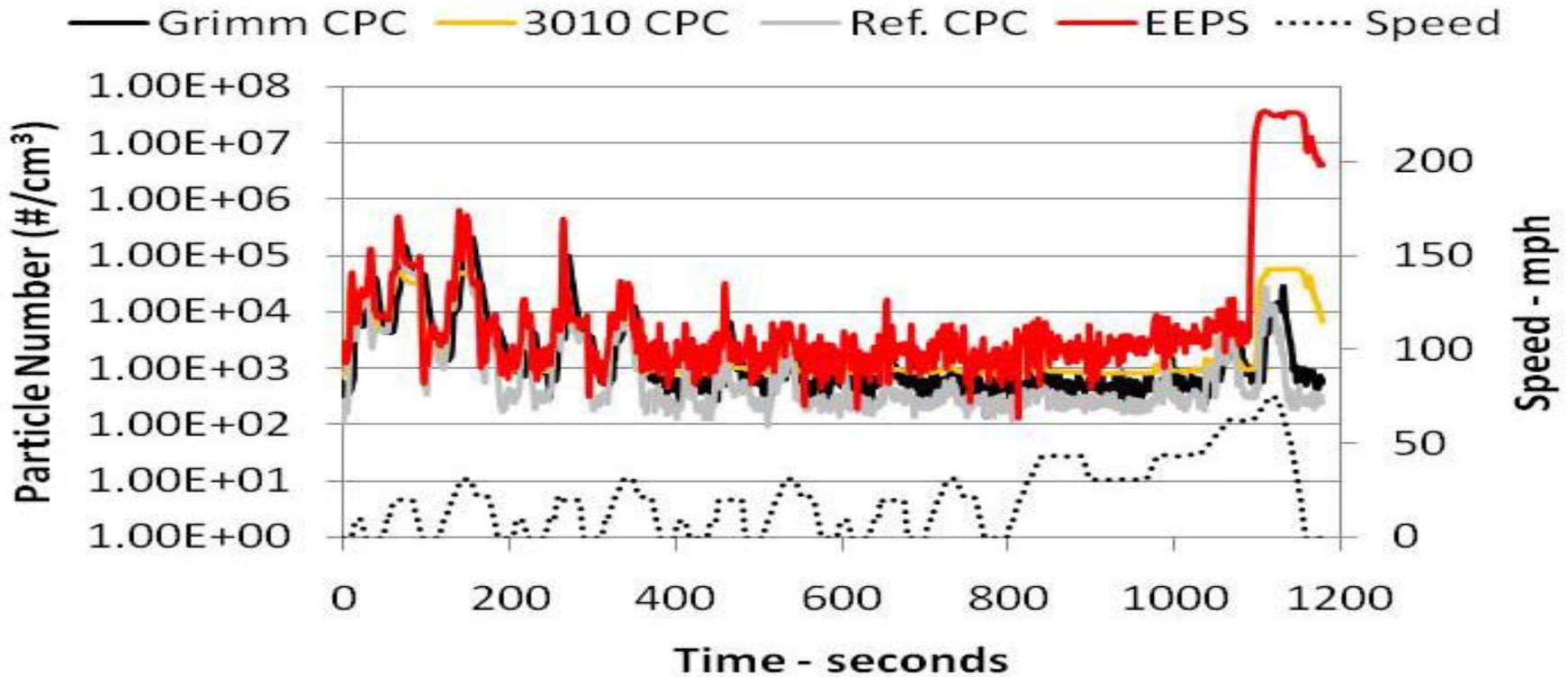


Total Particle Emissions during a Regeneration Event



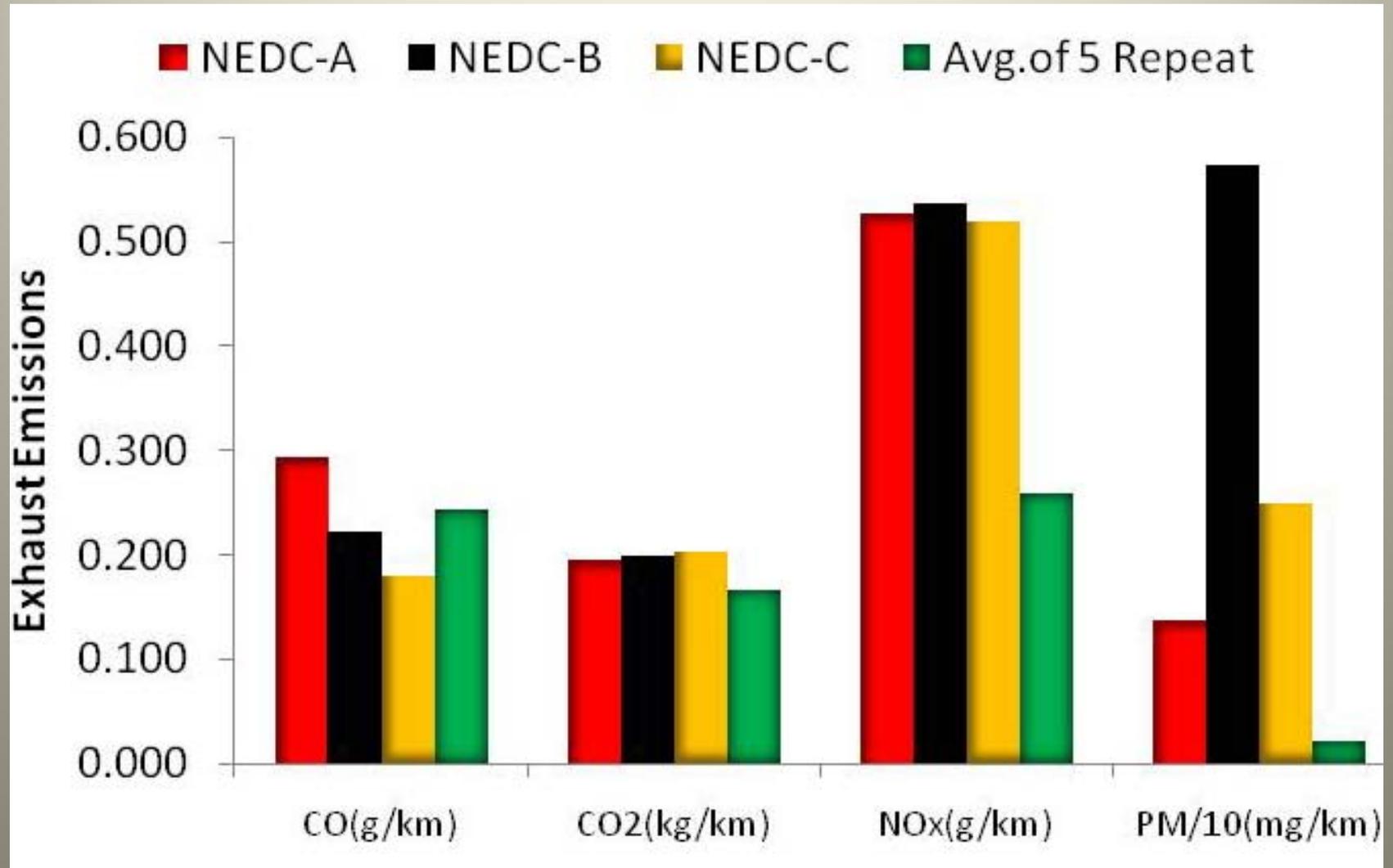
Total Particle Size Distribution during a Regeneration Event. Important Note: Most of the visible regions in the above graph are not included in the PMP Protocol.

Testing during a Partial DPF Regeneration Event (NEDC Cycle)

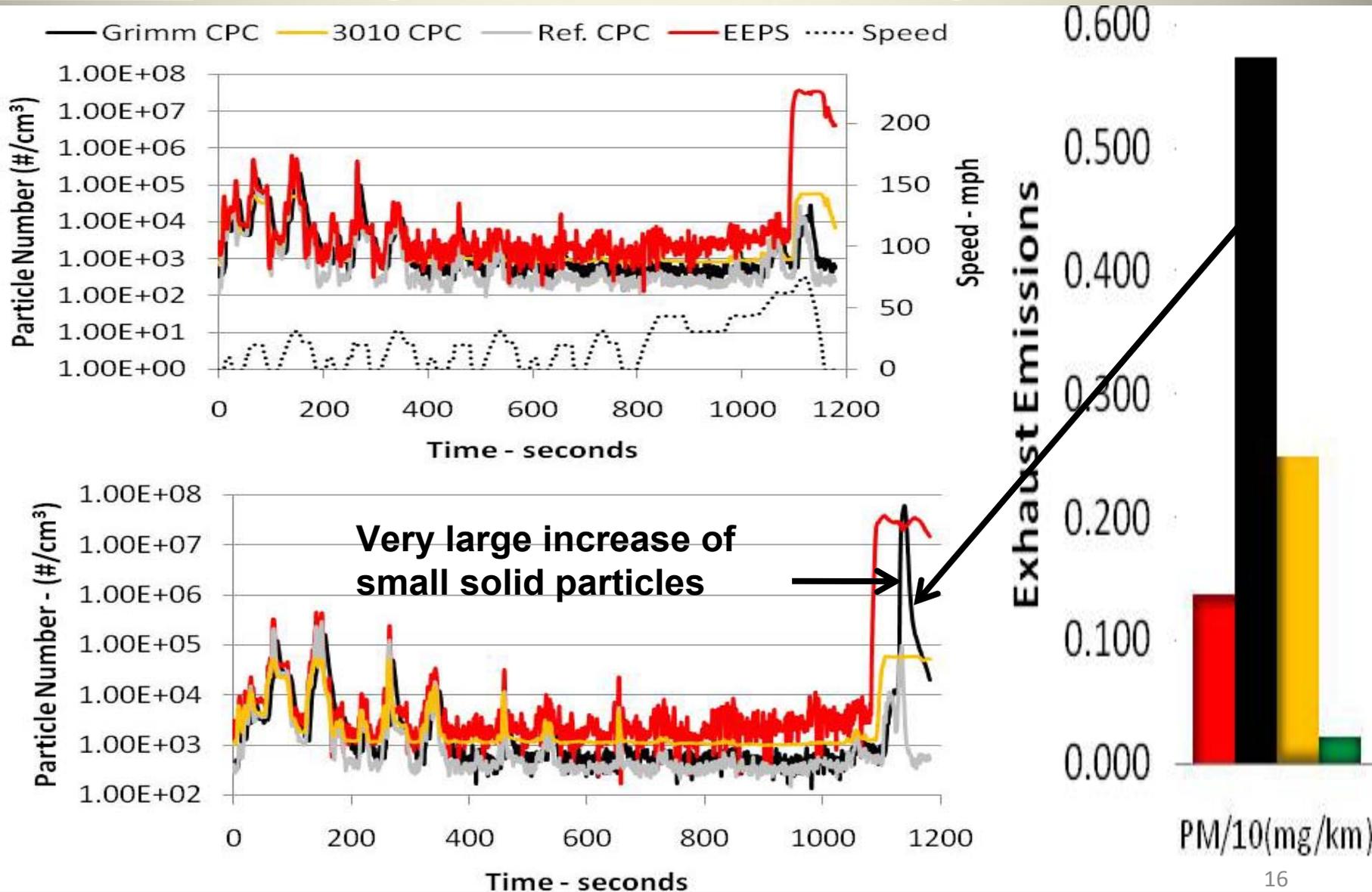


Particle number concentrations from a NEDC test with partial DPF regeneration. Note: The increased PM has not been measured by the PMP particle number instruments!!!

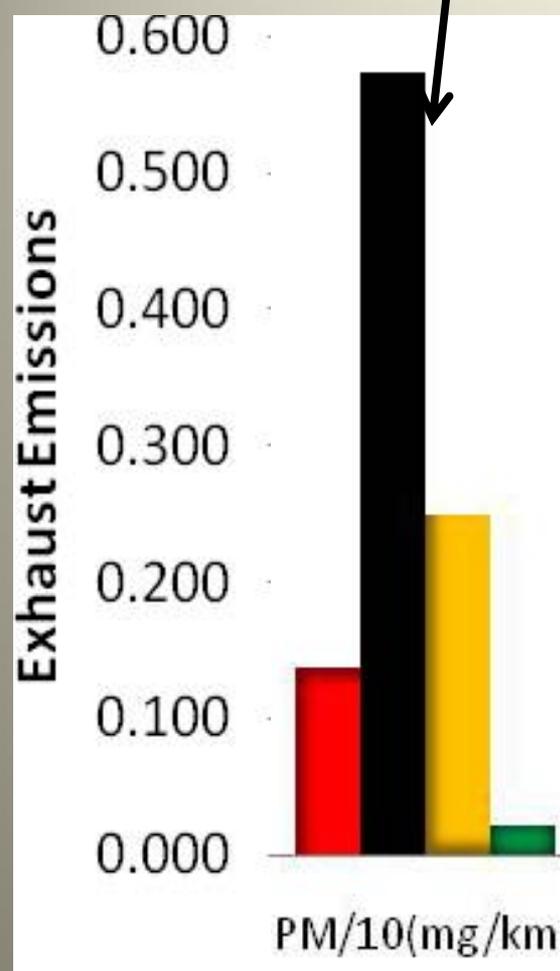
Summary of Influence of Partial Regeneration on Regulated Emissions during NEDC cycles.



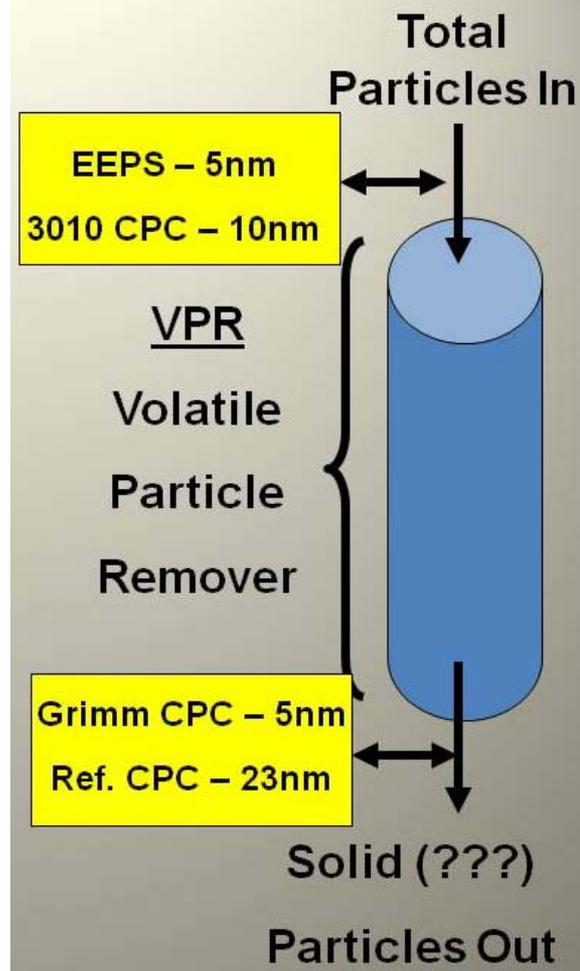
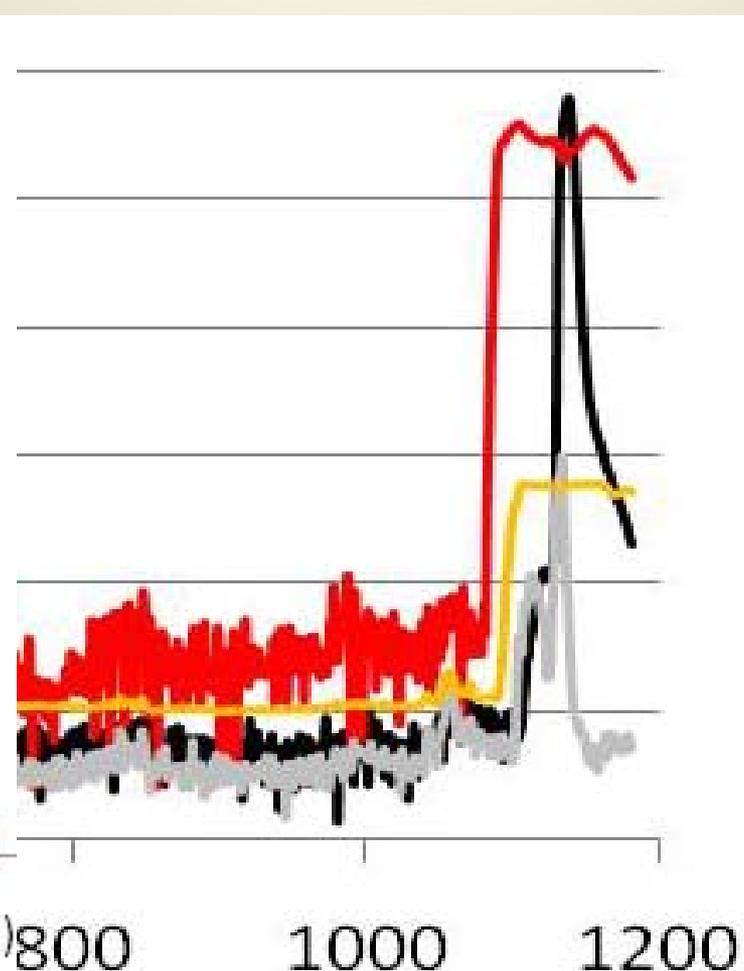
Real-time Particle Number Emissions from Two Consecutive “Partial” DPF Regeneration Events During NEDC Events



NEDC B Test



NEDC B Test



During NEDC B there is a large increase in PM and small solid particles, and the PM increase is not captured by PMP particle number instruments!!!

Summary and Conclusions

- Regeneration of the tested DPF released a very large number of volatile particles and PM increased.
- Regeneration events occurred over a wide range of driving conditions, such as constant speed and NEDC tests.
- Even if regeneration occurred during a NEDC test, the DPF performed “well” on all regulated emissions except NO_x.

- We do not know the composition or life history of the large number of volatile and solid particles released during regeneration.
- Repeated partial regenerations may cause changes in the mechanical and chemical properties of the PM in the DPF.
- For the limited data we have obtained, filter measurements seem to capture PM much better than PMP particle number density instruments.