HORIBA
Automotive Test Systems

Performance of HORIBA-SPCS in the PMP LDD ILCE

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Acknowledgement

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Motivation of Development

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- Conventional PM Measurement
  - **Mass Measurement is approaching to limit**
  - **Variation of Measurement is very high**
- PMP Background
  - **Alternative/Improvement of Mass Measurement**
  - **Considering danger of Nano-Particles**
- ECE Draft Regulation from PMP
  - **Number Counting of Particles**
  - **(Keeping Mass Measurement Active)**

PMP Recommended System

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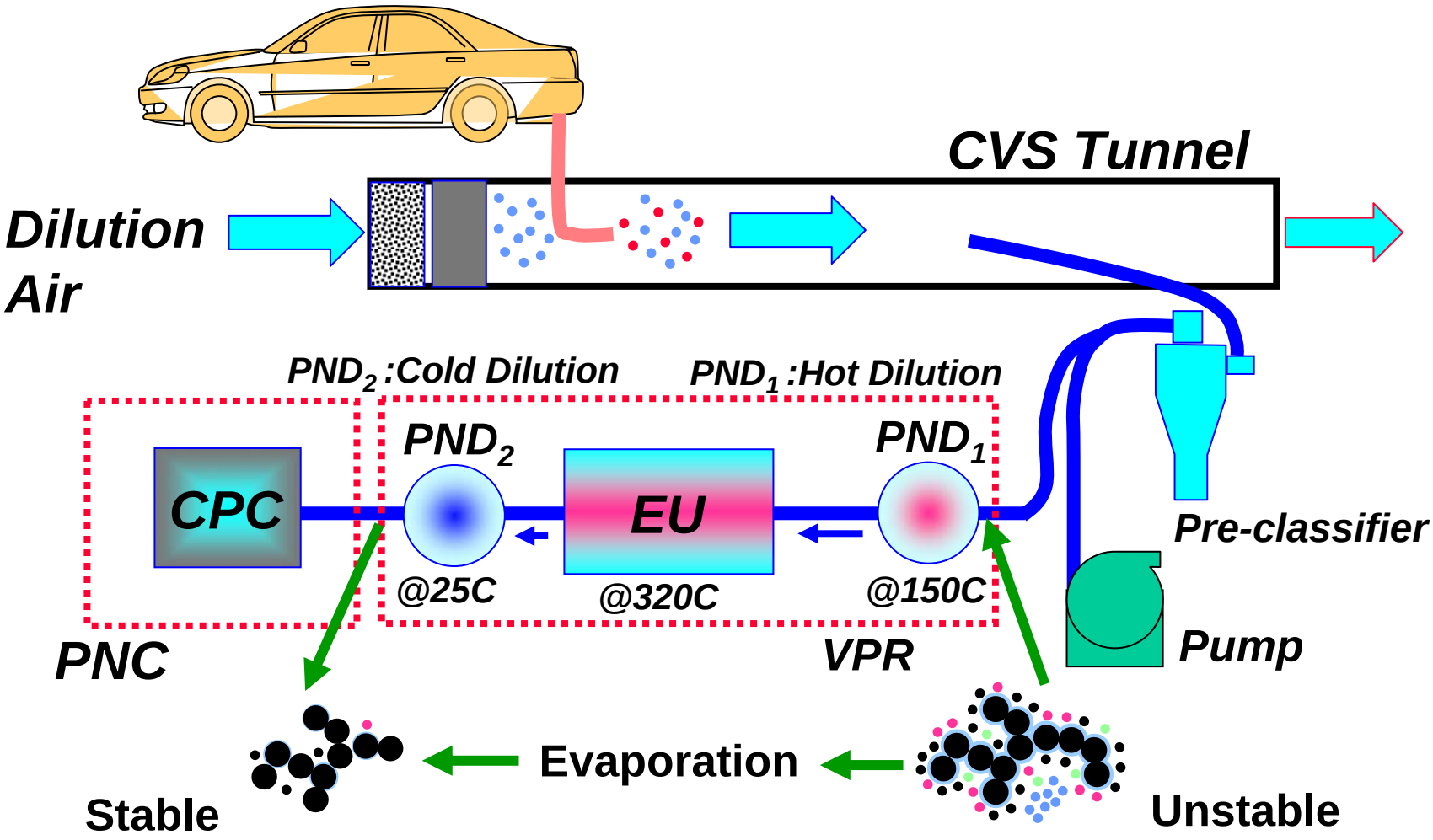

SPCS Flow Schematic

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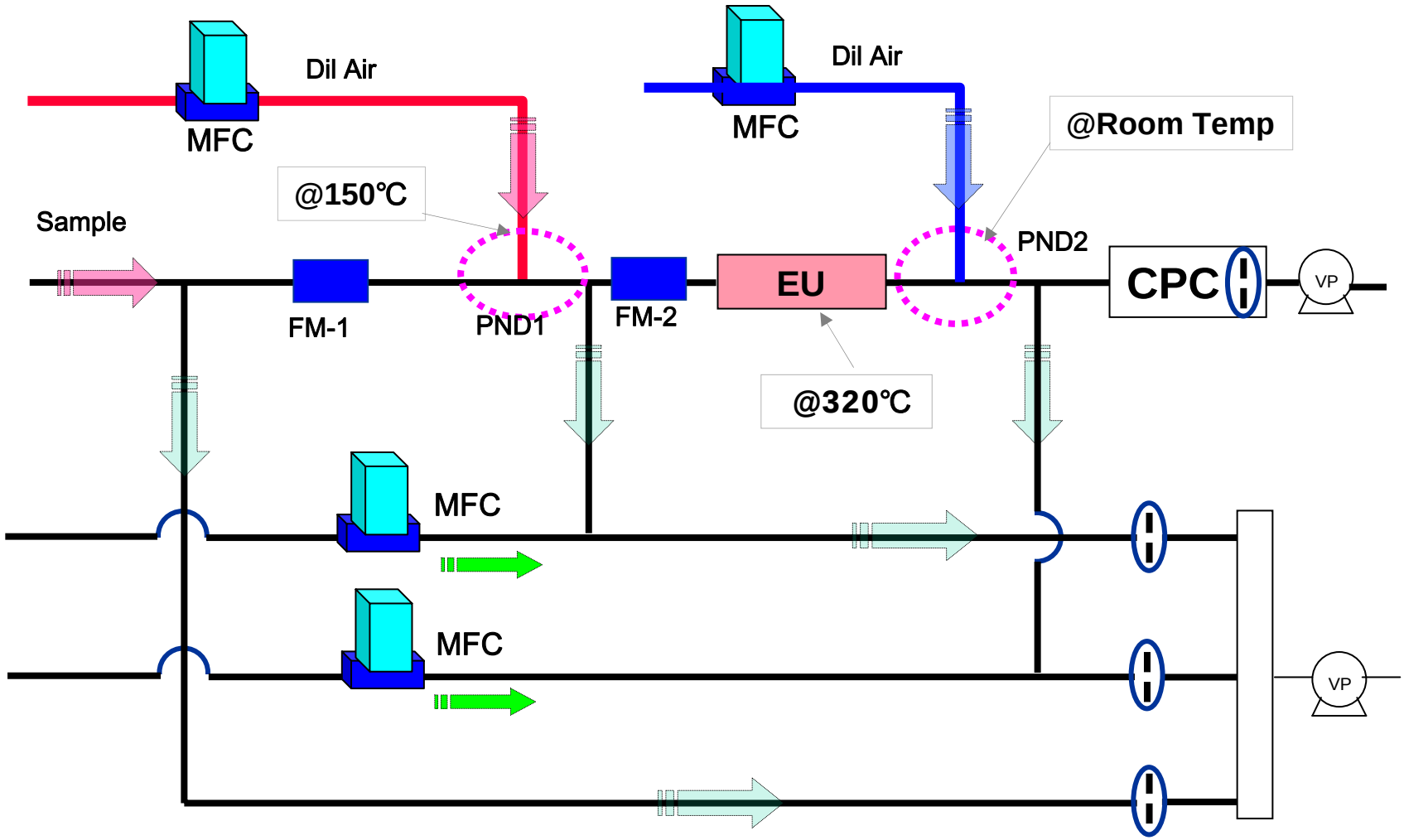

Detail of SPCS Design

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ETH 2005

SAE Paper 2006-01-0864

SAE Paper 2006-01-0865

JSAE Paper 20065044

Prototype HORIBA SPCS

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Front

Back

Basic Performances In Brief

Penetration of Solid Particles

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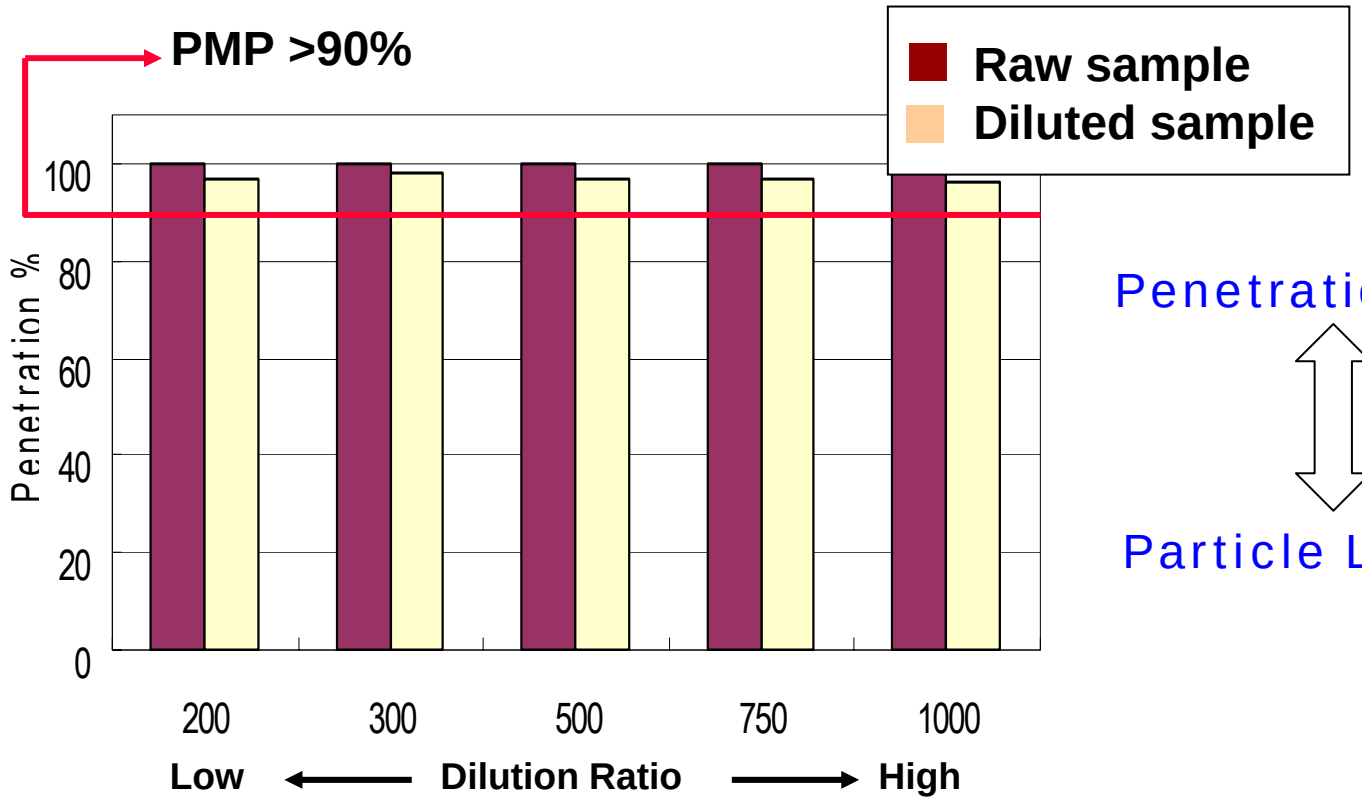
$$\text{Penetration} = \frac{\text{Concentration after SPCS x DR}}{\text{Raw Concentration Before SPCS}} \text{ X } 100$$



Penetration >97%

Particle Loss <3%

Dilution Ratio Check with C_3H_8

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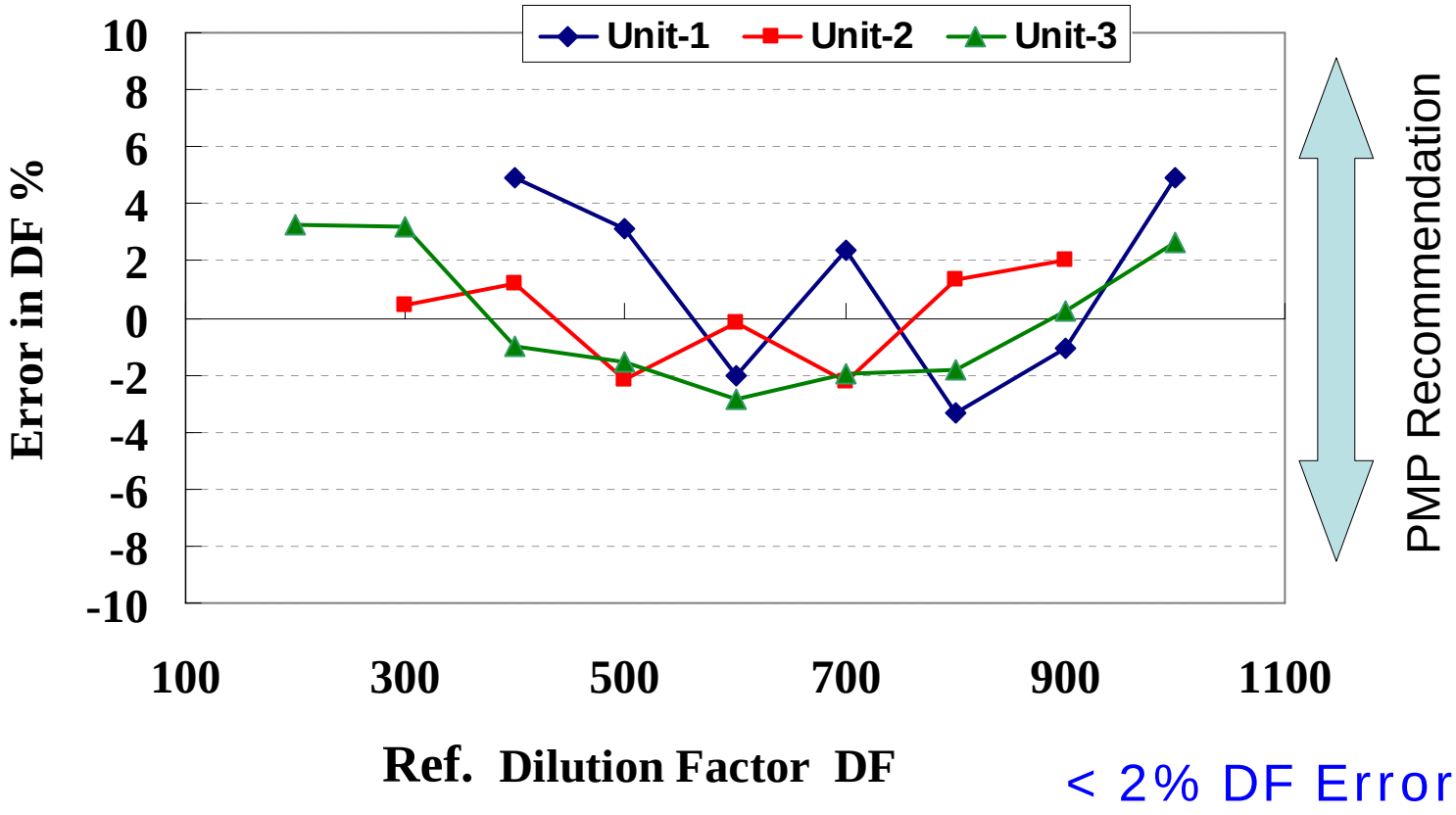
$$\text{Actual DF} = \frac{\text{Raw Concentration } (C_3H_8)}{\text{Diluted Conc. - Background}} \qquad \text{Error in DF} = \frac{\textbf{Ref. DF – Act. DF}}{\textbf{Ref. DF}} \times 100$$



< 2% DF Error <6%

Removal of 50nm C40 Particles

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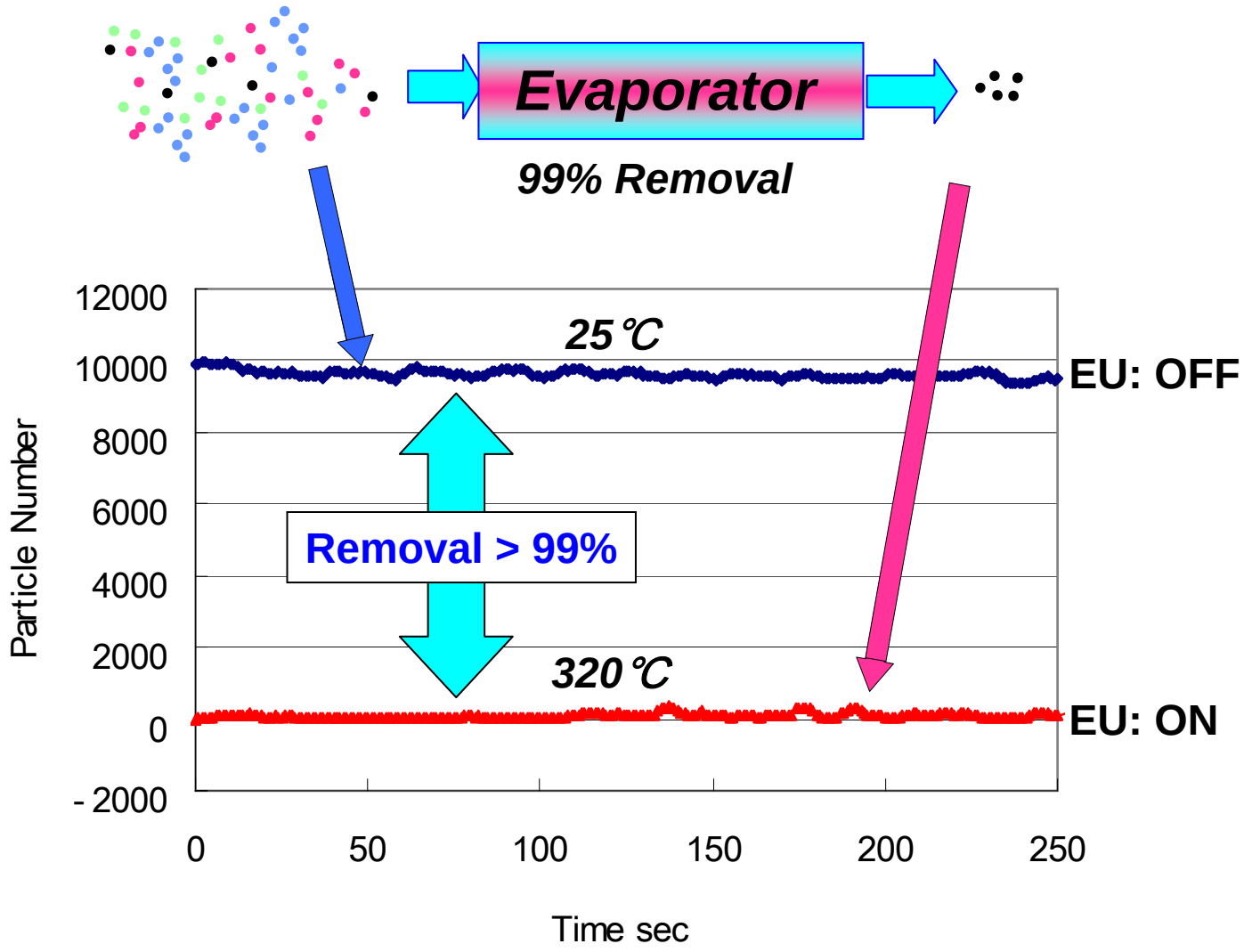

Linearity of Counter

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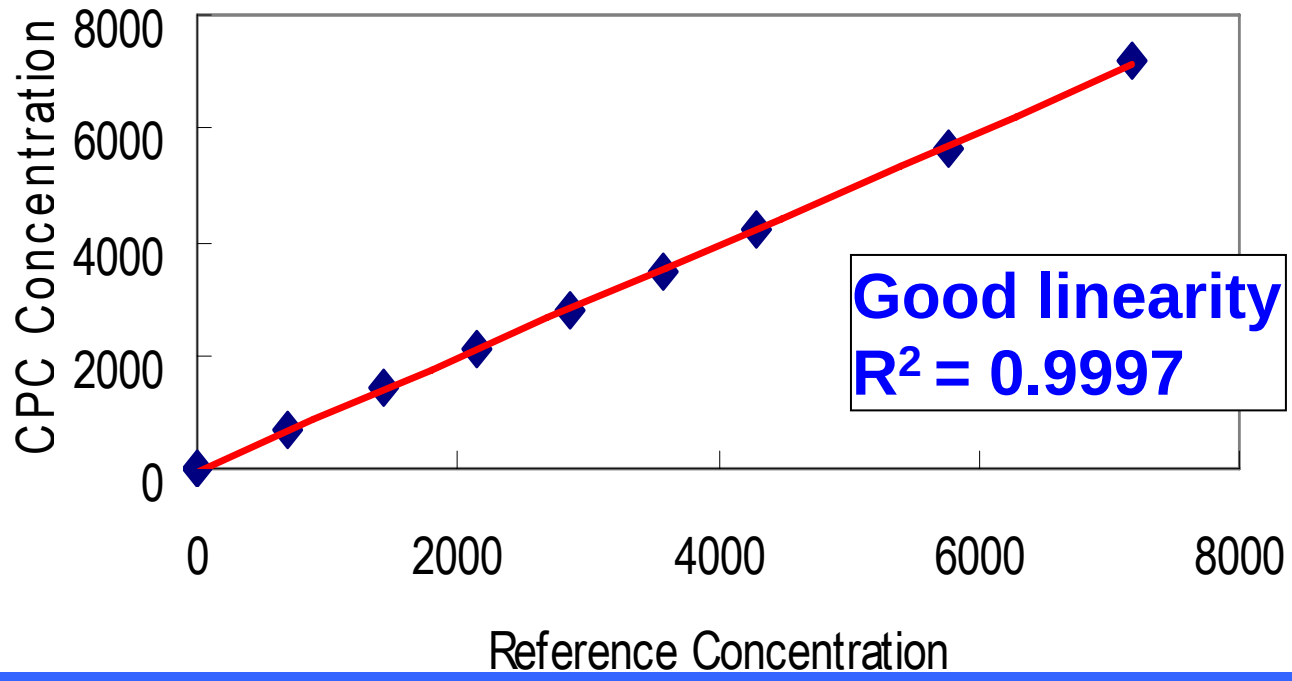
	Particle Only	Particle + Air						Air Only
Fraction	100%	80%	60%	50%	40%	30%	20%	10%	0%
Reference	7200	5760	4320	3600	2880	2160	1440	720	0
HORIBA-SPCS	7200	5757	4317	3598	2877	2164	1445	728	4

Calculated

Actual



Inter-Lab Correlation Test

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JRC (EC)

AVL-MTC
(Sweden)

UTAC
(France)

Ricardo
(UK)

Shell (UK)

RWTÜV
(Germany)

NMVERL
(Korea)

HORIBA

Aristotle Univ.
(Greece)

NTSEL
(Japan)

JRC (EC)

Test Vehicles

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	Engine	Swept Vol.	After Treatment system	Mileage	Transmission
GV	TC-DI Diesel	2.0 L	SiC + FBC	2898 km	Manual 6
AV-1	TC-DI Diesel	2.0 L	DPF + DOC	2140 km	Manual 5
AV-2	NA-DI Gasoline	3.0 L	TWC + NRC	9317 km	Automatic

Real Time Emission from GC

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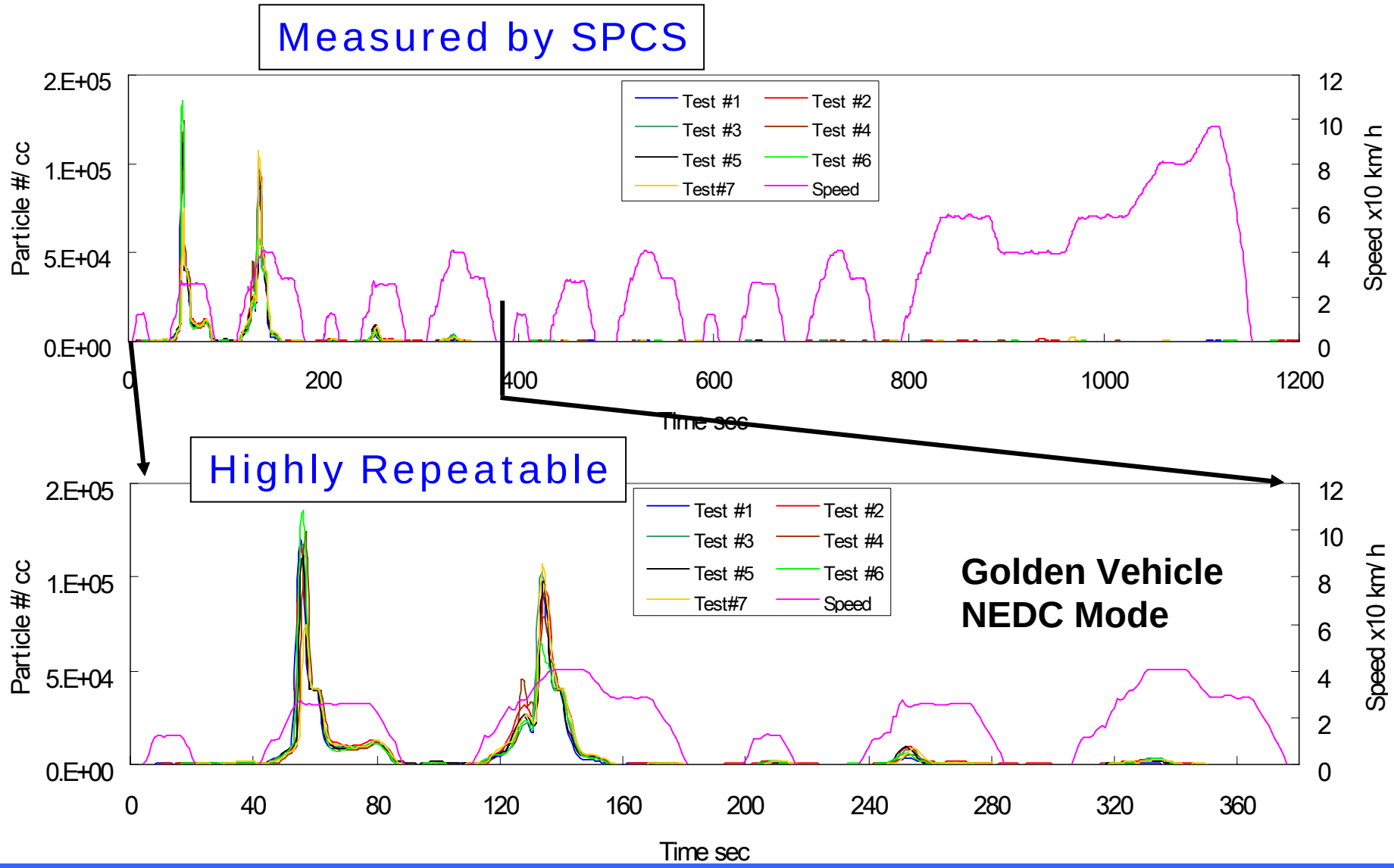

Particle Emission Rate

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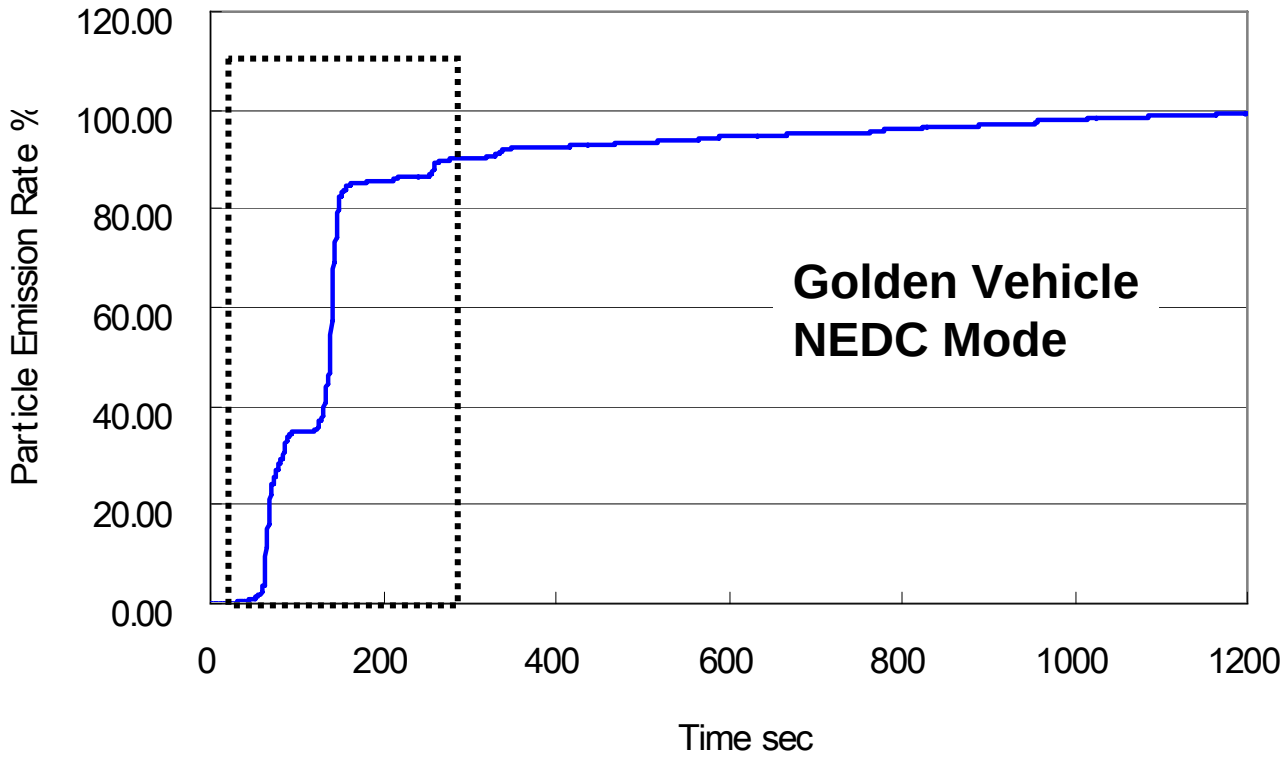
$$\text{Particle Emission Rate} = 100 \times \sum_{0}^{T=t} N \Big/ \sum_{0}^{T=1200} N$$



Test under JC08 Driving Mode

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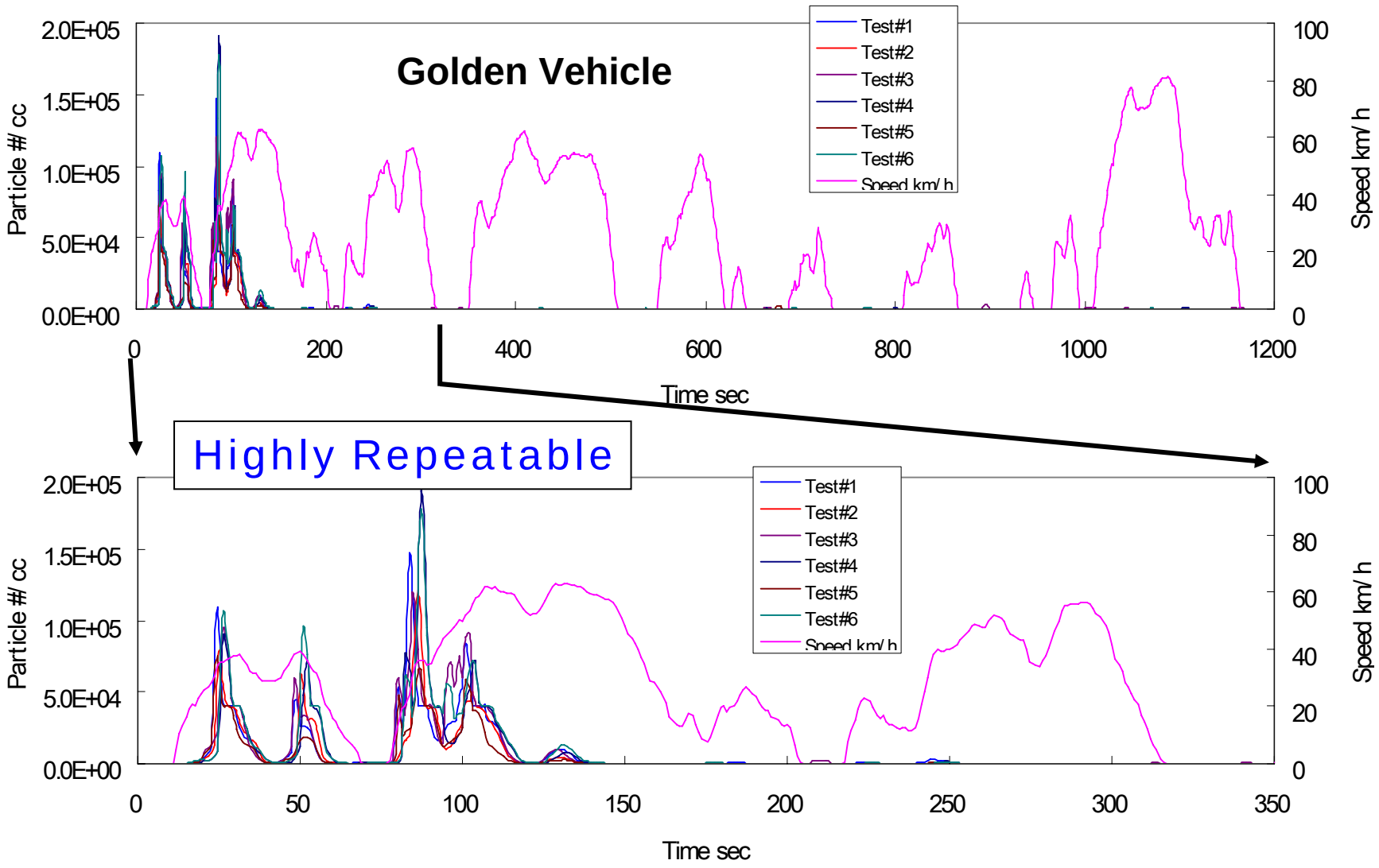

Emission from DI Gasoline

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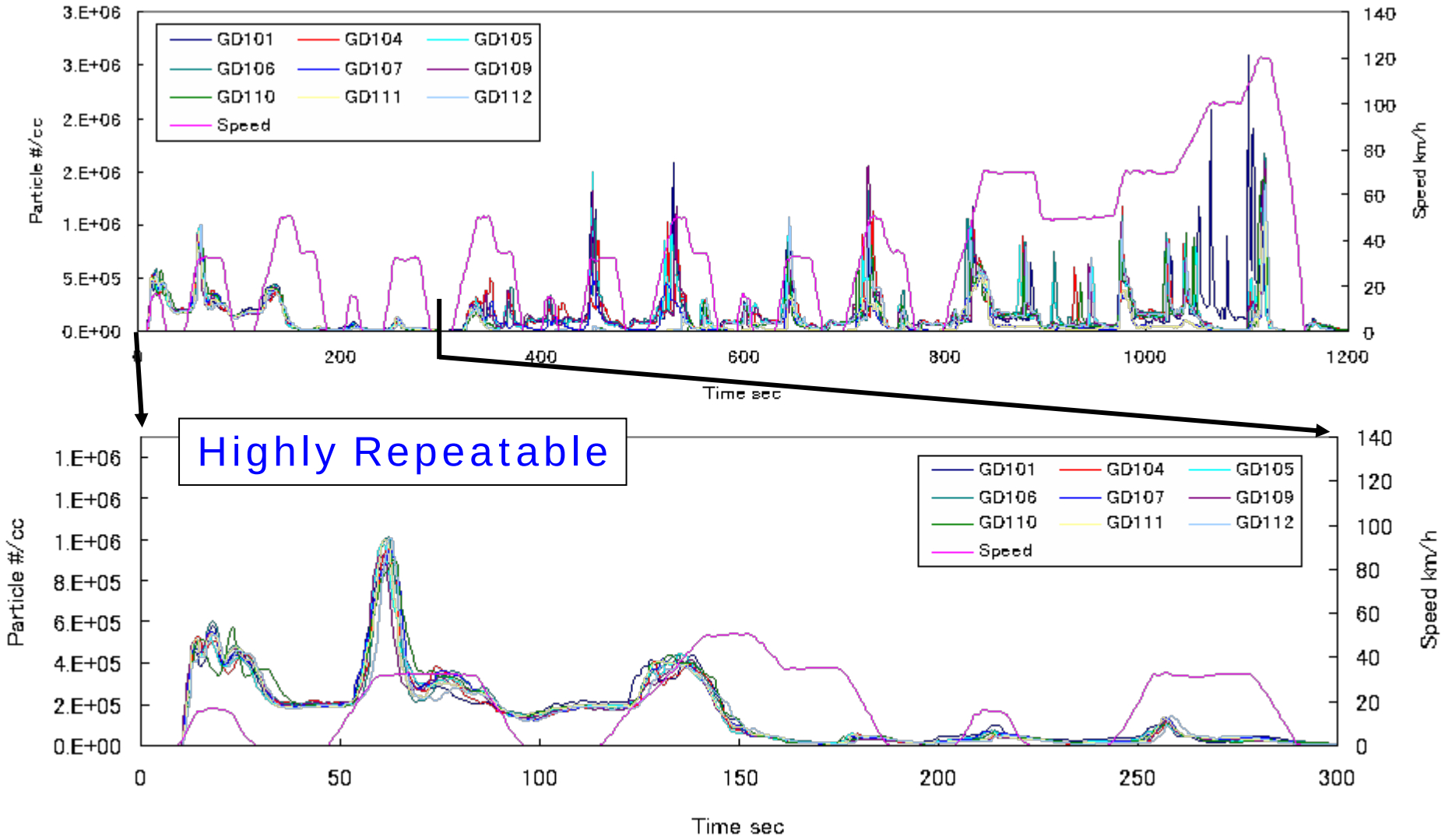

Particle Emission Rate

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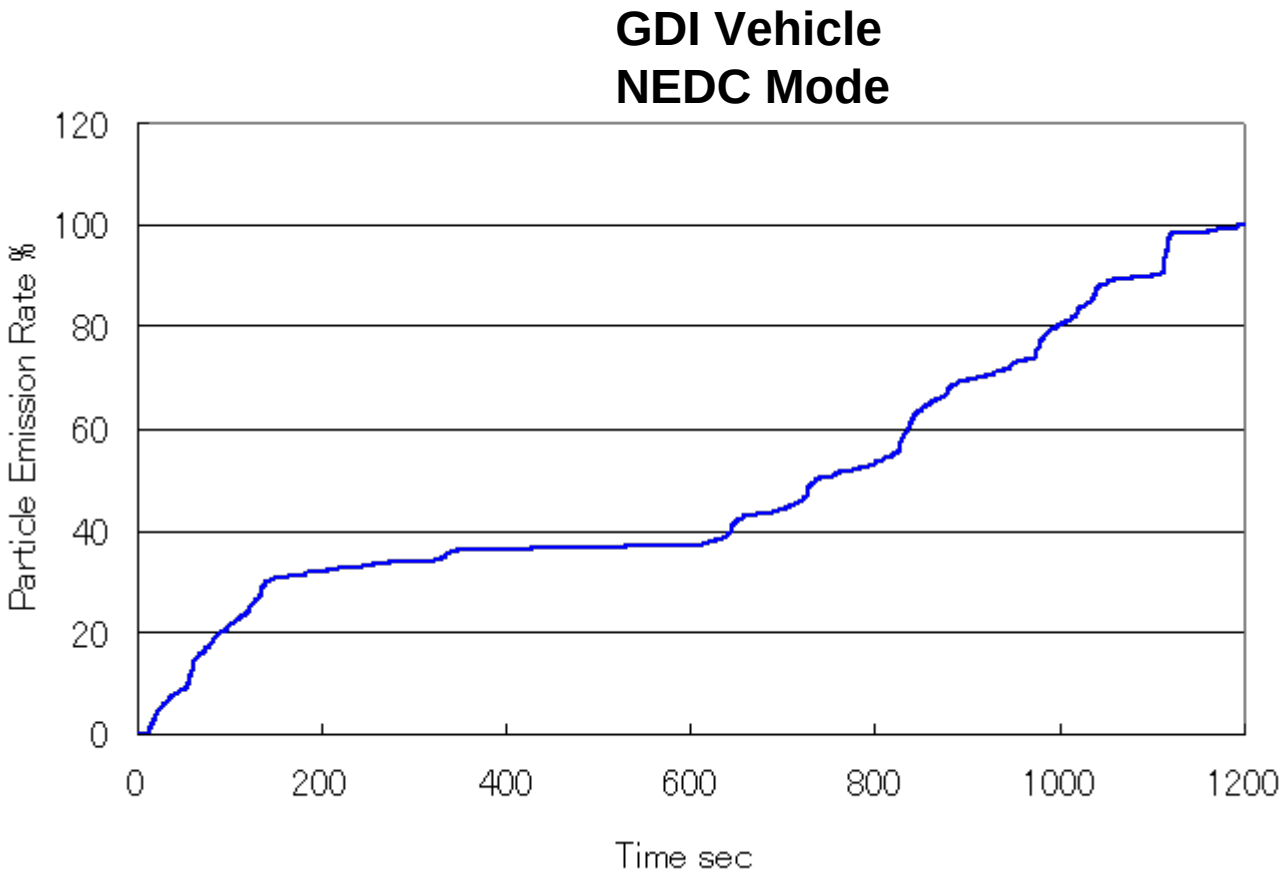

Repeatability of PM Mass

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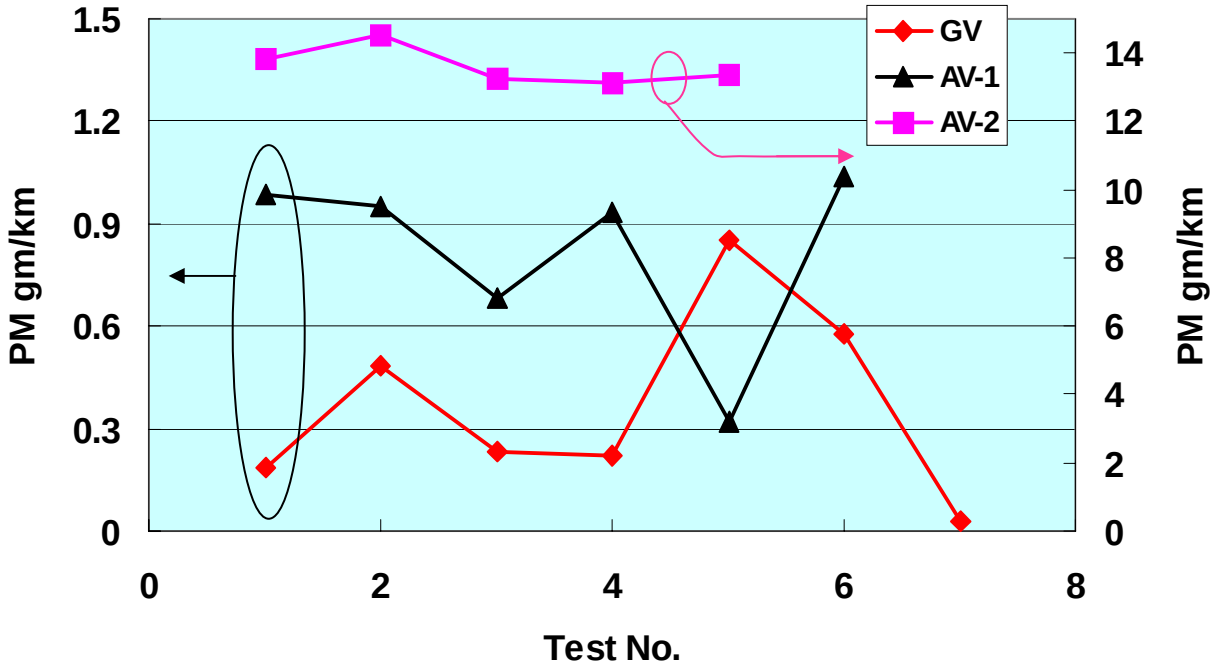

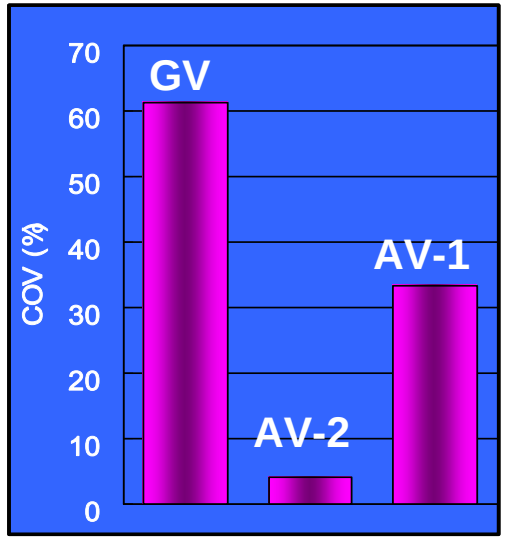

Repeatability of PM Number

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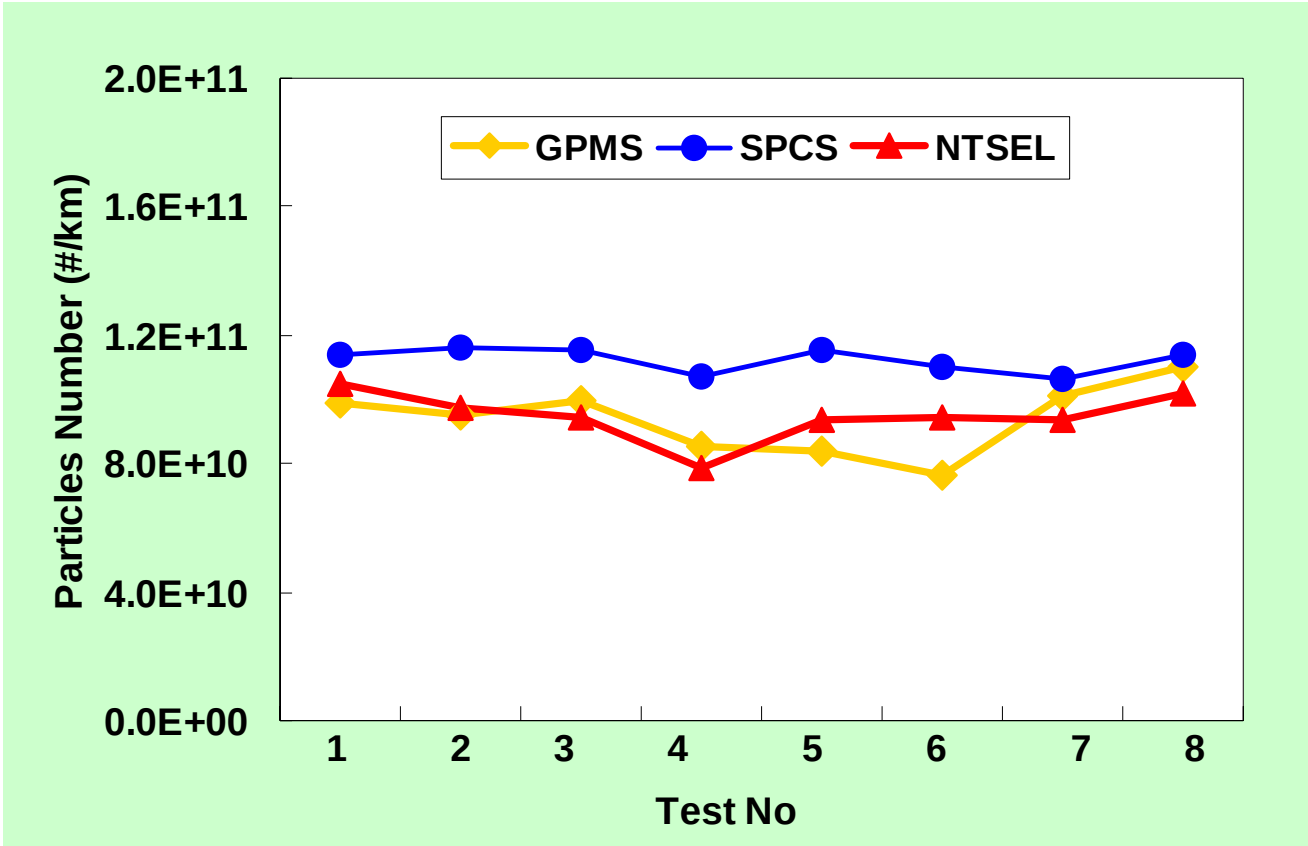
Golden vehicle driven under NEDC mode



Co-Efficient of Variation

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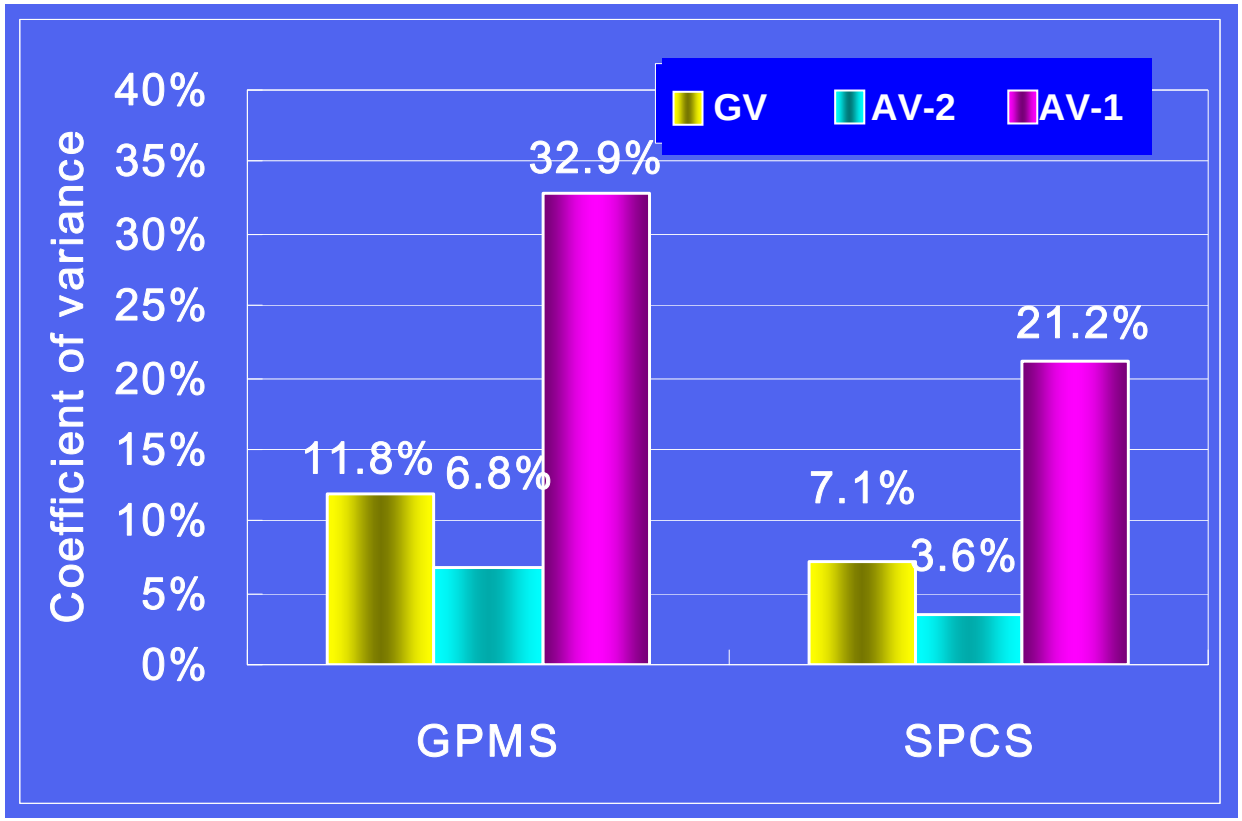

Conclusions

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- A solid particle counting system has been developed according to PMP recommendation.
- The SPCS shows excellent sensitivity and repeatability for vehicle test.
- The SPCS exhibits over 97% penetration for solid particles and error in dilution ratios less than ± 6%.
- The system participated to the LDD_ILCE@NTSEL successfully.
- Number counting of solid particles shows better repeatability than the conventional gravimetric mass measurement if the car is conditioned appropriately.

Thanking you

Explore the future

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