

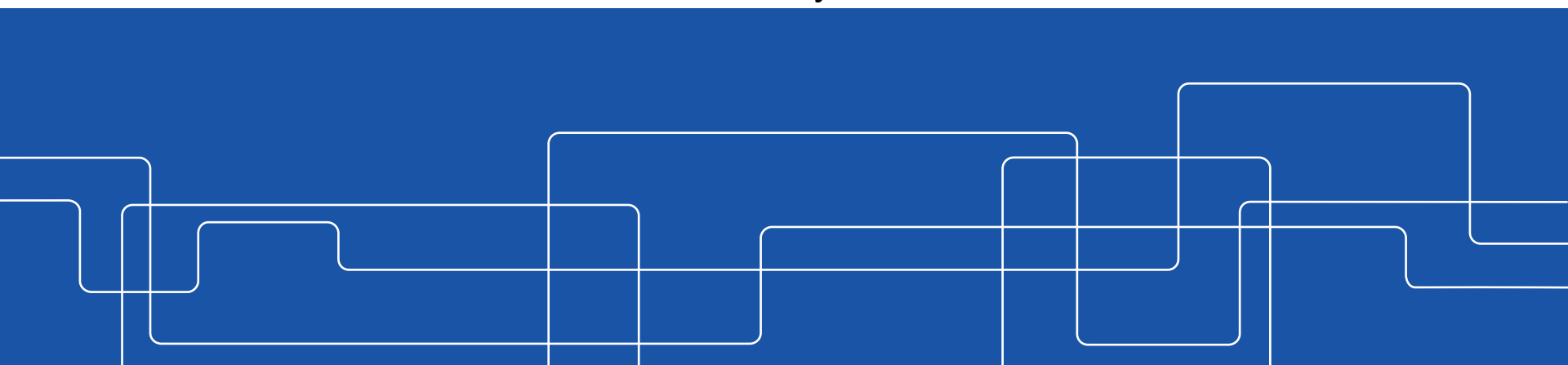
Characterization of particulates in the gas exchange system of DI/SI engines

Arun Prasath Karuppasamy, PhD Student

Anders Christiansen Erlandsson, Ola Stenlås, Supervisors

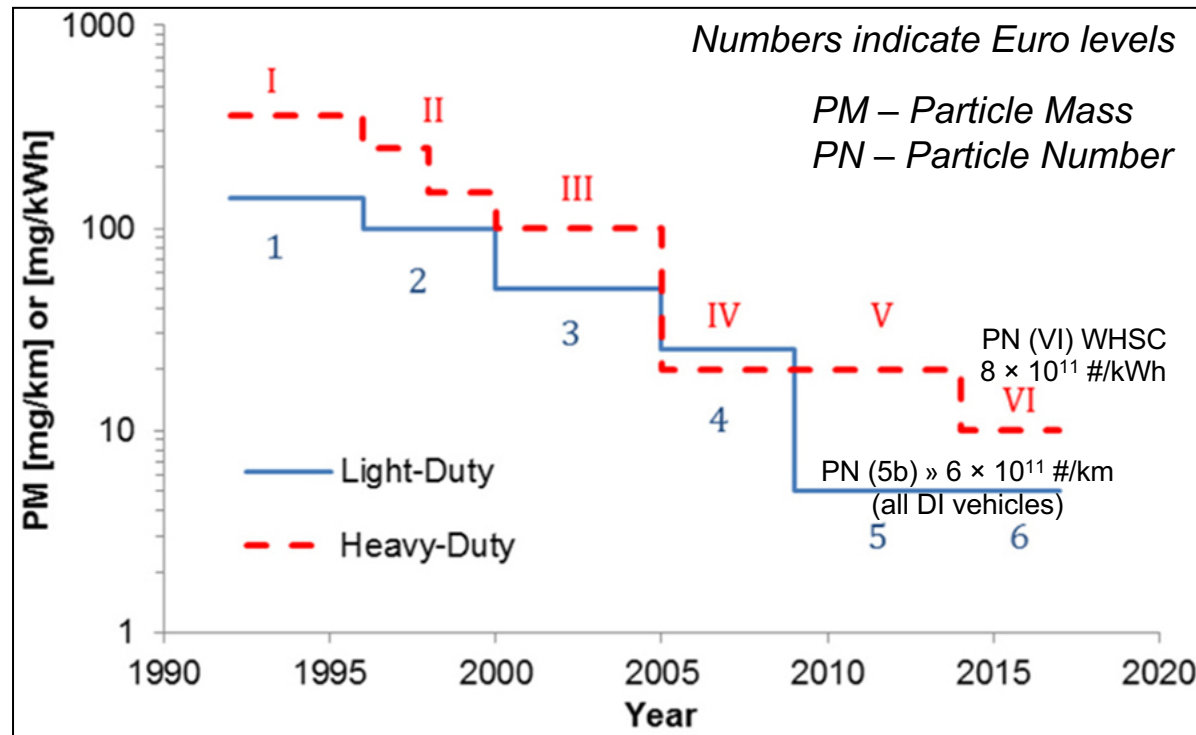


07.09.2017, CCGEx – Research Day



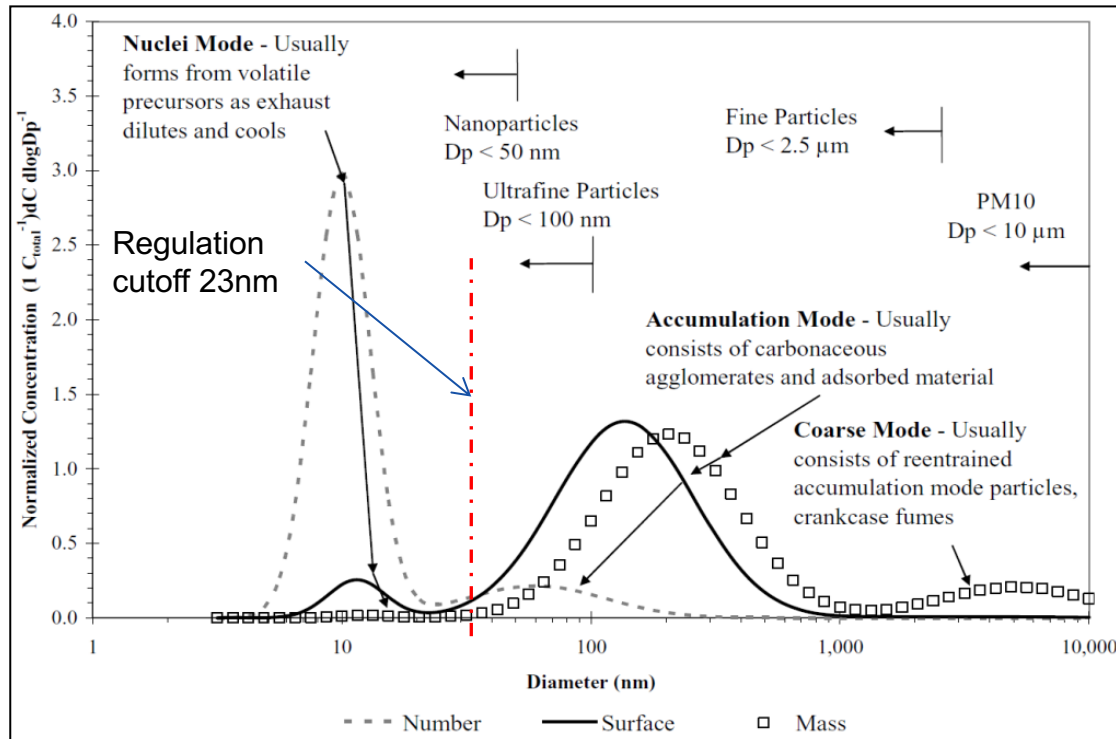
Particle Emissions

Particle: the matter being characterized (measured) in the airborne phase (suspended matter)



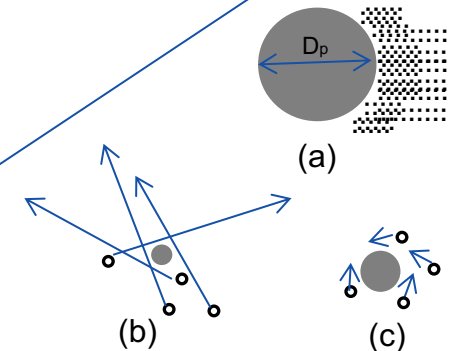
Giechaskiel, B., Schiefer, E., Schindler, W., Axmann, H. et al., "Overview of Soot Emission Measurements Instrumentation: From Smoke and Filter Mass to Particle Number", SAE 2013-01-0138

Particles in Engine Exhaust



Kittelson, D., Watts, W., Johnson, J., Rowntree, C. et al.,
 "Driving Down On-Highway Particulate Emissions",
 SAE Technical Paper 2006-01-0916, 2006, doi:10.4271/2006-01-0916

- Particle Number Distribution
 - Signifies number count of particles
- Particle Surface Distribution
 - Signifies chemically active area
- Particle Mass/ Volume distribution
 - Signifies the bulk of particles



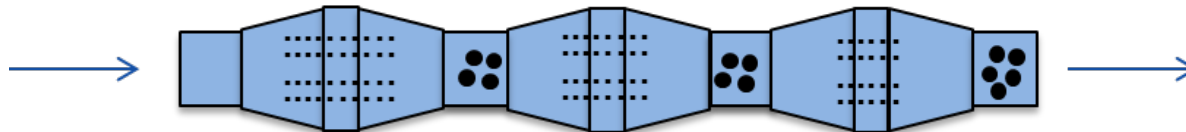
- (a) Continuum regime ($Kn \rightarrow 0$)
- (b) Free molecule (kinetic) regime ($Kn \rightarrow \infty$)
- (c) Transition regime ($Kn \sim 1$)
 (Here $Kn = 2\lambda/d$)

(Ref: Aerosol Chemistry and Physics, J. H. Seinfeld and S. N. Pandis)

PARTICLES IN ALL THREE REGIMES EXIST IN ENGINE EXHAUST

Outline of the work

- Setting up the engine for steady state load conditions
 - Use of experimental data (particle size distribution) for 1-D model generation between exhaust devices
- Concept development and designing of **agglomeration** device
 - Testing of the device in steady state conditions

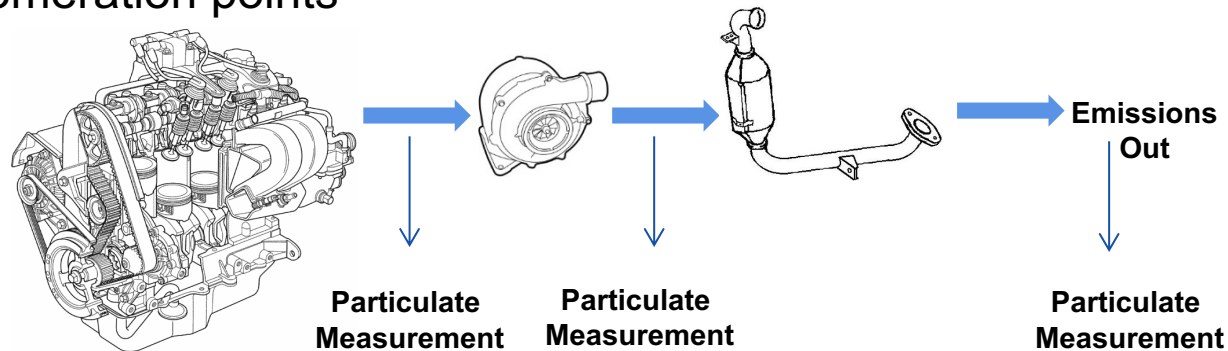


- 1-D model development of the agglomeration device
- Studying the effect of pipe geometries (straight pipe, bends, expansion, etc.,) on particle size distribution
- Implementation of the 1-D models generated in GT power/AVL BOOST
 - Checking for the accuracy of the model
- Setting up the engine for transient load conditions
 - Testing of the device in transient conditions and refining the accuracy of the model

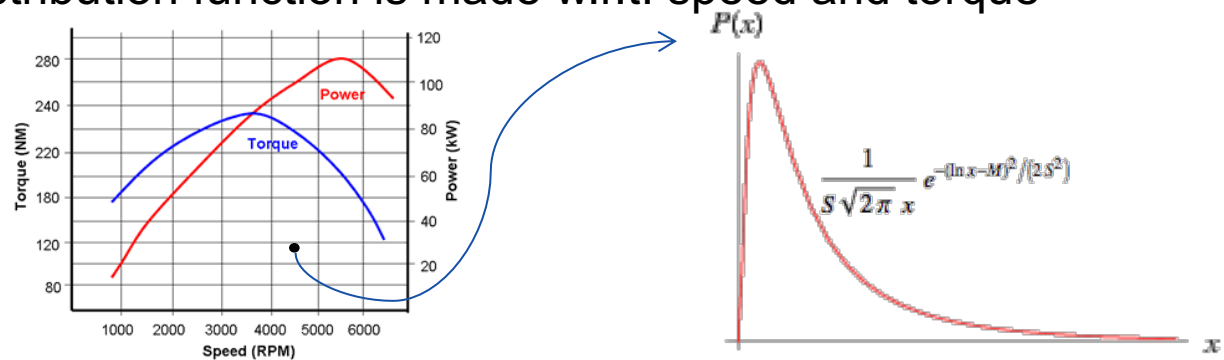
Agglomeration: Process of combining particles to form larger particles

Measurement and Modelling of Particles the Exhaust

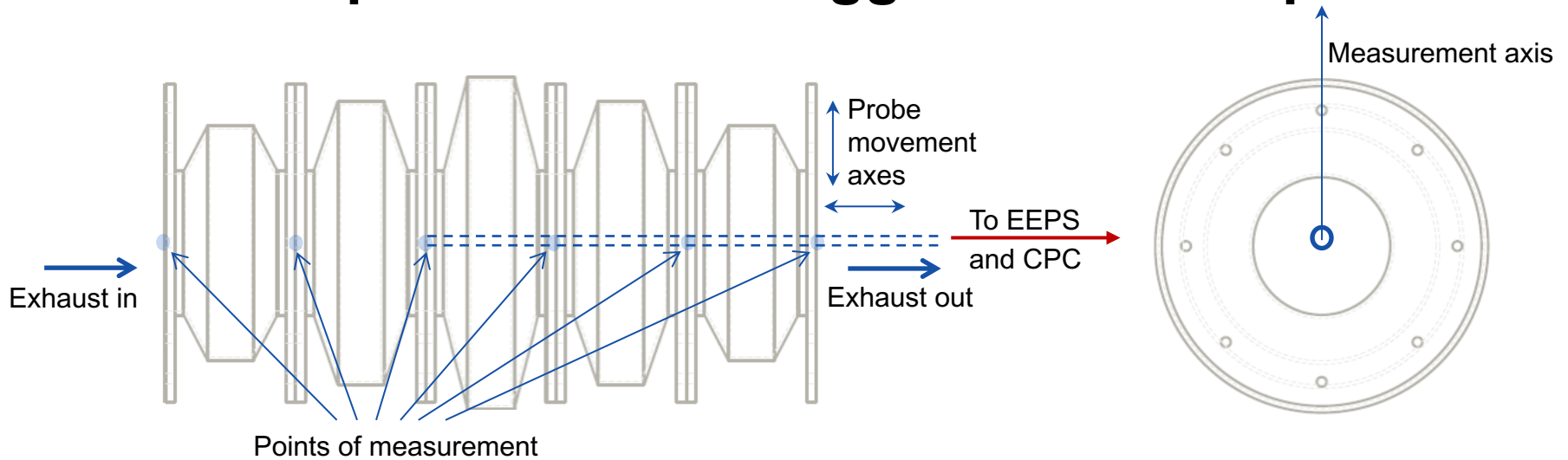
- Measurement of steady state points and identification of potential agglomeration points



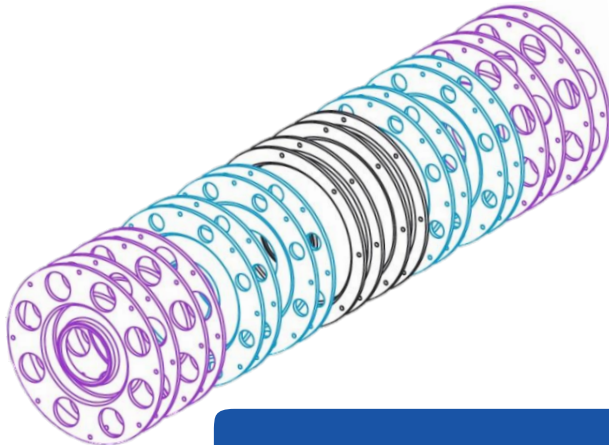
- Particle number distribution –log normal distribution, $f(M,S)$
 - Finally distribution function is made w.r.t. speed and torque



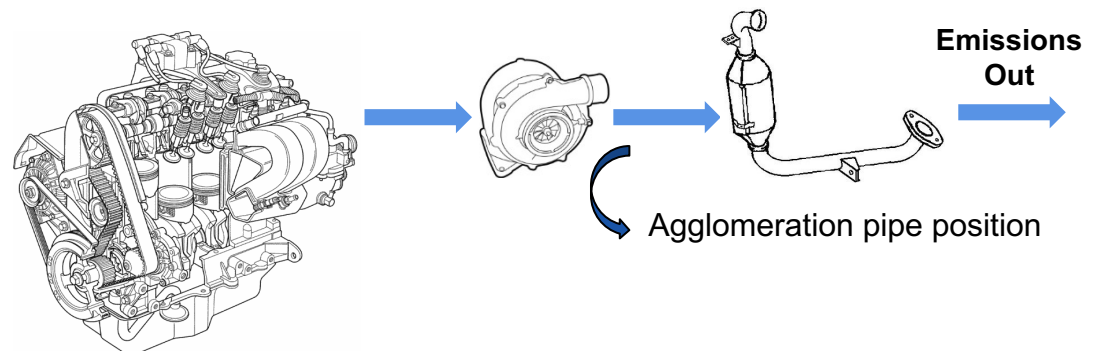
Experiments with Agglomeration Pipe



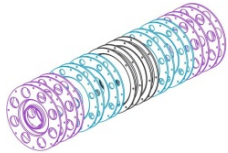
Design of agglomeration pipe



Location of agglomeration pipe



Progress of the Project



Agglomeration pipe ordered, pending delivery.
Delayed from estimate CW34



Ordering of sampling probe and traverse, pending advertisement according to the Swedish law of governmental procurement



Particle measurement system (EEPS) and dilution system to be borrowed from industrial partners.
Pending delivery estimate of above components



Laboratory booked 2018 Q1 @ 50% availability



Literature survey – Organizing
Plan of Experiments – Working on it
Data evaluation scripts – Working on it



Competence Center for Gas Exchange



"Charging for the future"



VOLVO



BorgWarner