Expanded Capabilities of Dual Pegasor PPS-M Sensor in PEMS Measurements Beyond PN, PM and Particle Size

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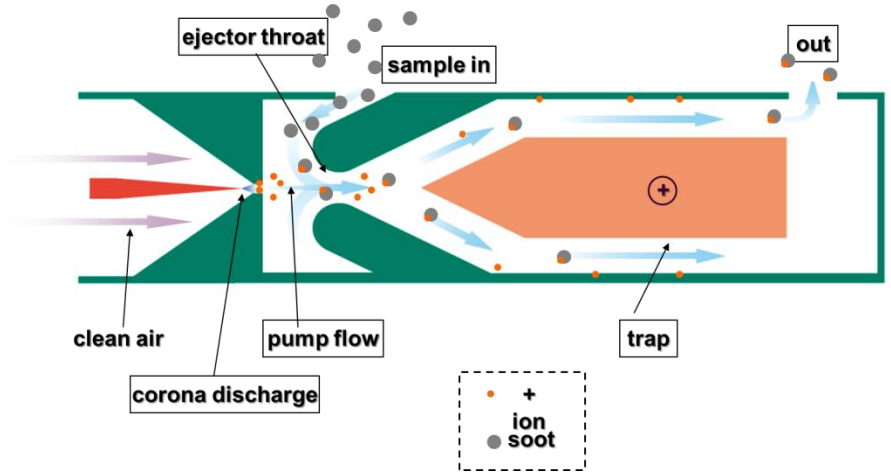
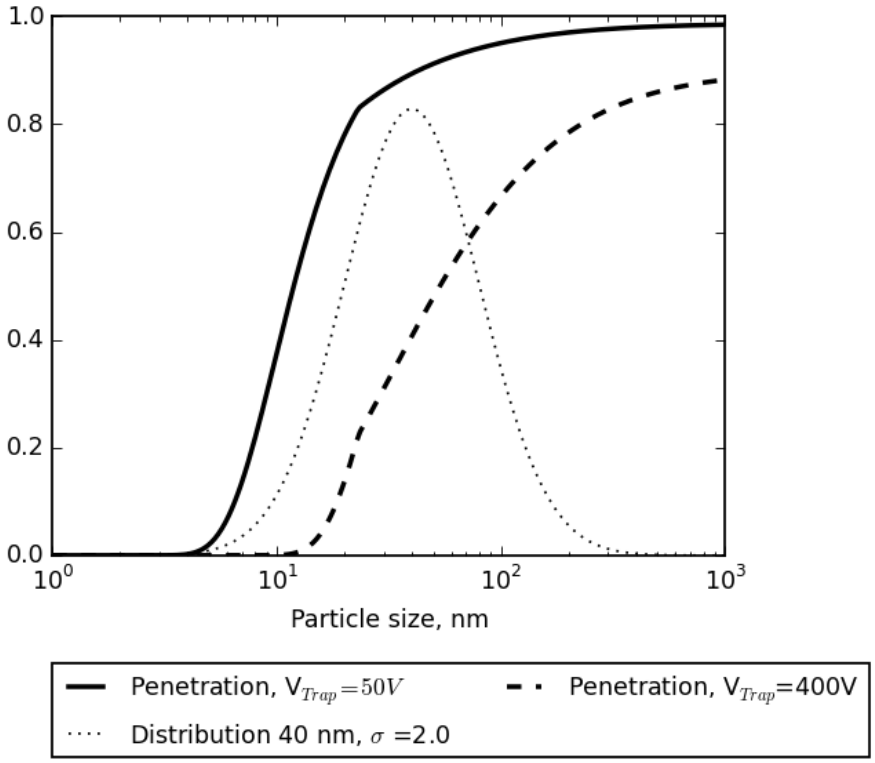
Introduction

- Dual PPS-M introduced by Amanatidis et al (2015)
  - Two PPS-M units have their trap set at different voltages->size response separation
- This leads to other ways of ”misusing” a pair of instruments
  - Charger off -> information about charge state
  - Volatile removal -> volatility analysis
- This was tested with an on-road PEMS study with Mi3 and PPS-M





Setup

- Renault Megane 1.2L TCe, Turbo, GDI, TWC, 50 000 km
- Sampling at the tailpipe

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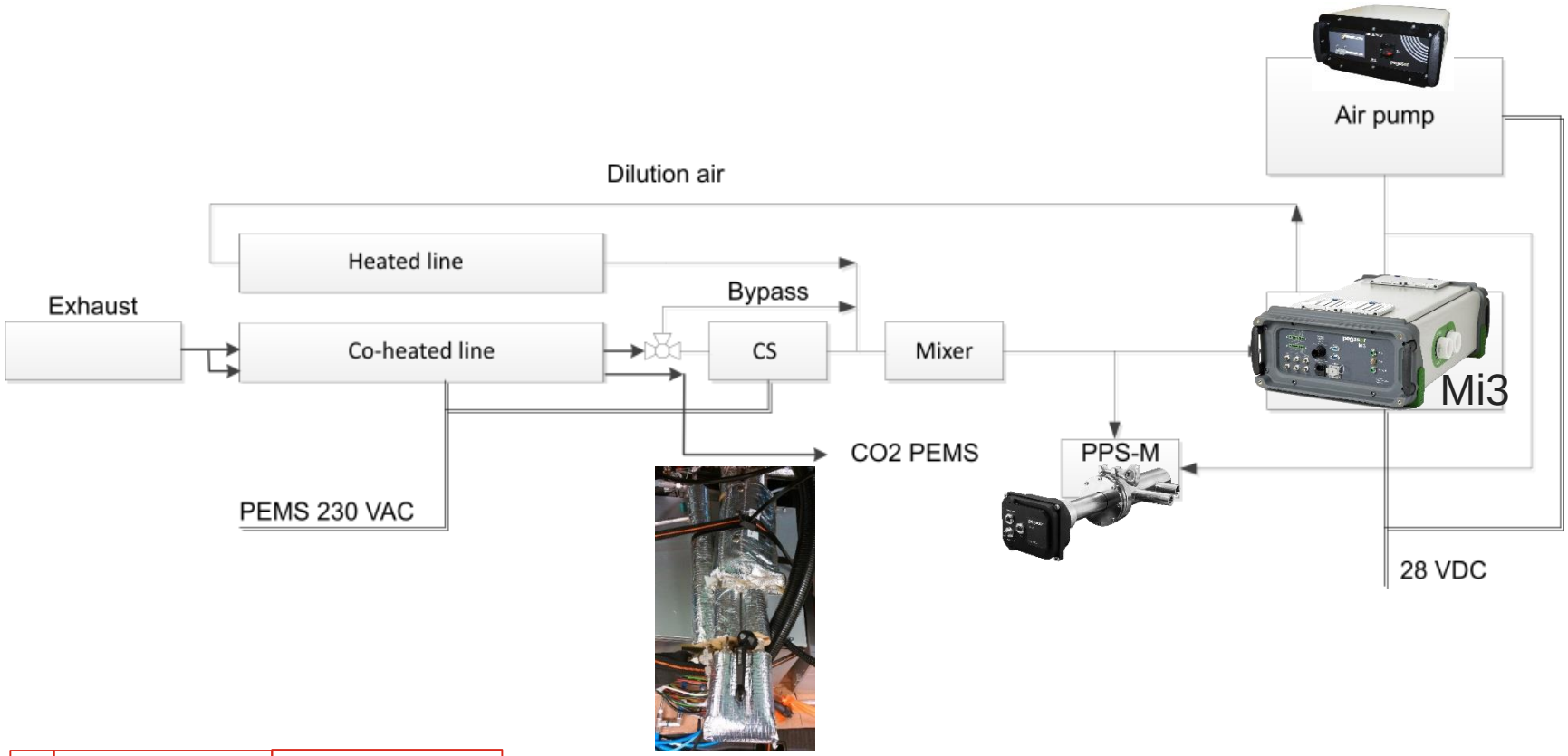
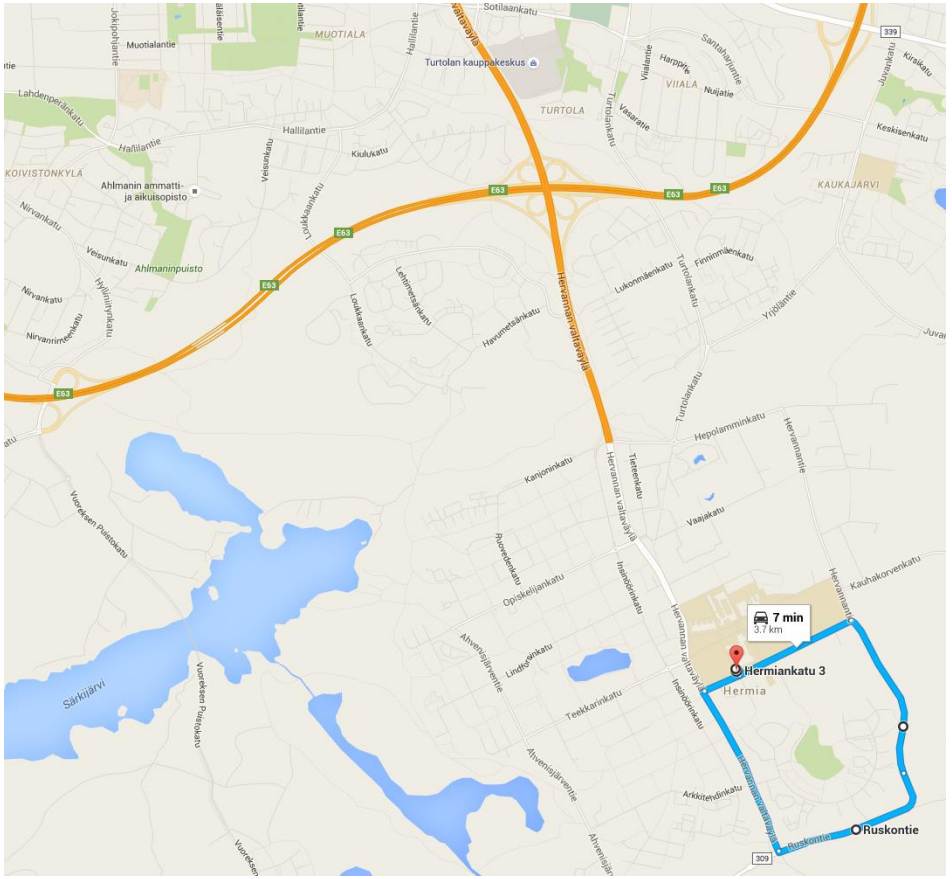


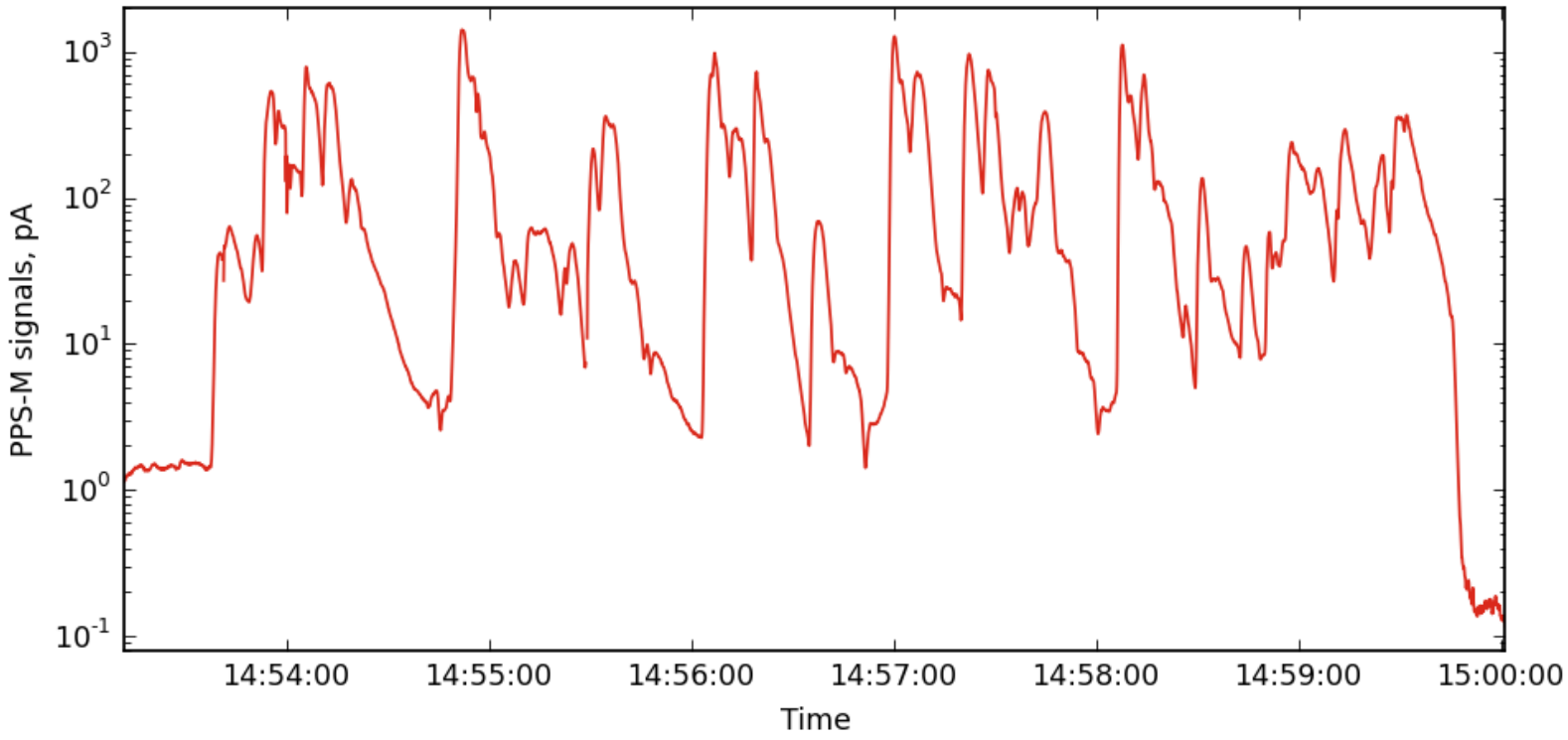
Transient intercomparison

- To derive any meaningful information from the difference of two sensors, we need good enough precision between instruments
- Intercomparison test route similar to the actual drive cycle, minus higway.



Transient intercomparison

- 4 orders of magnitude used, 2 to spare



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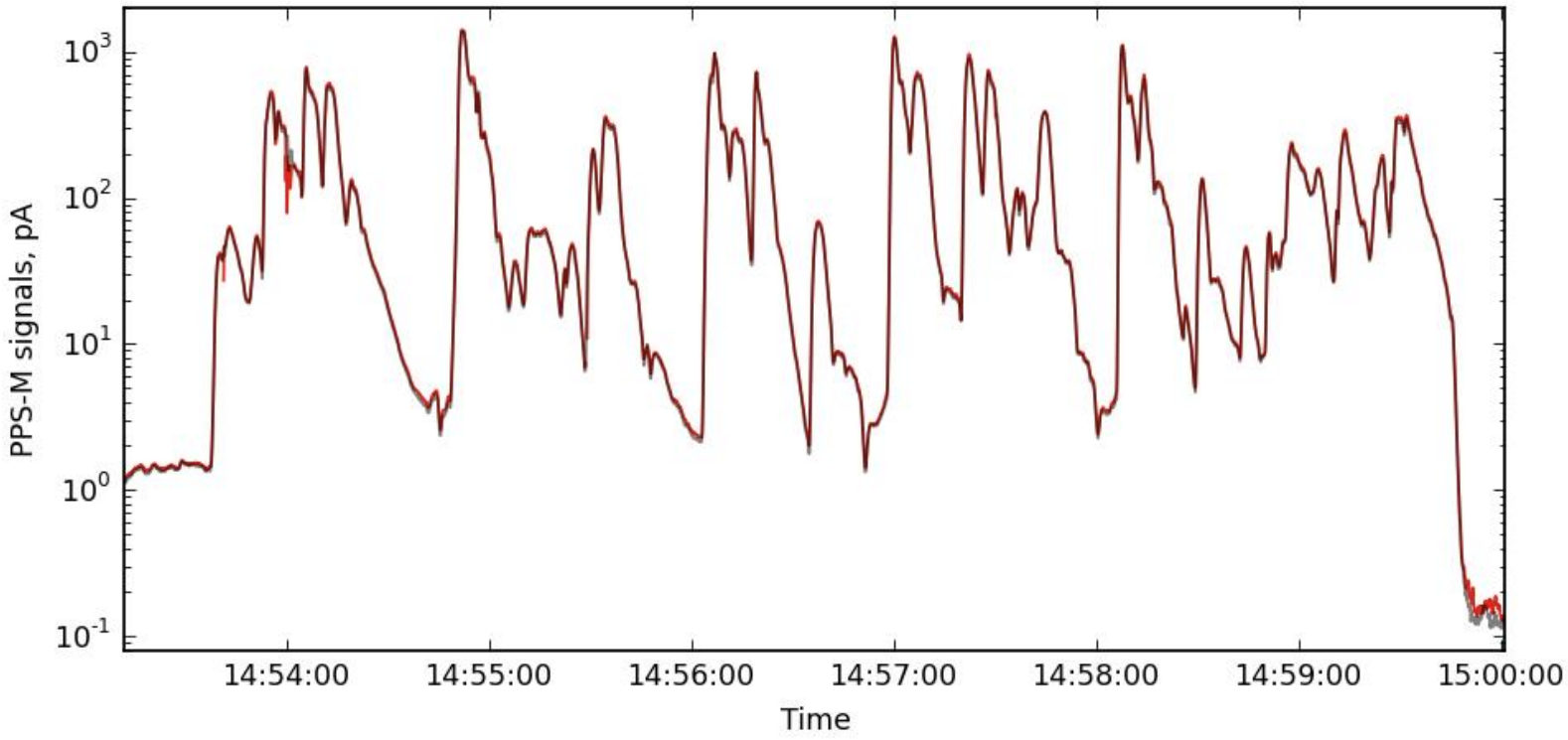

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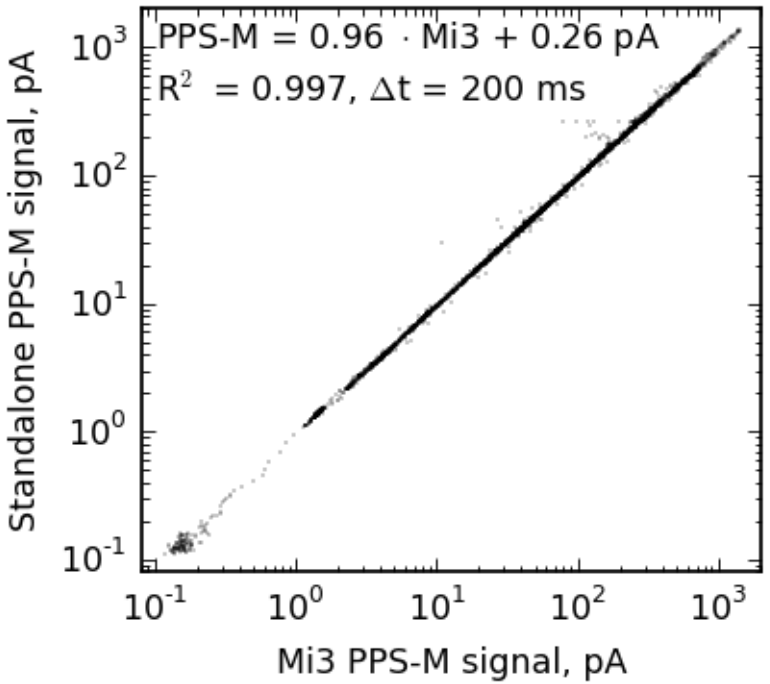
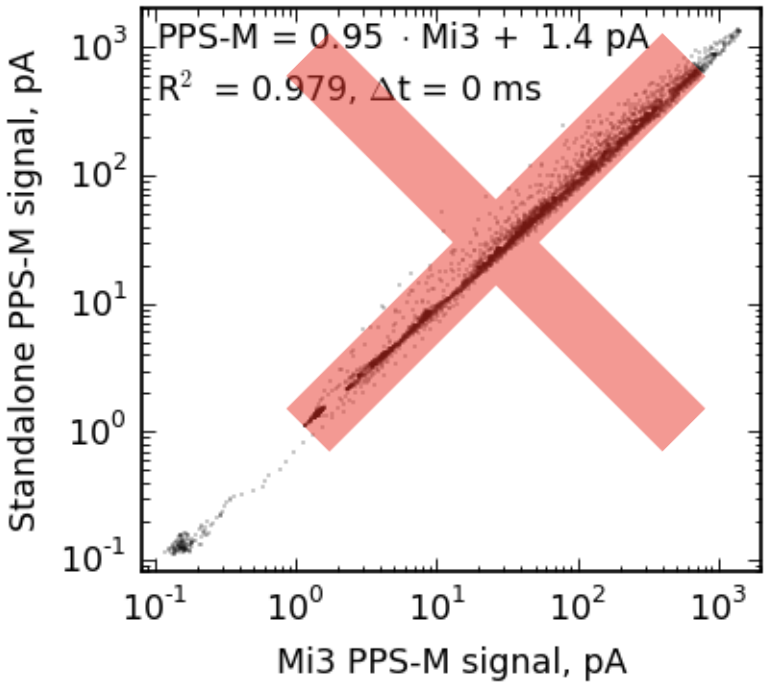


Transient intercomparison

- 4 orders of magnitude used, 2 to spare
- Remember the time offset!



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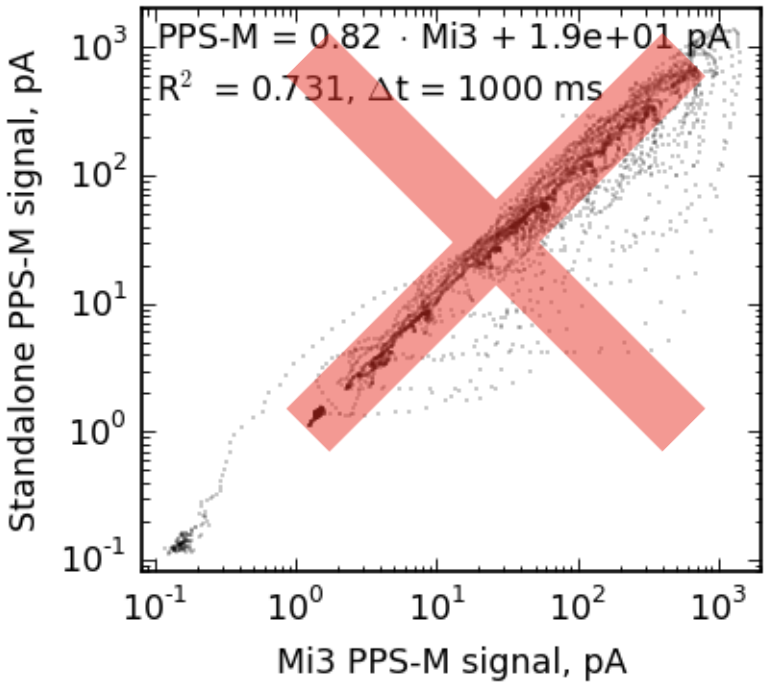

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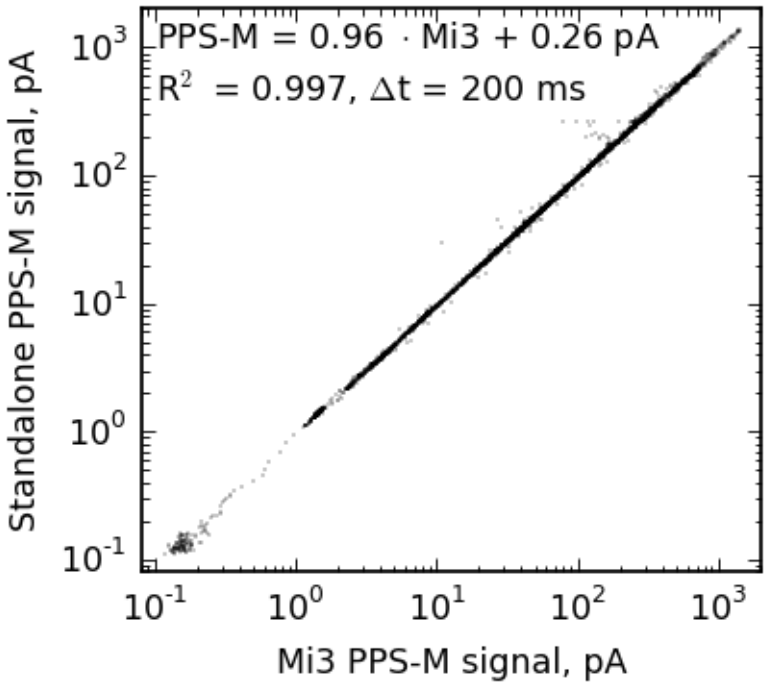
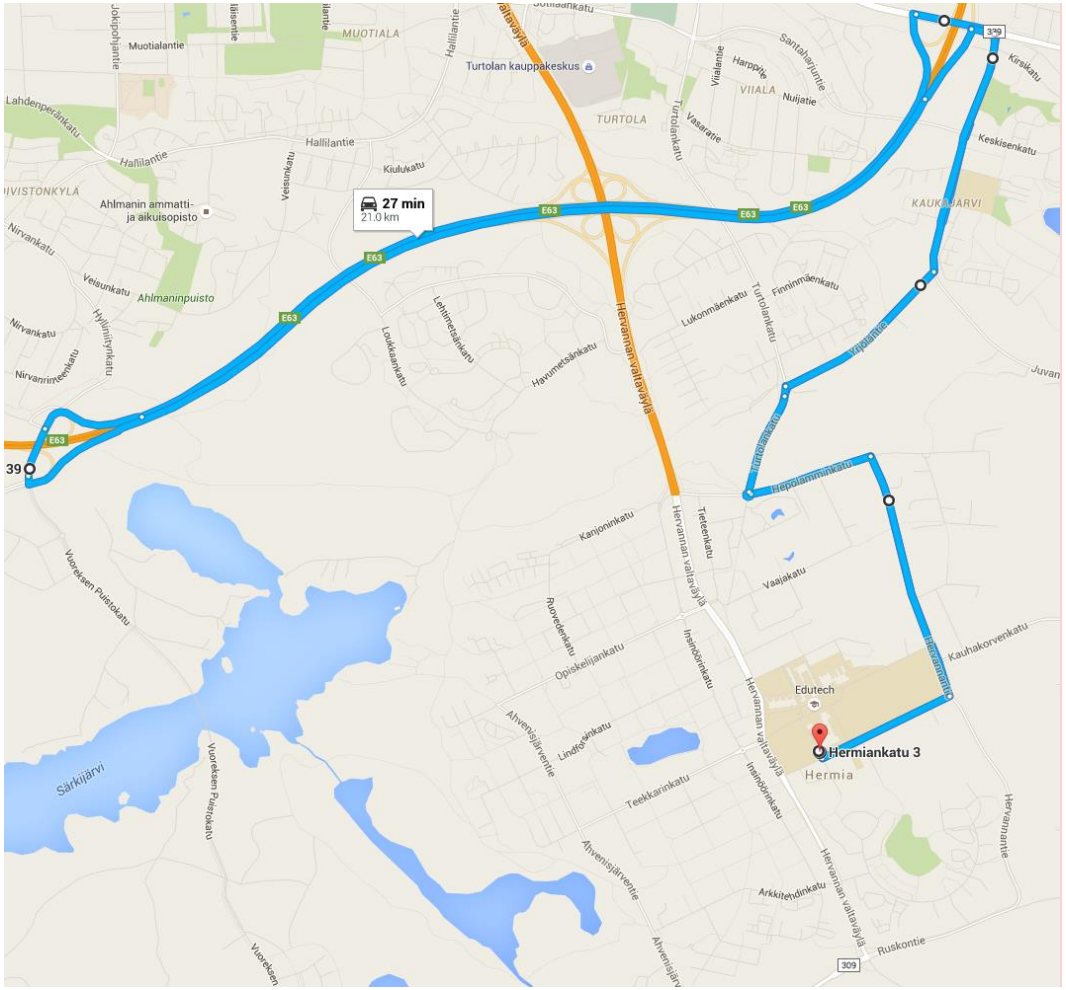


Main test route

- (sub-) urban area
- +Highway part
- Some steep (12%) hills

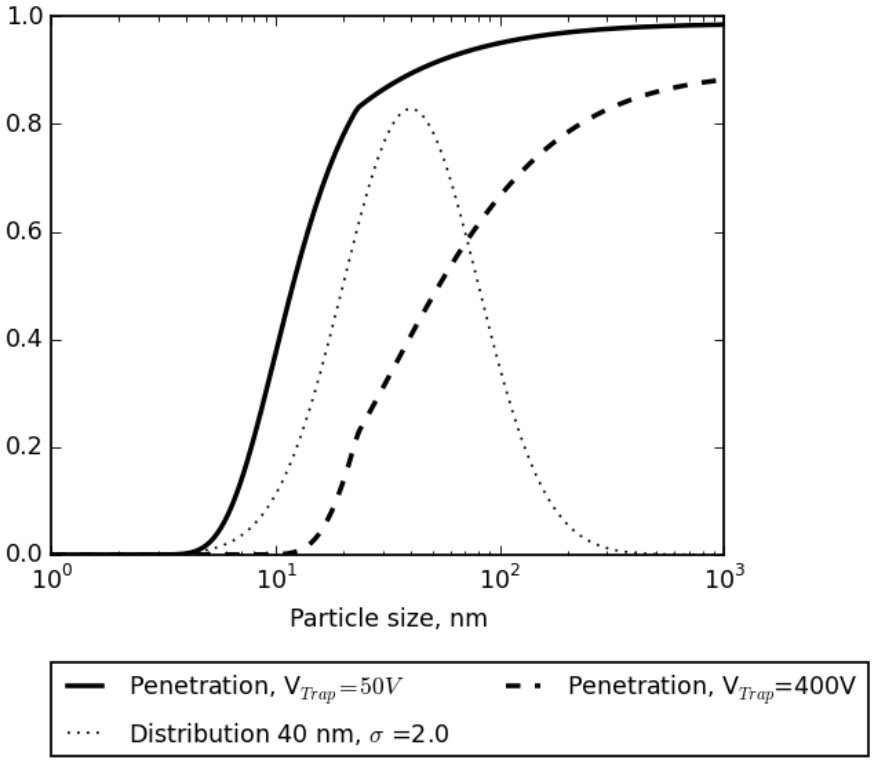


Particle volatility

Setup:

- CS@300°C
- PPS at 400V
- Mi3 as reference at 50V

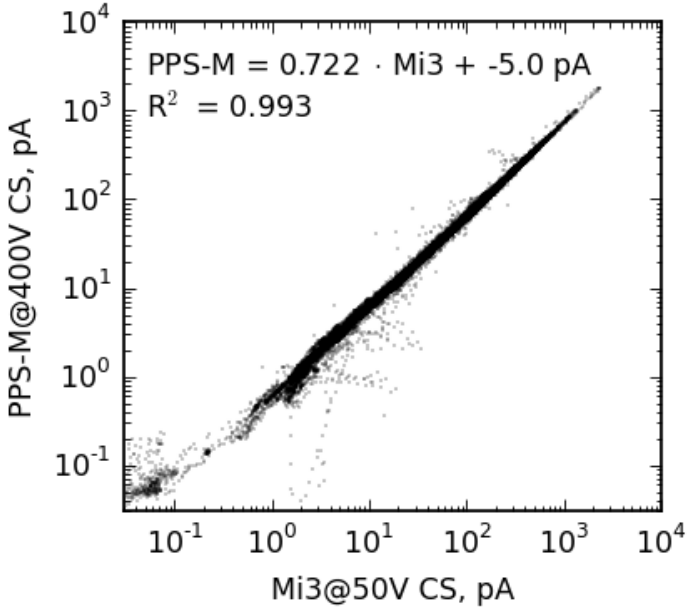
- Reasoning for this:
  - At different voltages we catch size changes more easily, rather than concentration changes->volatile coating
  - Less prone to signal change due to losses or delay differences

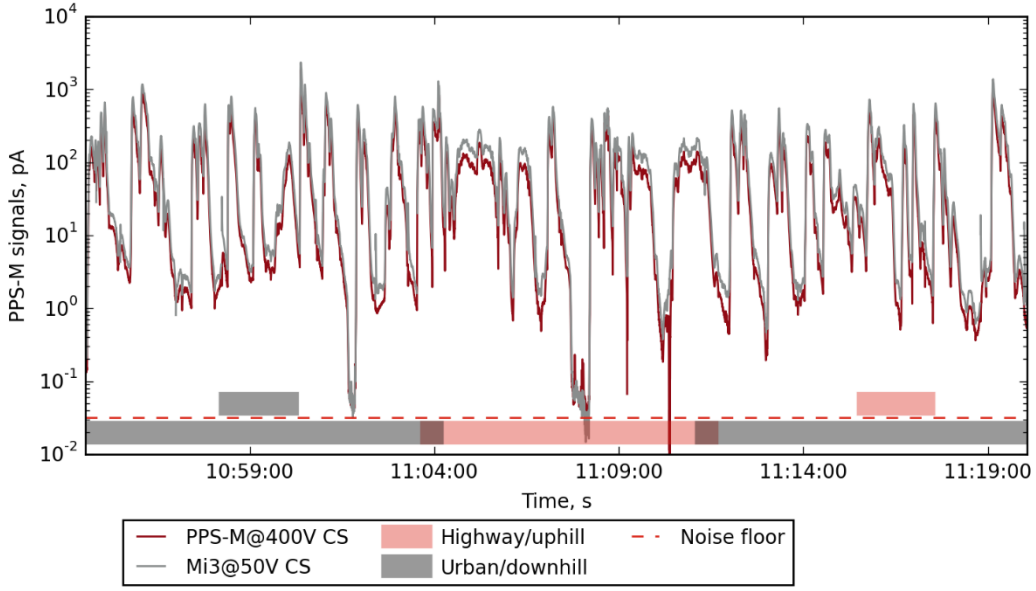


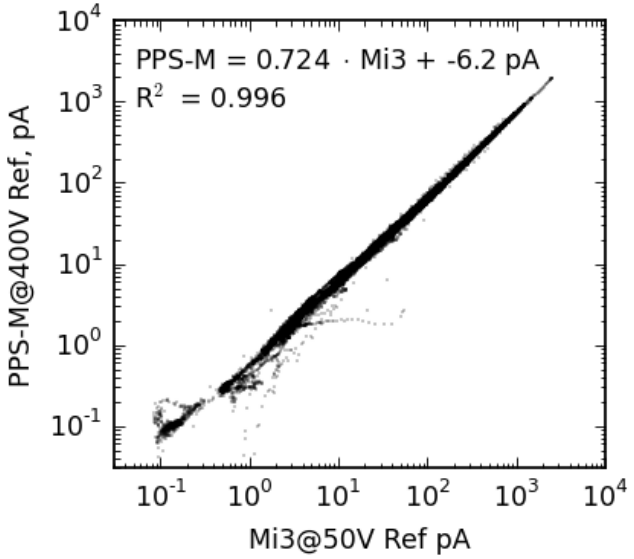
Particle volatility

Result:

- No difference when averaged over the cycle
- Temporal size changes do exist, no size analysis done yet (à la Amanatidis et al. 2015)

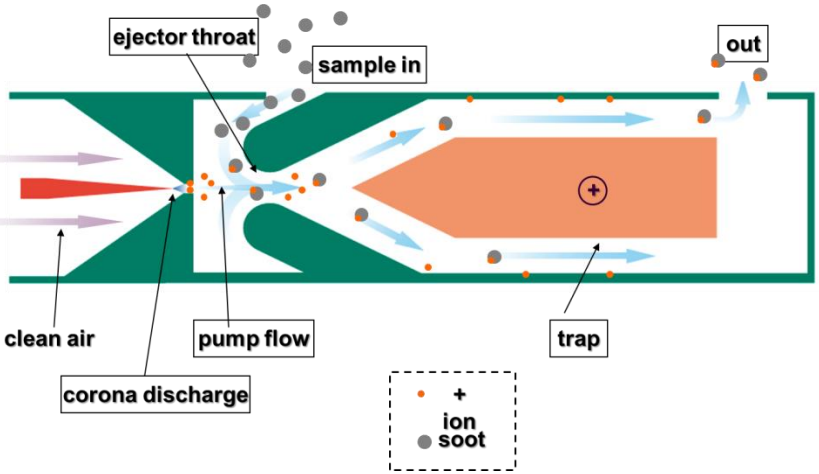


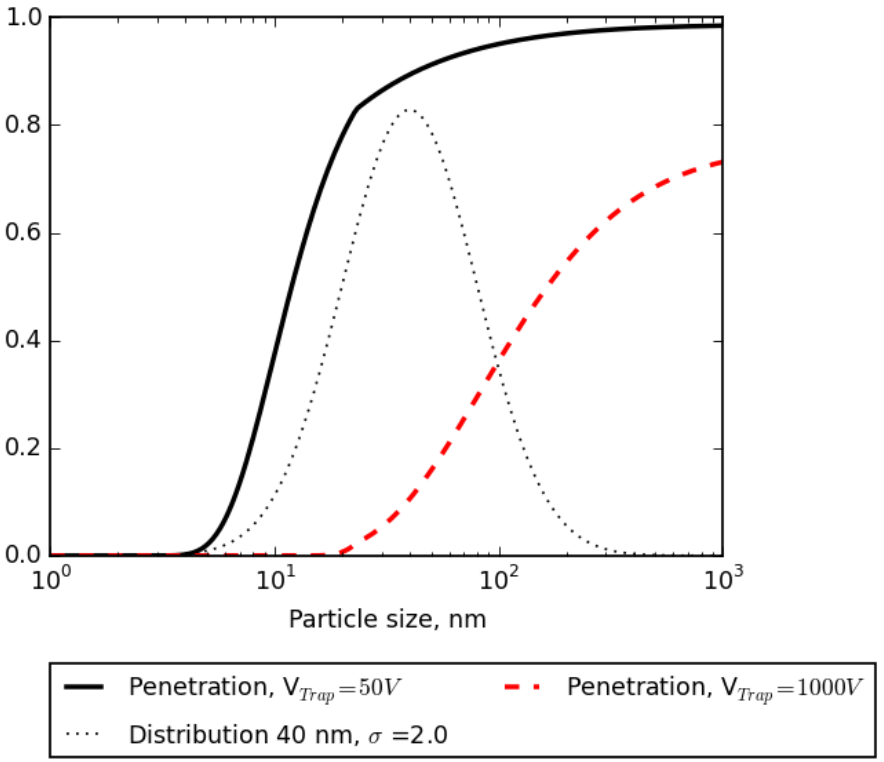




Charge state measurement

- Mi3 (unit A): charger on, trap at 50V
- PPS-M (unit B): charger off, trap at 1000V to catch as much of the particles as possible
- Caveat: We measure overlapping, but different size ranges





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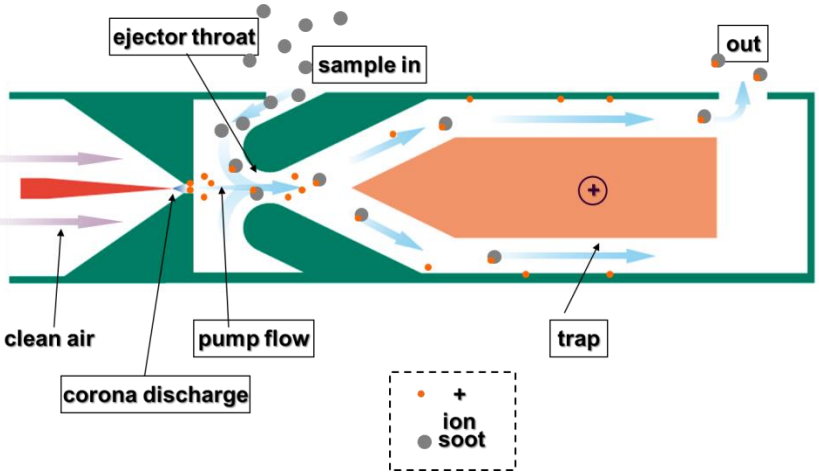
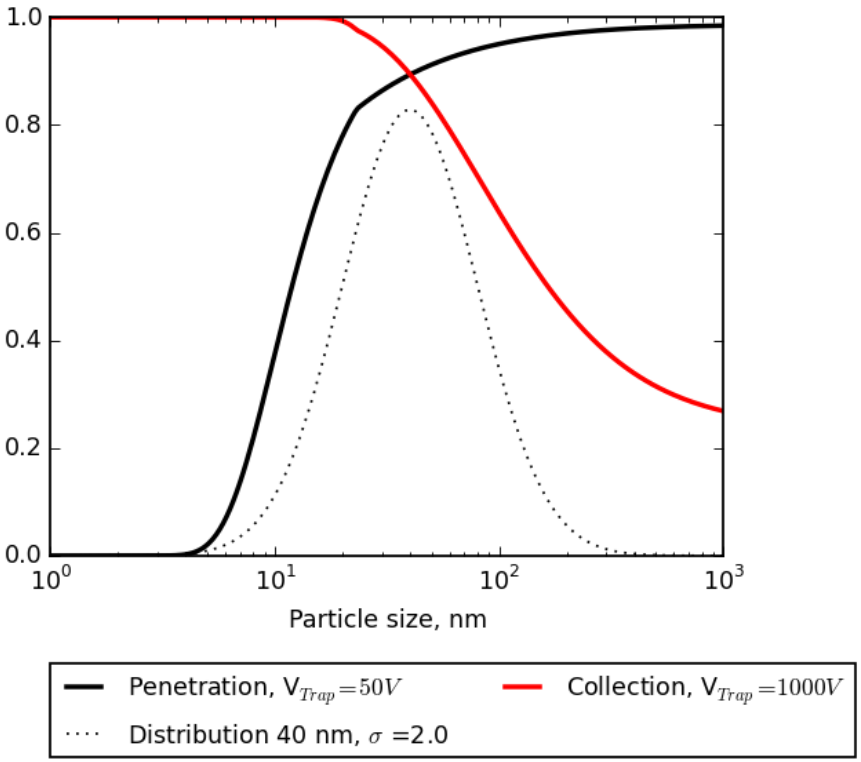
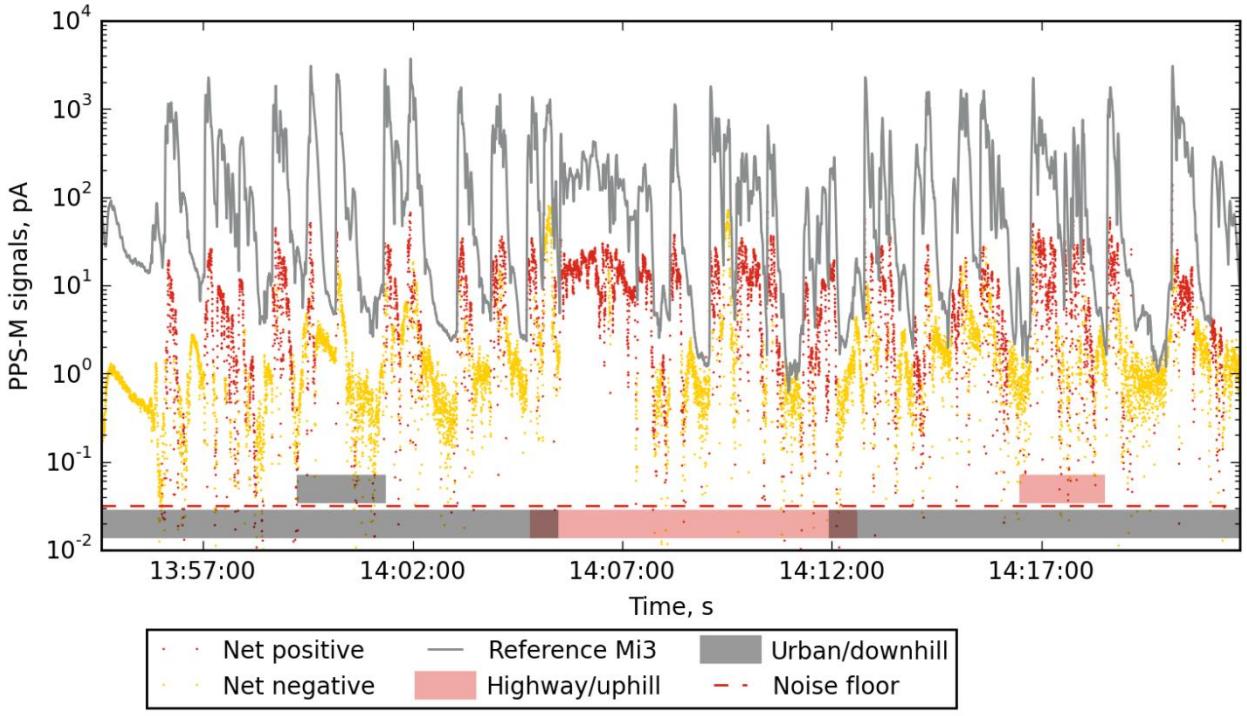




Charge state measurement

- High emission -> net positive
- Low emission -> net negative



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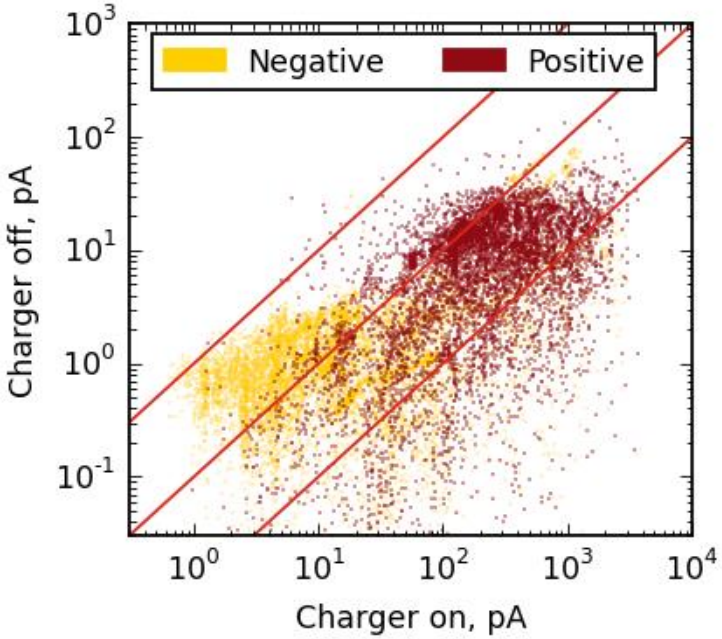
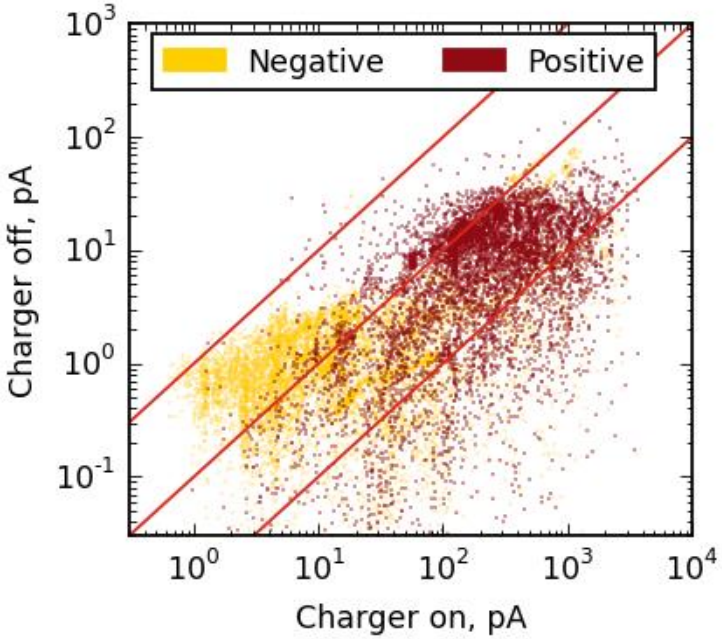
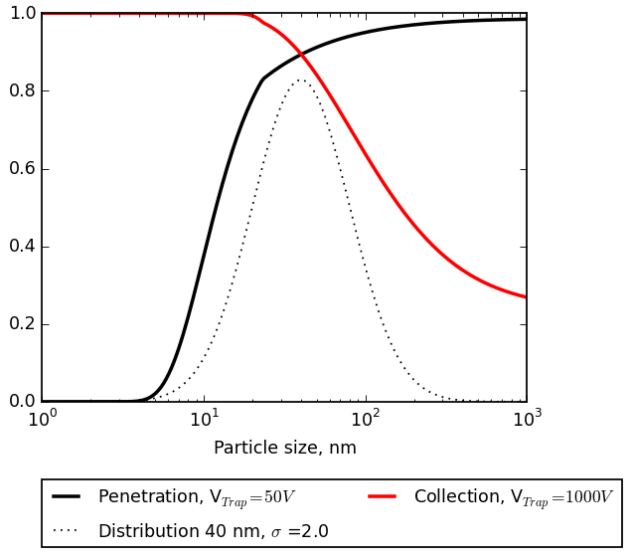


Charge state measurement

- Not enough data here to have the full story; chemistry missing.
- Normally Boltzmann favors negative charging. Also for combustion products (Maricq, AS&T, 2006&2008, Lähde 2014)
- At high load and acceleration, gasoline engines emit typically high NO and even some NH3, which have high proton affinity
- Hypothesis: at high load, positive ions are favored due to increased proton affinity of the gas
  - Lambda?
- High charging efficiency at negative side lkely explained by nucleation mode outside the response overlap





Conclusion

- Use of CS@300ºC did not show any volatiles not already evaporated at 200ºC
- GDI net charge state swings widely
  - Proton/electron affinity balance effects?
- Simple sensor can be tweaked to give another dimension of information when paired with a reference

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References

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Thank You

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Charge state measurement

- PS. CTe engine has a ”boost mode” at gears 2-4 at high load