SHIMADZU

Development of a novel electro mobility analyzer based on a new classifying principle and applications for nanoparticles from different types of vehicles under various conditions.

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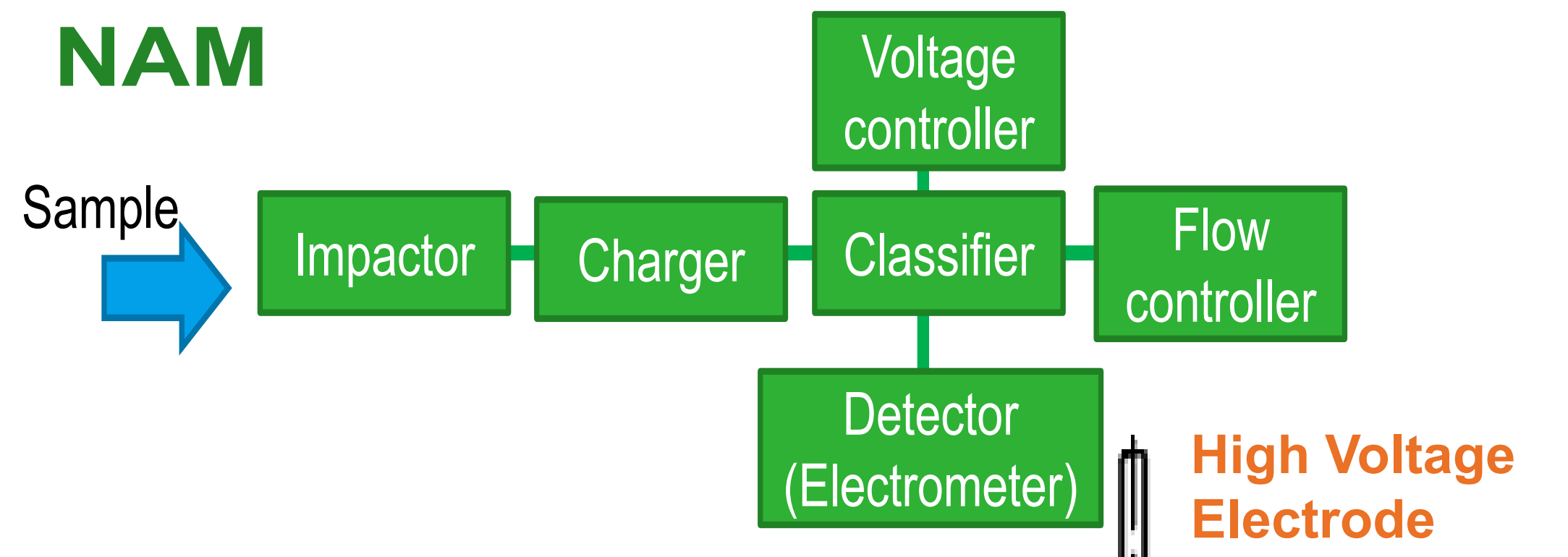
1. Introduction

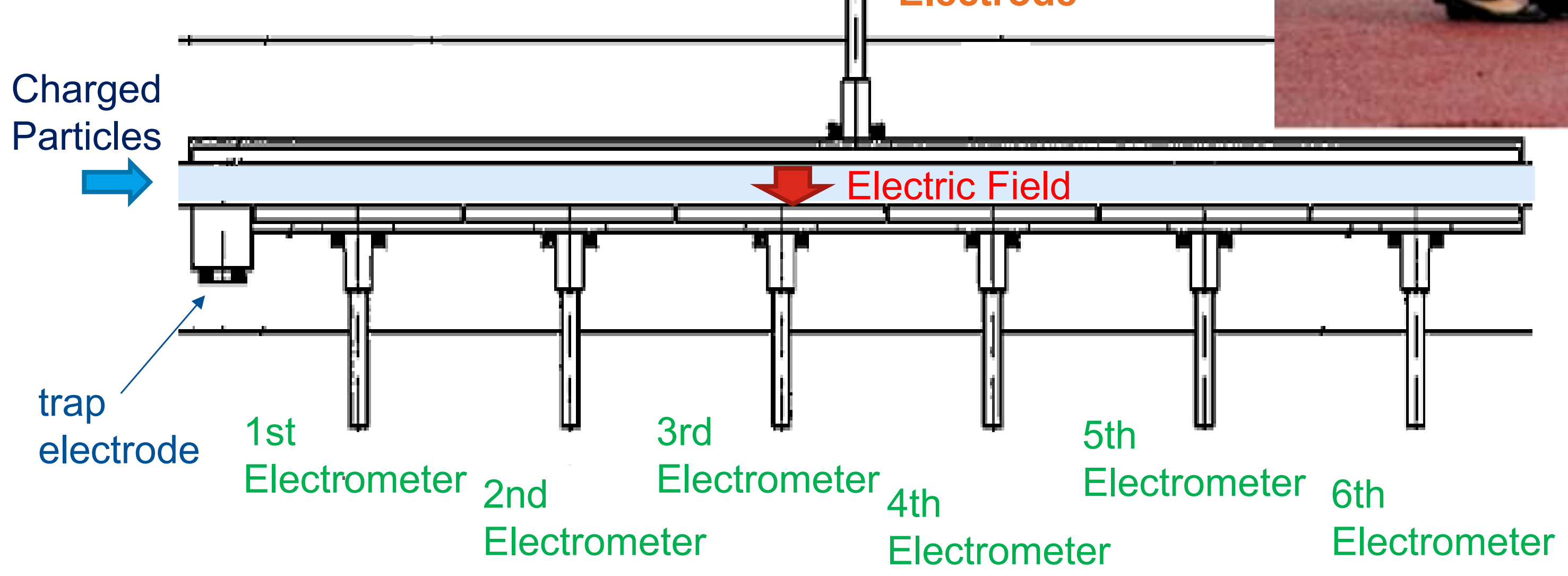
We developed new device, Nano-Aerosol Monitor (NAM), that…

- has a same sensitivity with PMP system
- is not so expensive.
- can define particle diameter.
- **has a possibility to perform PN PEMS**

2. New equipment, NAM

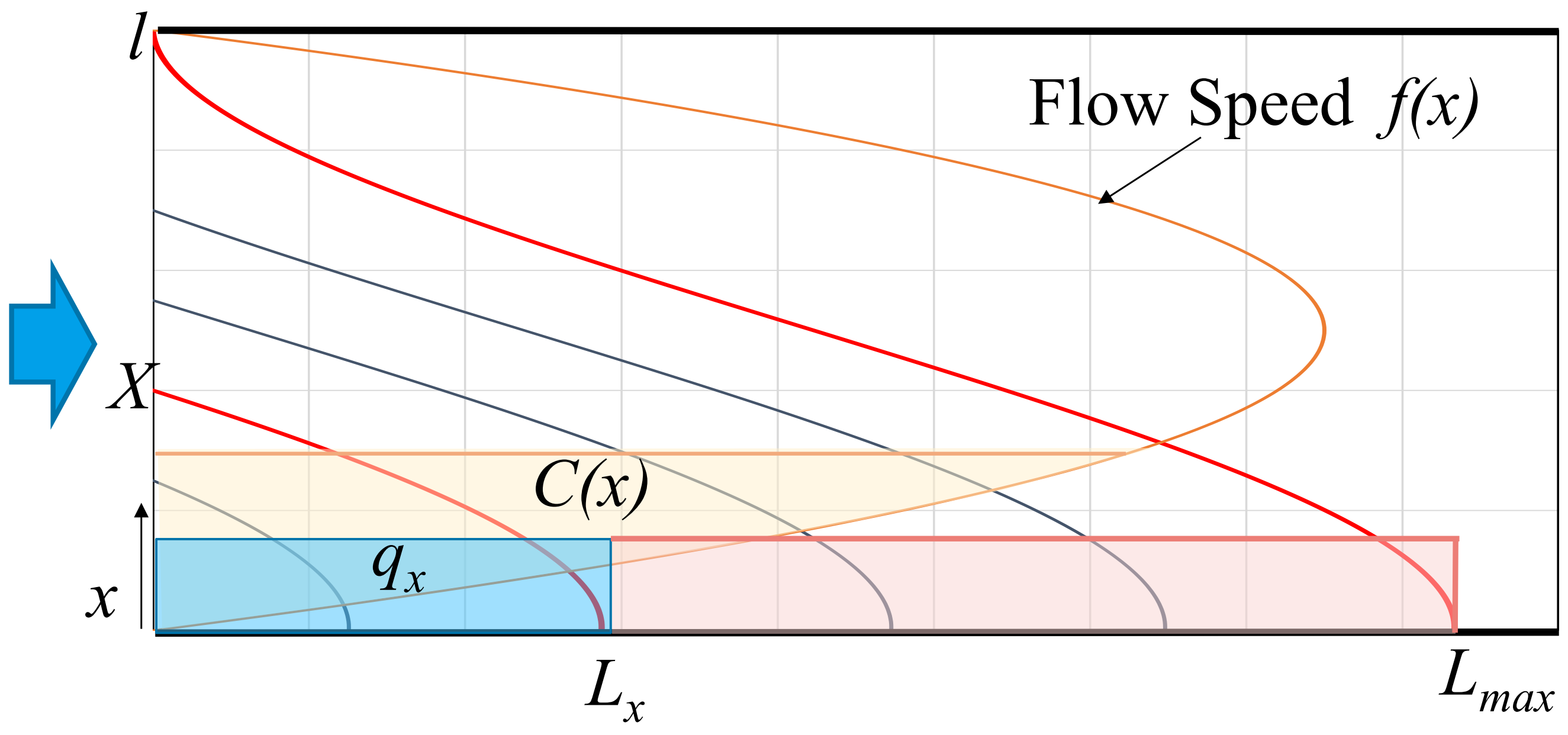
- **No pre-treatment to remove the volatile particles**
- Electrometer for on-board measurement
- Classifier for compatible with PMP system





- Charged particles are moved to bottom side by the electric field and detected by the electrometer.
- **NAM does not use sheath flow.**

2. Classification Principle



Particle Concentration: $C_0(\text{-}/m^3)$ Width: $W(m)$ Voltage: $V(V)$

Flow Rate: $Q(m^3/sec)$

$$Q = W\int_0^l f(x)dx$$

Maximum Flight Length of the particle with Electromobility Zp: $L_{max}(m)$

$$L_{\max} = \frac{Ql}{WZ_pV}$$

Accumulation range L_{max} depends on Z_p.

Flight Length: $L_X(m)$ $0<X\leqq l$

$$L_X = \bar{v}_X t_X = \frac{1}{X}\int_0^X f(x)dx \frac{X}{Z_p\frac{V}{l}}$$

Particles which passed 0-X per sec : $C_X(number/sec)$

$$C_X = C_0Q\frac{\int_0^X f(x)dx}{\int_0^l f(x)dx}$$

Density of particles which arrive 0 to L_X : $q_X(number/sec/m^2)$

$$q_X = \frac{C_X}{WL_X} = \frac{C_0Q\frac{\int_0^X f(x)dx}{\int_0^l f(x)dx}}{W\frac{1}{X}\int_0^X f(x)dx\frac{X}{Z_p\frac{V}{l}}} = C_0Z_p\frac{V}{l}$$

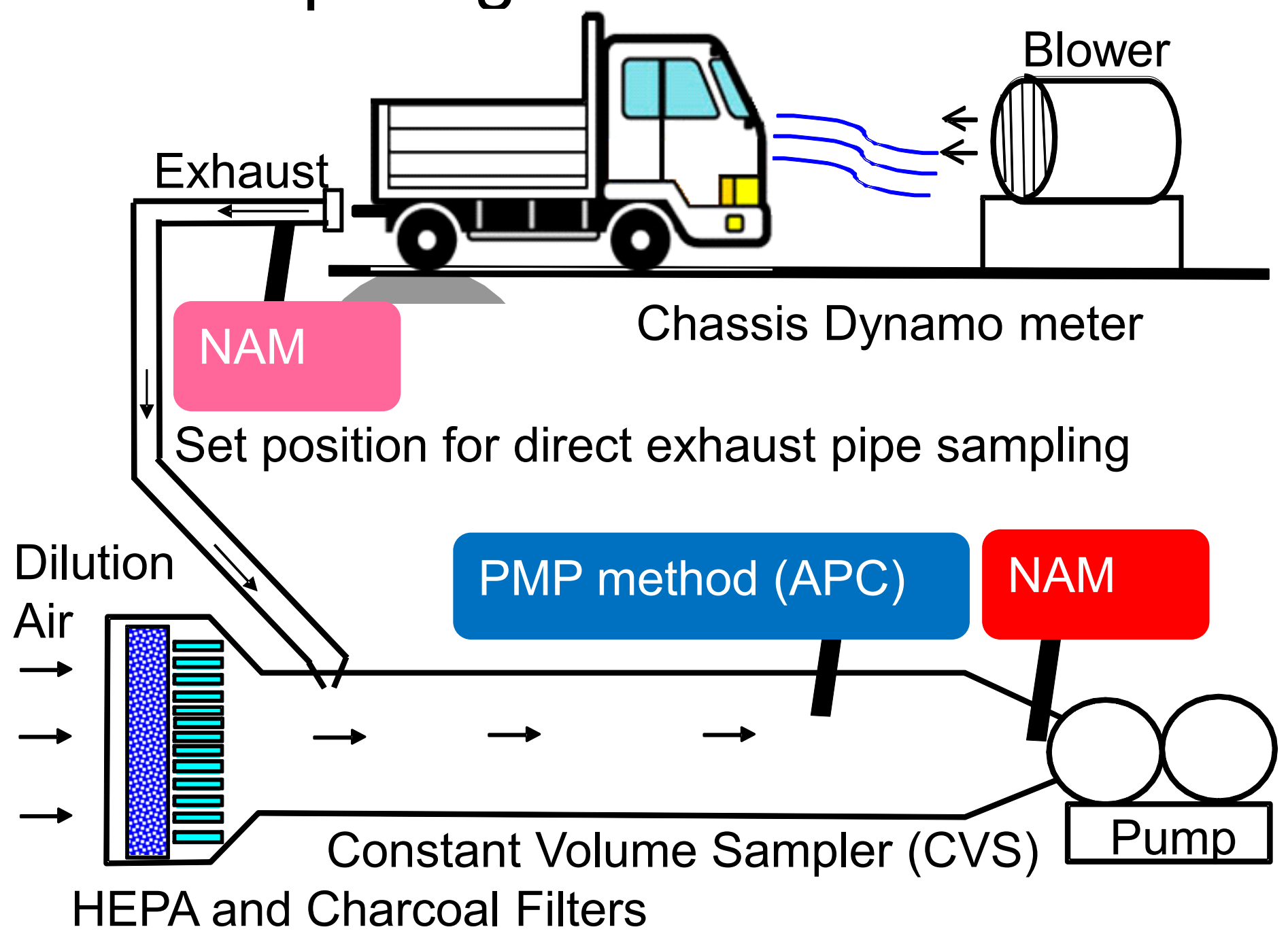
Accumulation density q_x is horizontal.

Same area of electrodes catch same level of signals from same Z_p particles when they are in accumulation range. Differential signal from the electrodes can cancel the effect of low Z_p particles. High Z_p particles can be caught on only the electrode which is set closer to inlet.

⇨ **NAM can define particle diameter without sheath flow.**

3. Exhaust observation

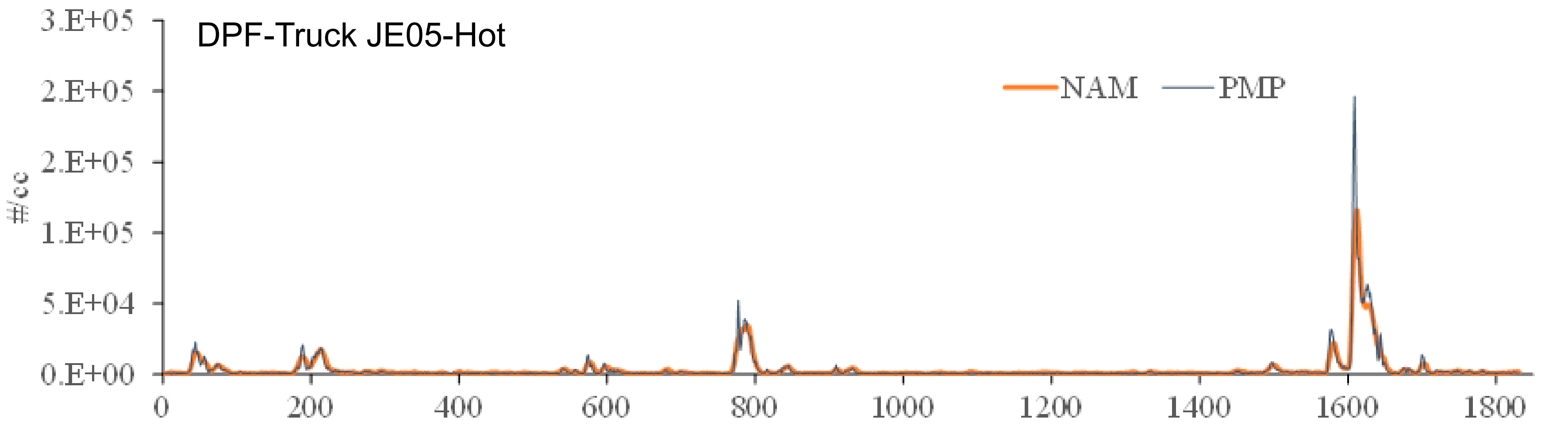
Measuring particles from automobiles by the procedure of European type approval tests (not PEMS) with NAM and PMP methodology. And comparing the each results.

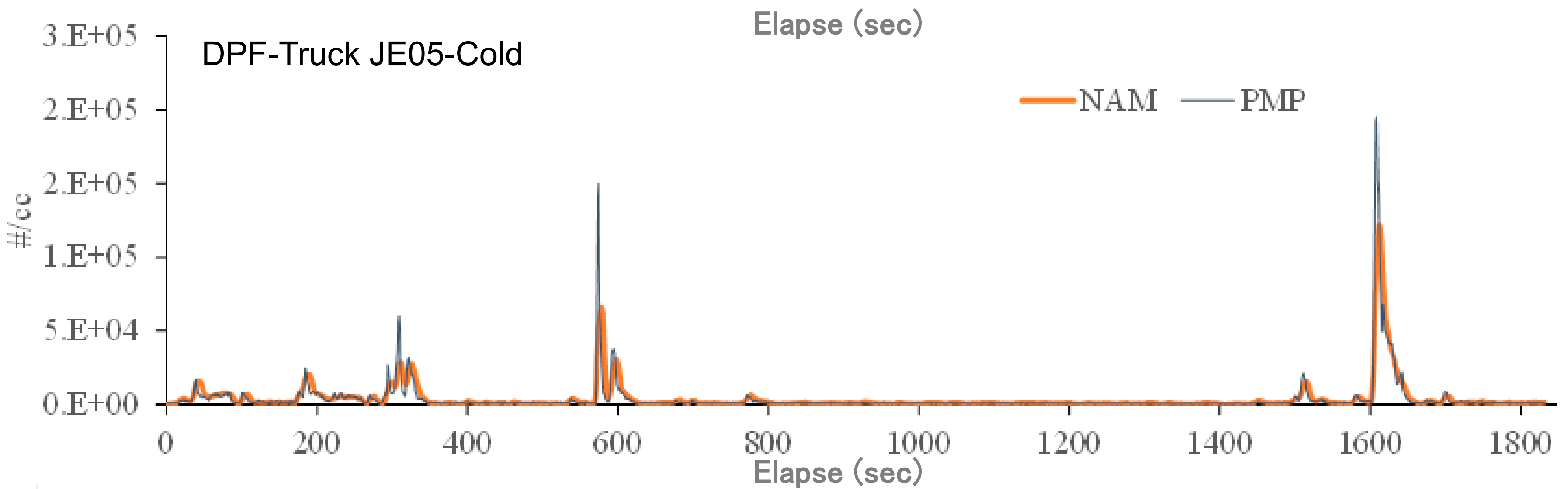


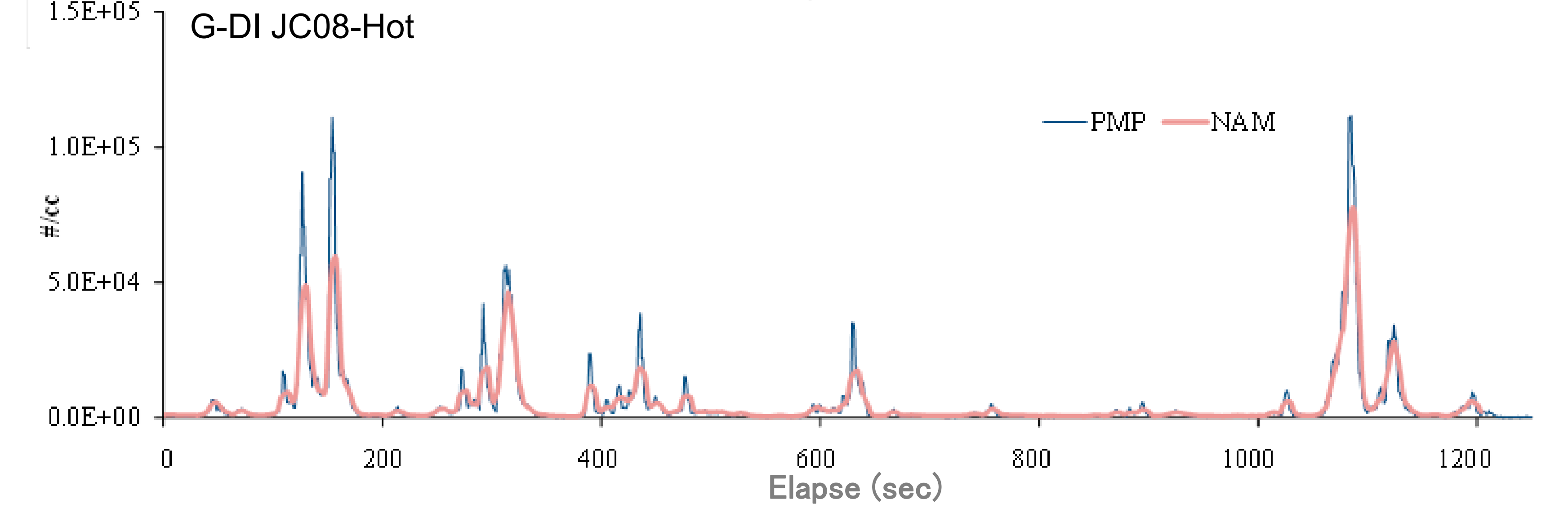
Tested Vehicles

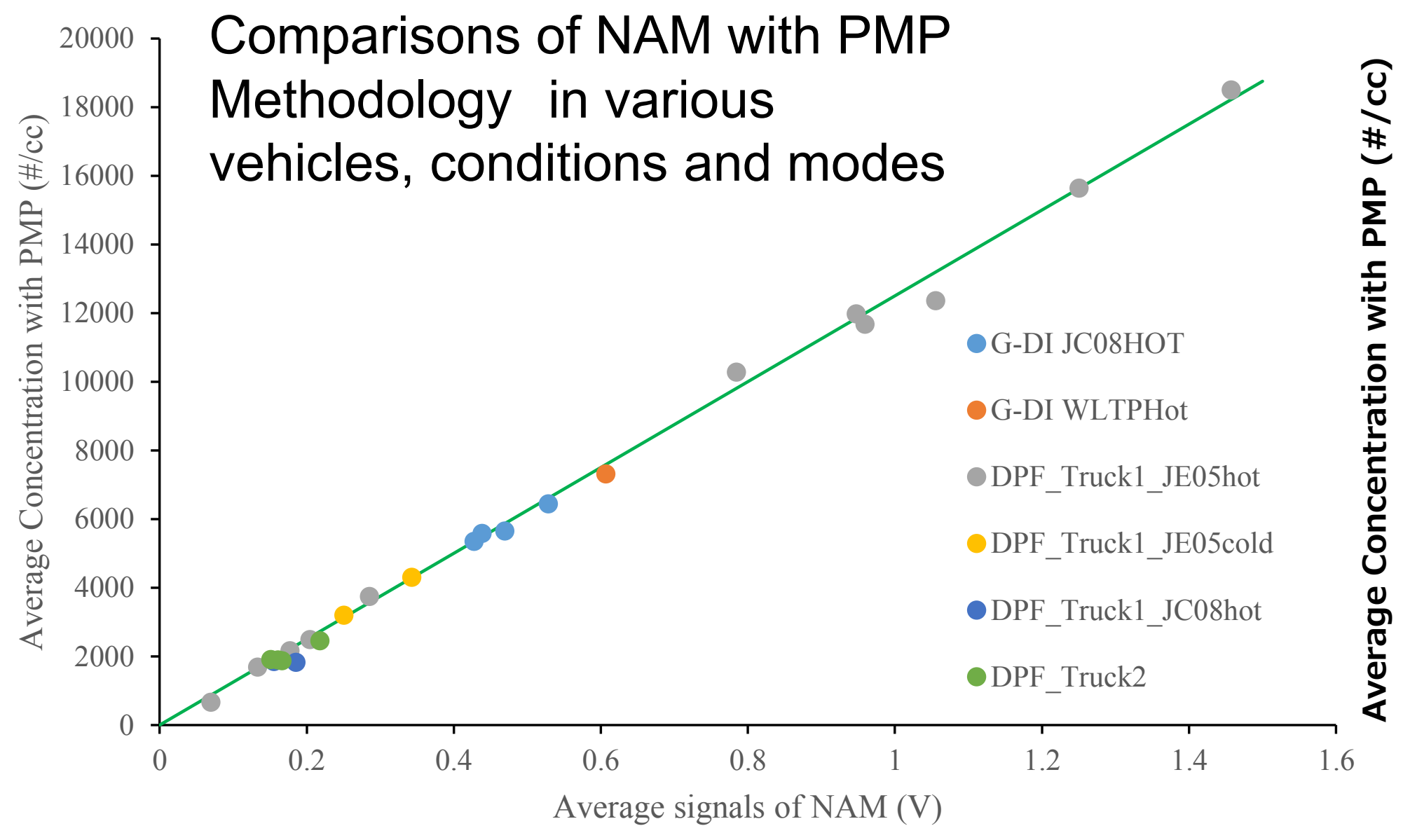
Name	Engine	Displace-ment	After treat-ment	Emission	Vehicle Weight
G-DI	Gasoline D I	1.977L	3 Way Cat.	2005JP (=Euro 6)	1460 kg
DPF-Truck1	Diesel	2.999L	DOC + DPF	2010JP (=Euro VI)	3105 kg
DPF-Truck2	Diesel	2.999L	DOC + DPF	2005JP (=Euro V)	3430 kg

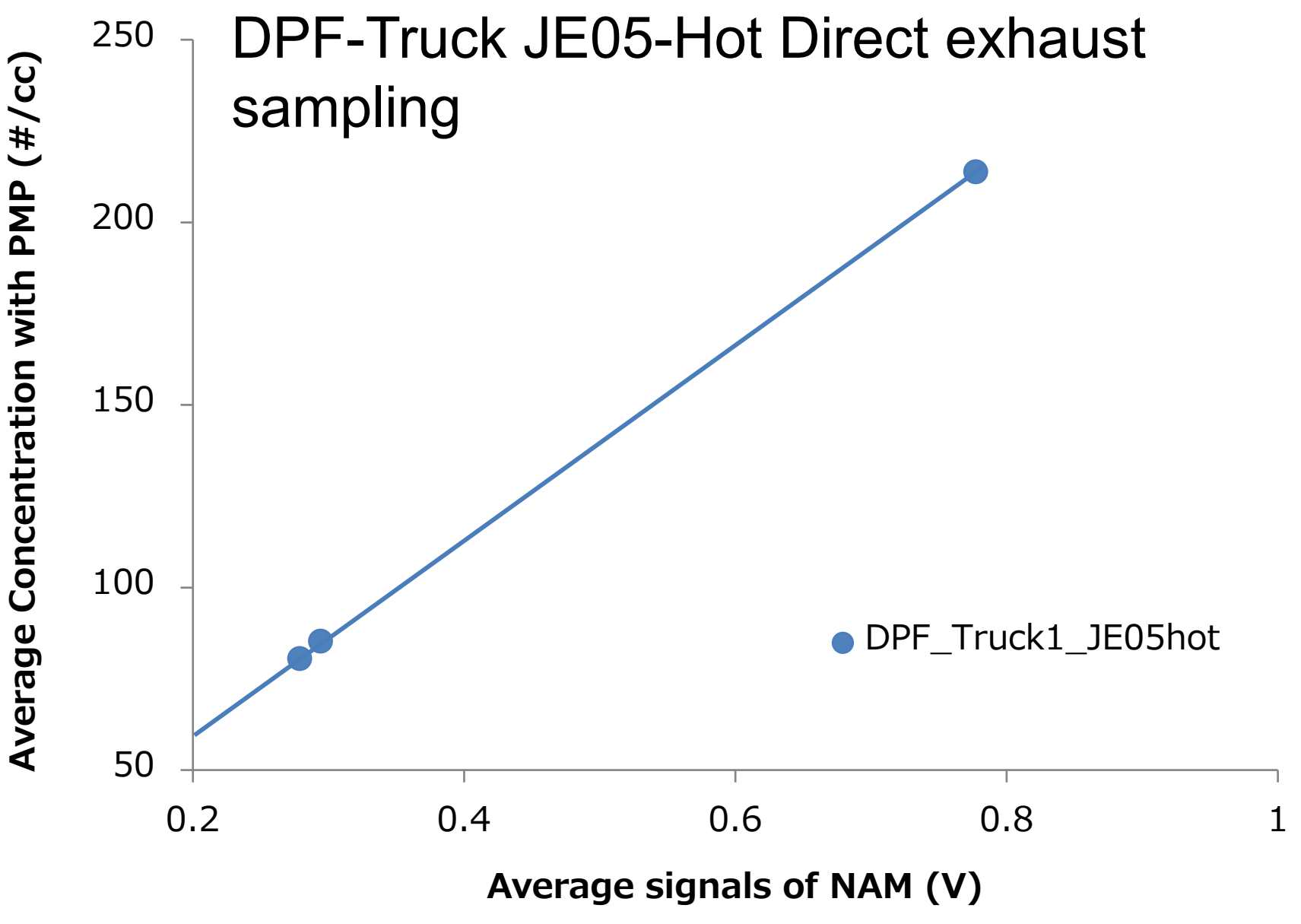
4. Result











5. Conclusion

- Comparisons of NAM with PMP were performed by the exhaust of a gasoline DI passenger car and 2 DPF diesel trucks.
- In the measurements of cold start gasoline DI car, exhaust was over- scaled, however except this condition, NAM profiles were agree with those by PMP.
- Correlations of NAM with PMP were excellent even though NAM does not equip VPR.
- This study indicated that NAM can be used for diesel and gasoline-DI engines / vehicles developments.
- We will apply NAM to on-board measurements, near future.

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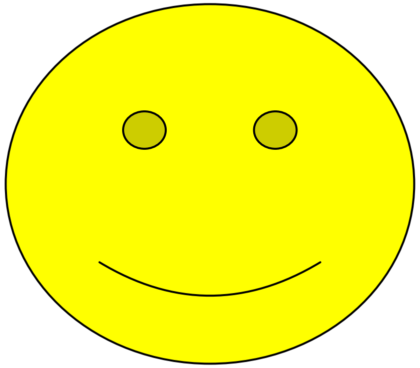

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