PMP HD Validation Exercise and Round Robin

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PMP Heavy Duty Validation Exercise and Round Robin
Both coordinated by the JRC

PMP HD Validation Exercise

- Golden Engine-1

- Golden Systems

- Golden Engineer

- Same fuel and lubricant

- Both full flow system and partial flow system

- Participant: JRC, UTAC, AVL MTC, EMPA, …

PMP HD Round Robin exercise

- Golden Engine-2

- Instrument chosen by each lab

- No Golden Engineer

- Standard ref. fuel/lubricant

- Both full flow system and partial flow system

- 10 laboratories from EU, Japan Korea, Canada

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PMP HD Round Robin exercise

- Golden Engine-2 : DC Engine provided by ACEA

- Each lab will use its own instrument

- No Golden Engineer

- Standard ref. fuel/lubricant

- Both full flow system and partial flow system

- 10 laboratories from EU, Japan Korea, Canada

- Expected start: after the exploratory work

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PMP HD Validation Exercise

- *Golden Engine-1 :* IVECO Cursor 8 Euro III + CRT

- *Golden Systems :* 2 SPCS from HORIBA

- *Golden Engineer:* Jon Andersson (Ricardo)

- *Fuel:* RF06-03 PMP (10 ppm sulphur)

- *Lubricant:* BP Vanellus E8 Ultra 5W-30

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PMP HD Validation Exercise

- *Total flow dilution system*

- *Partial flow system 1 :* AVL Smart Sampler

- *Partial flow system 2:* PSS-20 Control System
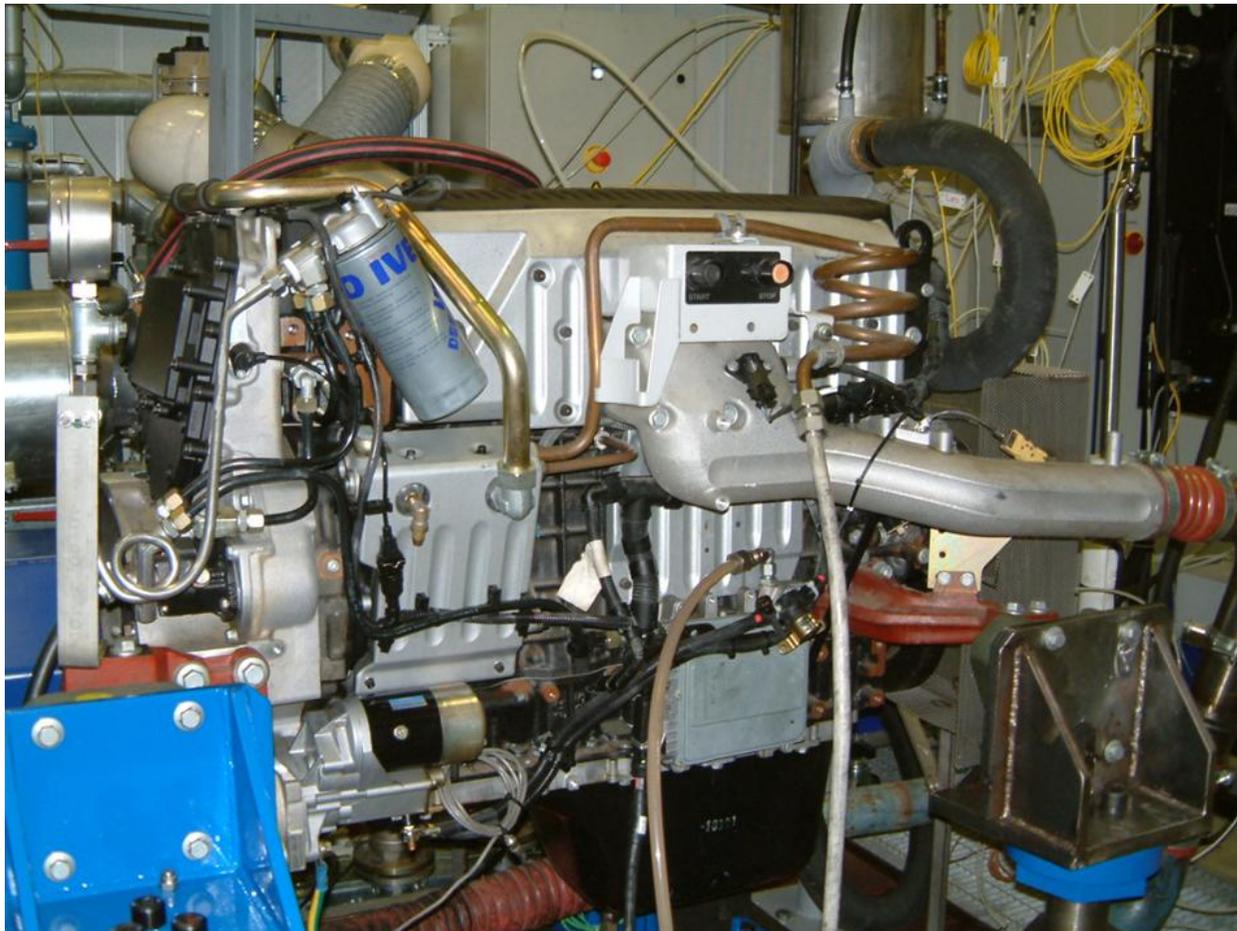
PMP HD Validation Exercise: Current status

– Upgrade of the test cell completed

– Golden Engine installed and running

– Lubricant and fuel OK

– Test protocol revised by the Golden Engineer

– Golden Instruments installed

– Exploratory work started

PMP HD Validation Exercise

– Works required for the test cell upgrade

- Upgrade of the test cell software in order to run the WHDC cycles
- Dilution air filtration system: checked and OK
- Secondary dilution air pump: HEPA filter added
- Use of heating blankets to control the temperature in the secondary dilution tunnel
- Installation of a cyclone in the PM sampling line
- Replacement of the 70 mm filter holders with 47 mm filter holders
- New sampling points for the particle counter systems
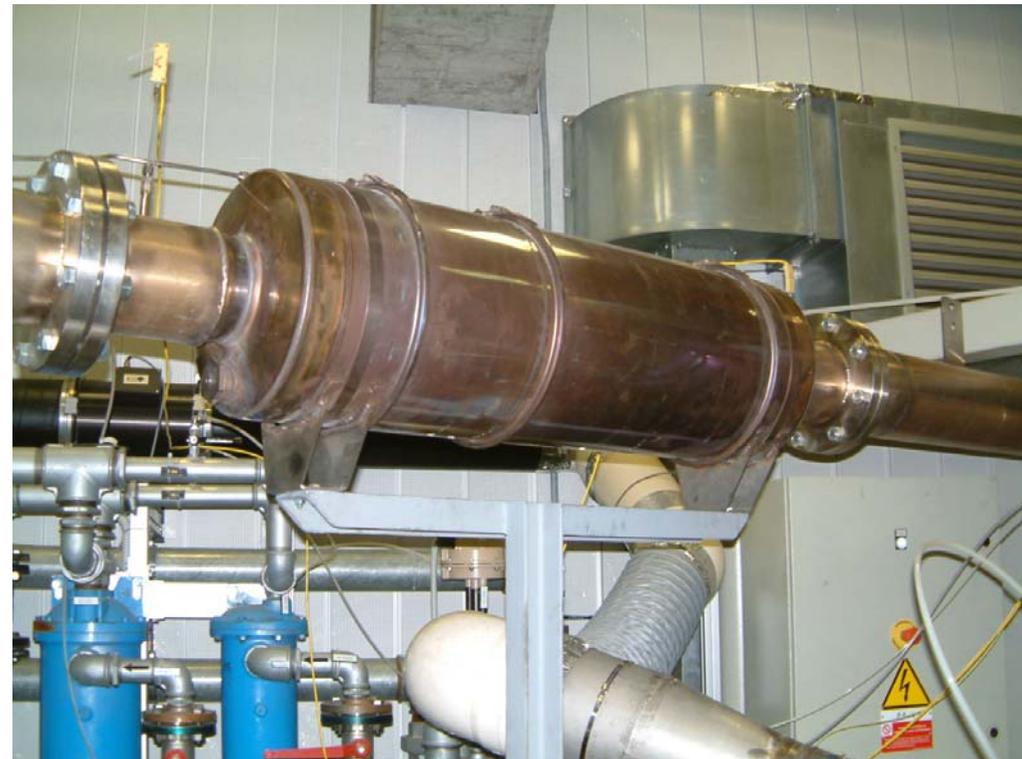- Upgrade of the partial flow system

PMP HD revised protocol

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
1		IFV	IFV	IFV	IFV	IFV	IFV	IFV	IFV	Warm-up	Warm-up
2		C-WHTC#1	C-WHTC#2	C-WHTC#3	C-WHTC#4	C-WHTC#5	C-WHTC#6	C-WHTC#7	C-WHTC#8	PC/IFV	PC/IFV
3		5 min soak	5 min soak	5 min soak	5 min soak	5 min soak	5 min soak	5 min soak	5 min soak	CP/IFV	CP/IFV
4		H-WHTC_5#1	H-WHTC_5#2	H-WHTC_5#3	H-WHTC_5#4	H-WHTC_5#5	H-WHTC_5#6	H-WHTC_5#7	H-WHTC_5#8	WHSC#1	WHSC#5
5		20 min soak	20 min soak	20 min soak	20 min soak	20 min soak	20 min soak	20 min soak	20 min soak	CP	CP
6		H-WHTC_20#1	H-WHTC_20#2	H-WHTC_20#3	H-WHTC_20#4	H-WHTC_20#5	H-WHTC_20#6	H-WHTC_20#7	H-WHTC_20#8	WHSC#2	WHSC#6
7		IFV	IFV	IFV	IFV	IFV	IFV	IFV	IFV	IFV	IFV
8		CP	CP	CP	CP	CP	CP	CP	CP	CP	CP
9		ETC#1	ETC#2	ETC#3	ETC#4	ETC#5	ETC#6	ETC#7	ETC#8	WHSC#3	WHSC#7
10		CP	CP	CP	CP	CP	CP	CP	CP	CP	CP
11	Warm-up	ESC#1	ESC#2	ESC#3	ESC#4	ESC#5	ESC#6	ESC#7	ESC#8	WHSC#4	WHSC#8
12	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
13	SMP	SMP	SMP	SMP	SMP	SMP	SMP	SMP	SMP	SMP	Shut-down
14	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	Shut-down	

PMP HD Validation Exercise

Golden engine

PMP HD Validation Exercise

After-treatment Device

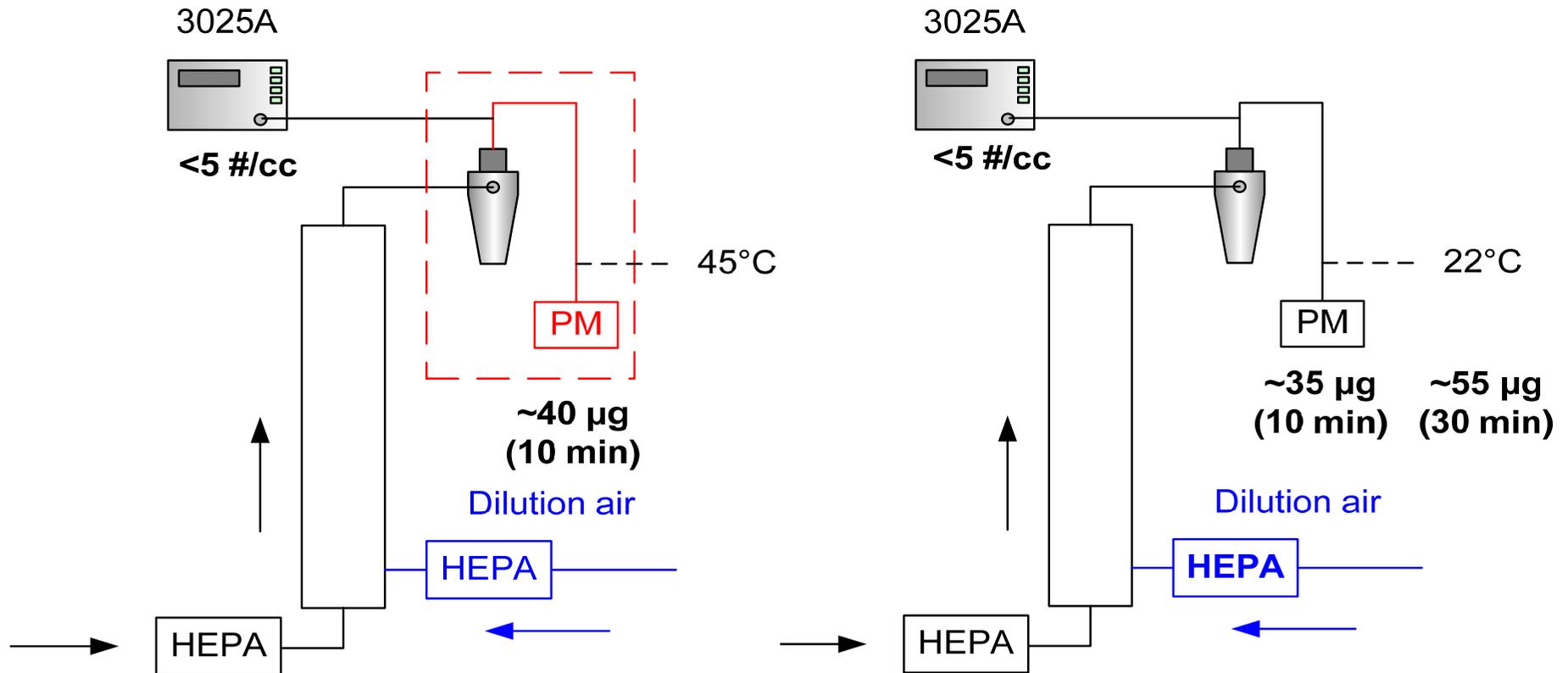- Preliminary results of exploratory work in JRC

Tasks

- Background mass/number
  - Primary / Secondary tunnel
  - Partial flow systems
- Preconditioning
- Mass
  - 47°C (how we achieve, dilution air, mixed flow?)
  - 47mm or 70mm filters
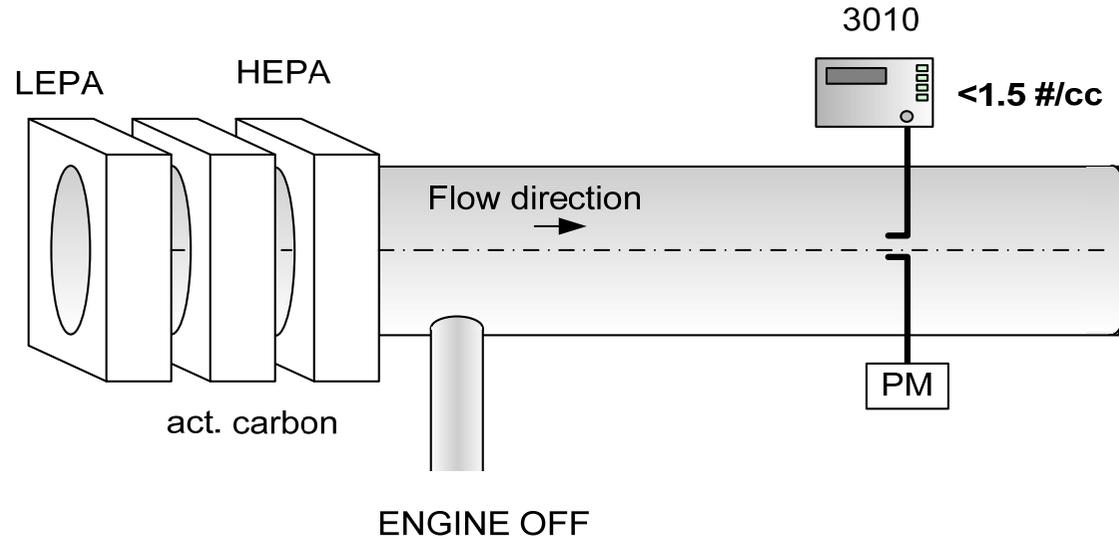 - Filter material
  - Backup filter
  - Cyclone

Tasks

- Number
  - SPCS at the same position
  - Different sampling temperatures (47ºC or 192ºC)
  - Evaporation tube temperature
- Partial – Full flow comparisons
  - AVL
  - Control Sistem PSS 20
  - Look ahead
  - Decisions on positions, flowrates etc

Tasks

- **Background mass/number**
  - Primary / Secondary tunnel
  - Partial flow systems
- **Preconditioning**
- **Mass**
  - 47°C (how we achieve, dilution air, mixed flow?)
  - 47mm or 70mm filters
  - Filter material
  - Backup filter
  - Cyclone

Reference filter and weighting procedure

- Balance Precision of 1μg for a reference weight → No, Sartorius M5P (we wanted to measure 47 and 70mm filters at the same balance)

- Weighting room
  - T: 22 ±3°C → 23 ±3°C
  - RH: 45 ±8% → 51 ±1.5%

- Conditioning of filters 8 to 80 h → 2 to 24 h

- Neutraliser → yes

- Reference Filter: 89.934 ±0.005 (min/max)

  (or 0.0035 for 1 stdev)

Background (Smart Sampler)

Background (Primary tunnel)

Background (secondary tunnel)

LEPA   HEPA

act. carbon

ENGINE OFF

Flow direction   dilution tunnel

60 m³/min

Dilution air

HEPA   **HEPA**

45°C   45°C

47mm PM   70mm PM

47mm TX40

Pre-baked at 52°C

No flow

-3 (+3) µg

(30 min)

no flow   no flow

7 (-4) µg   **-7 (-3) µg µg**

(30 min)   **(30 min))**
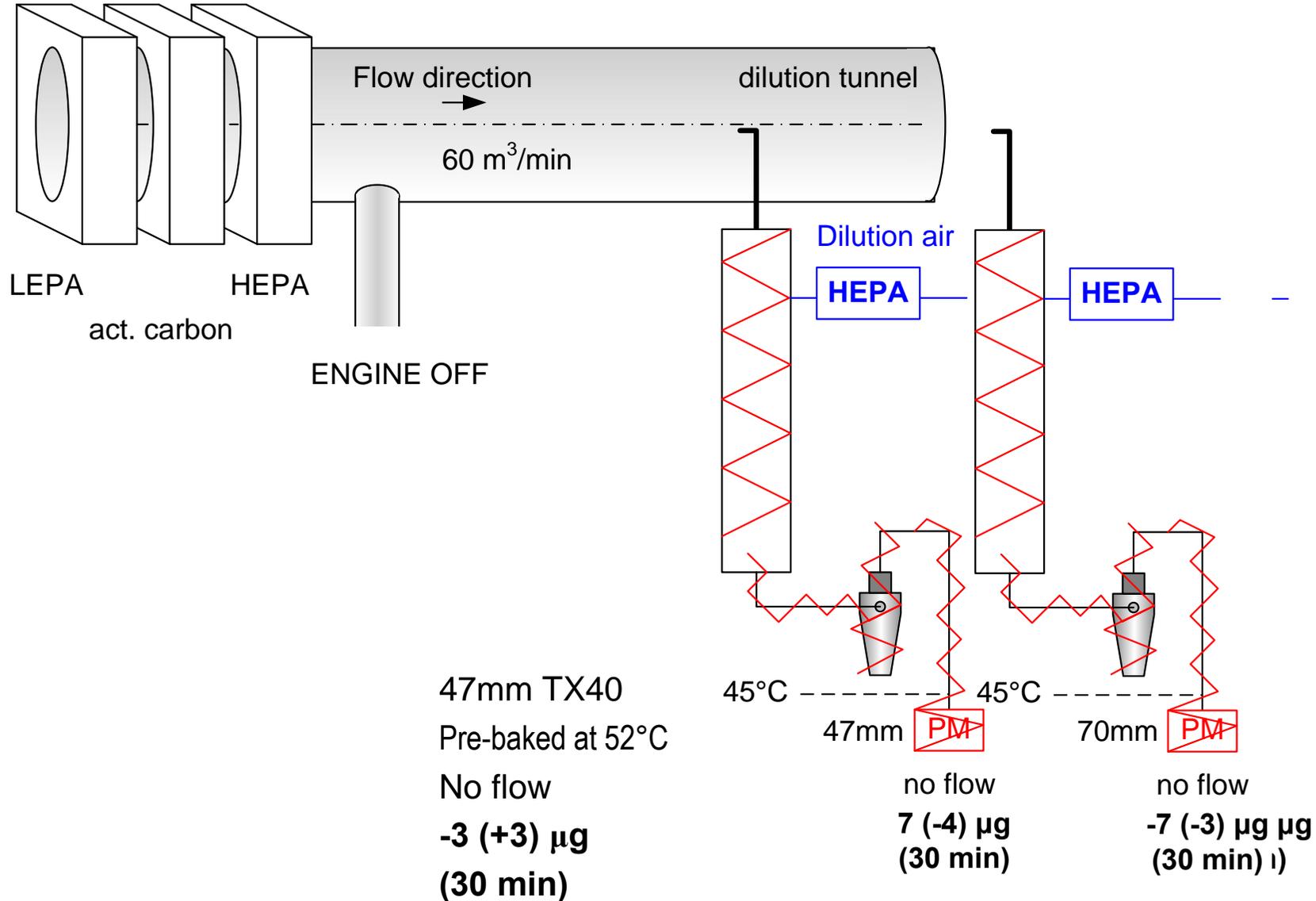
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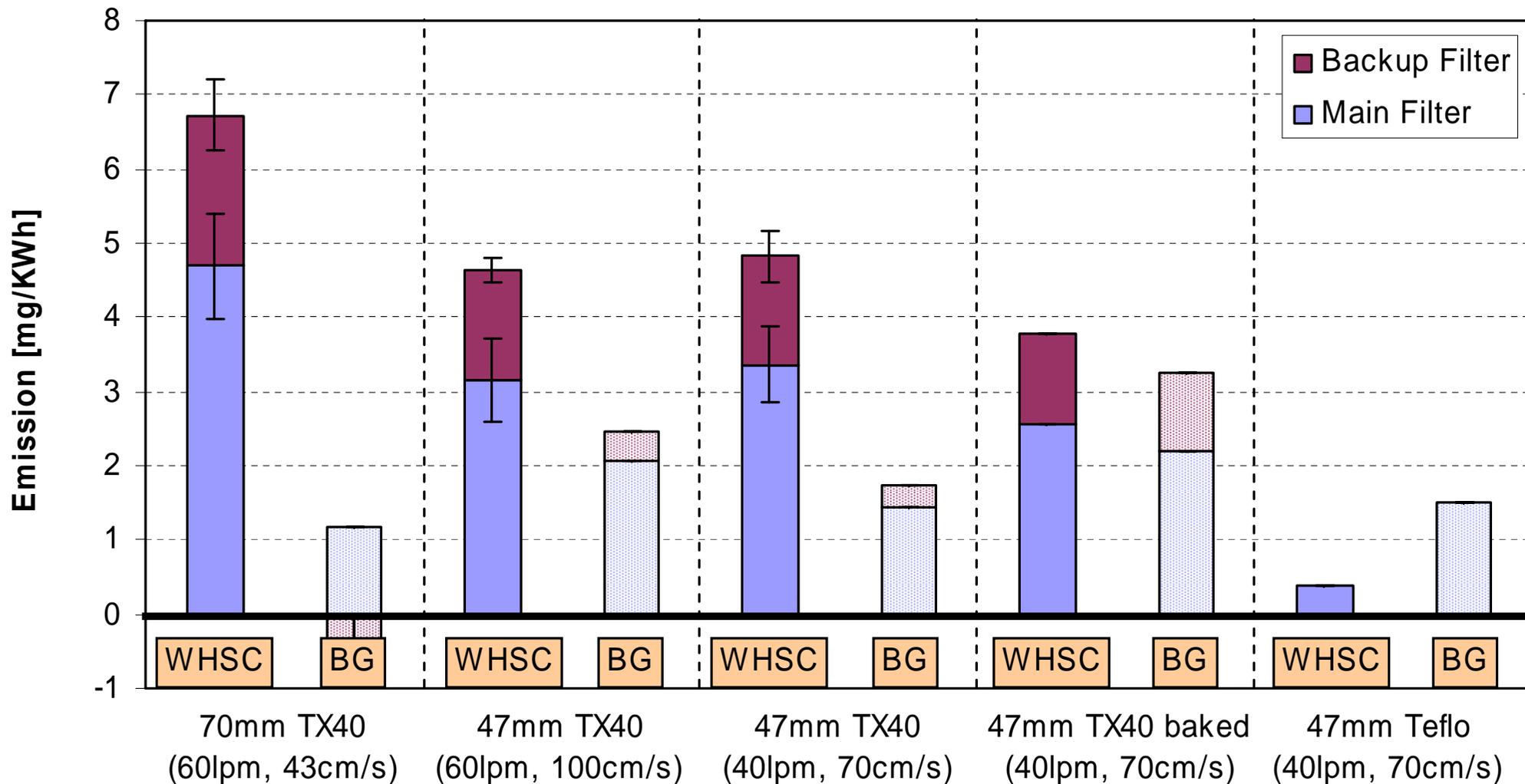
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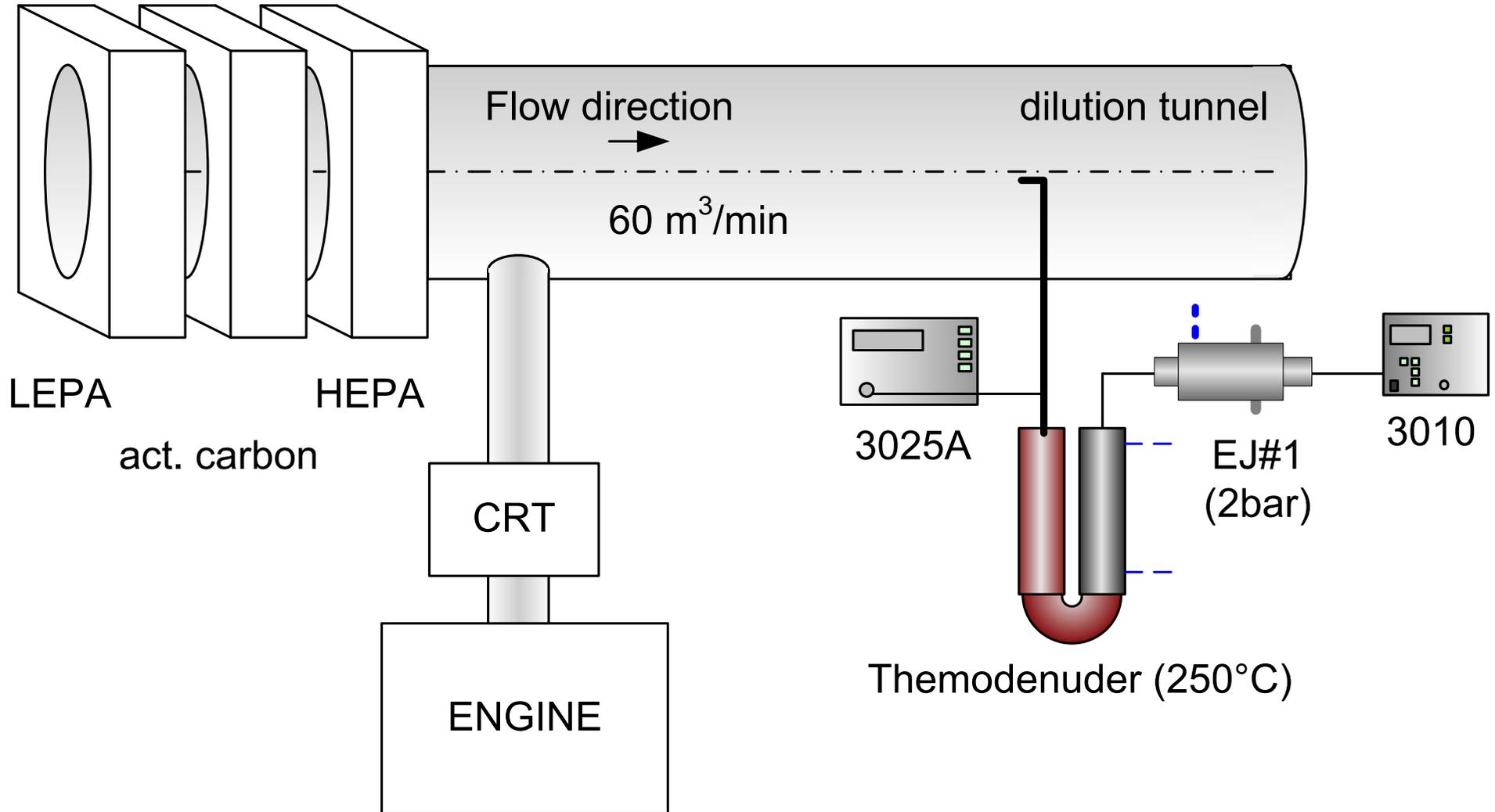
Importance of preconditioning
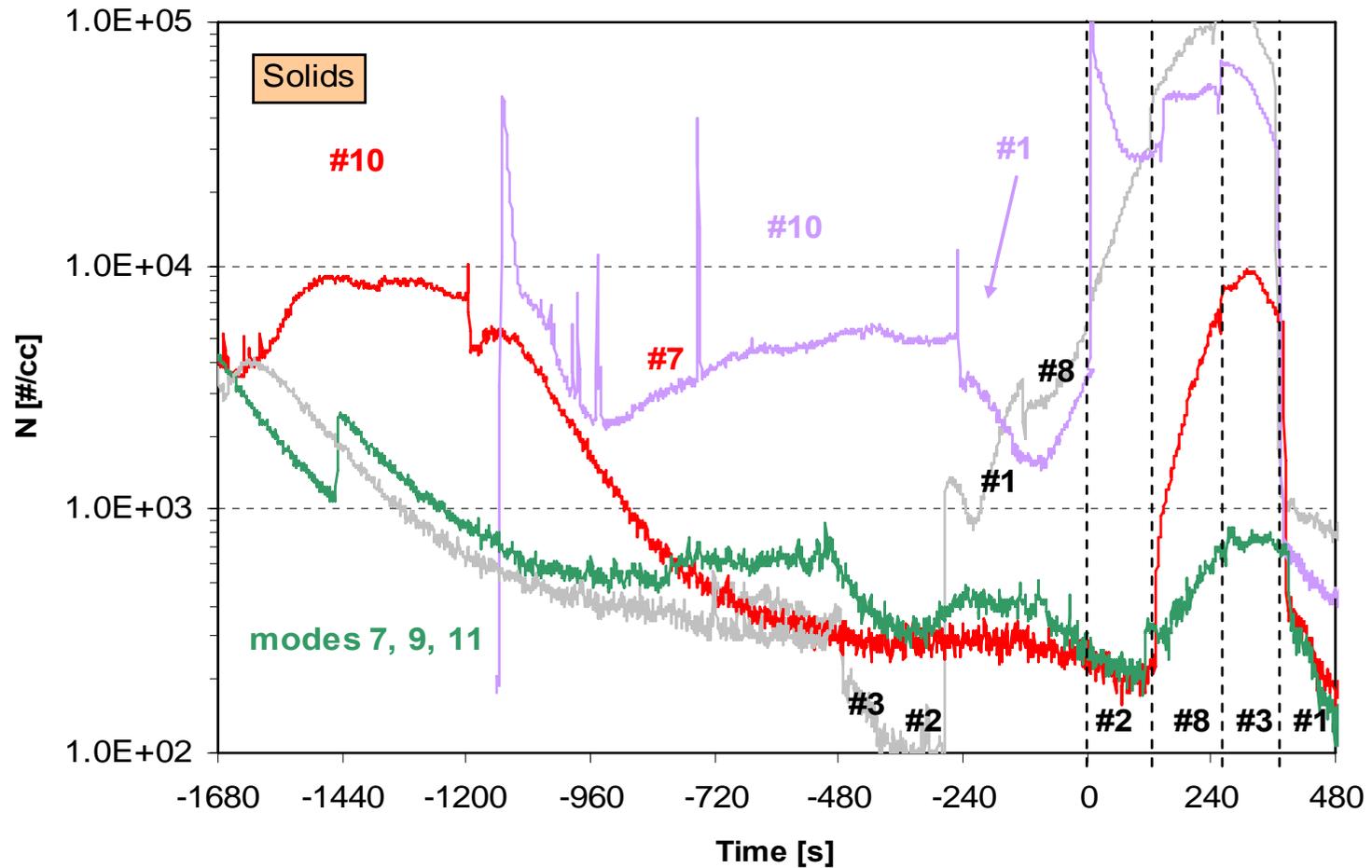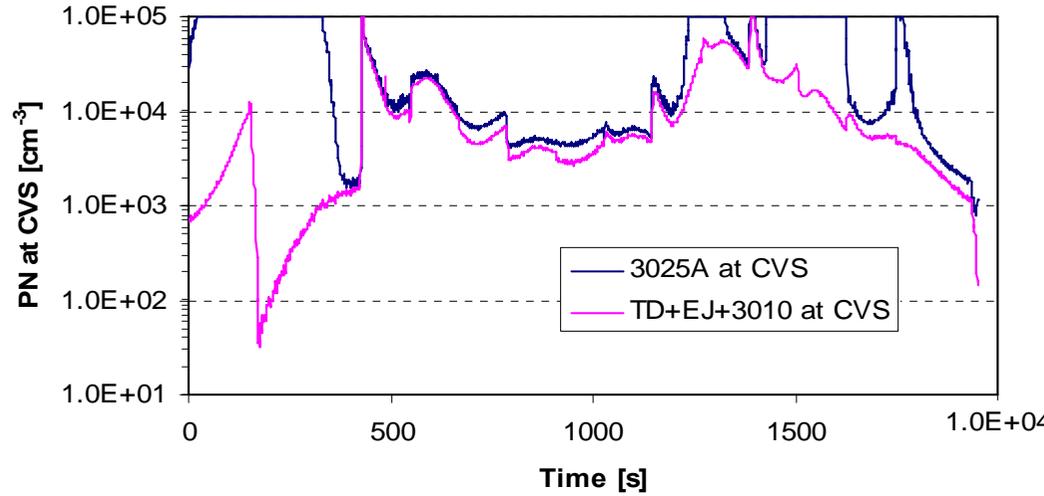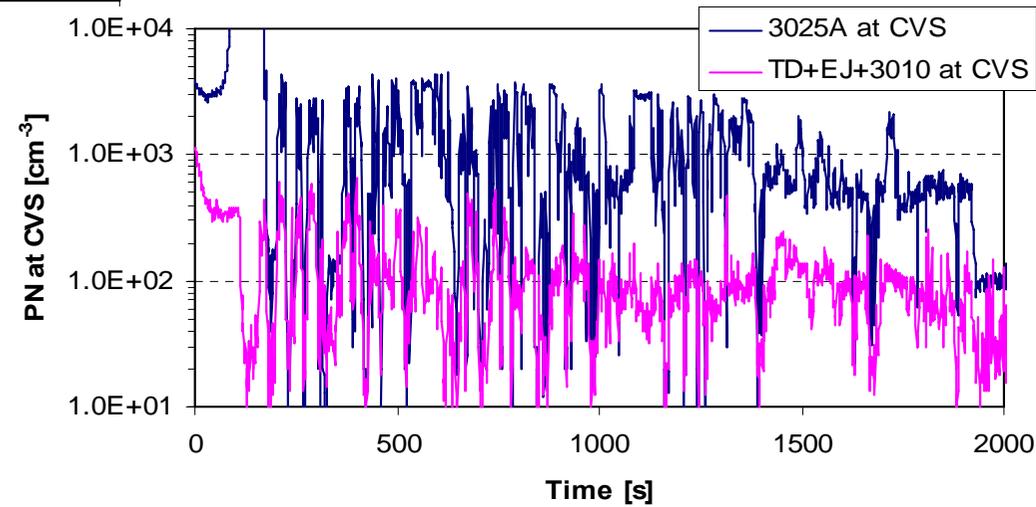
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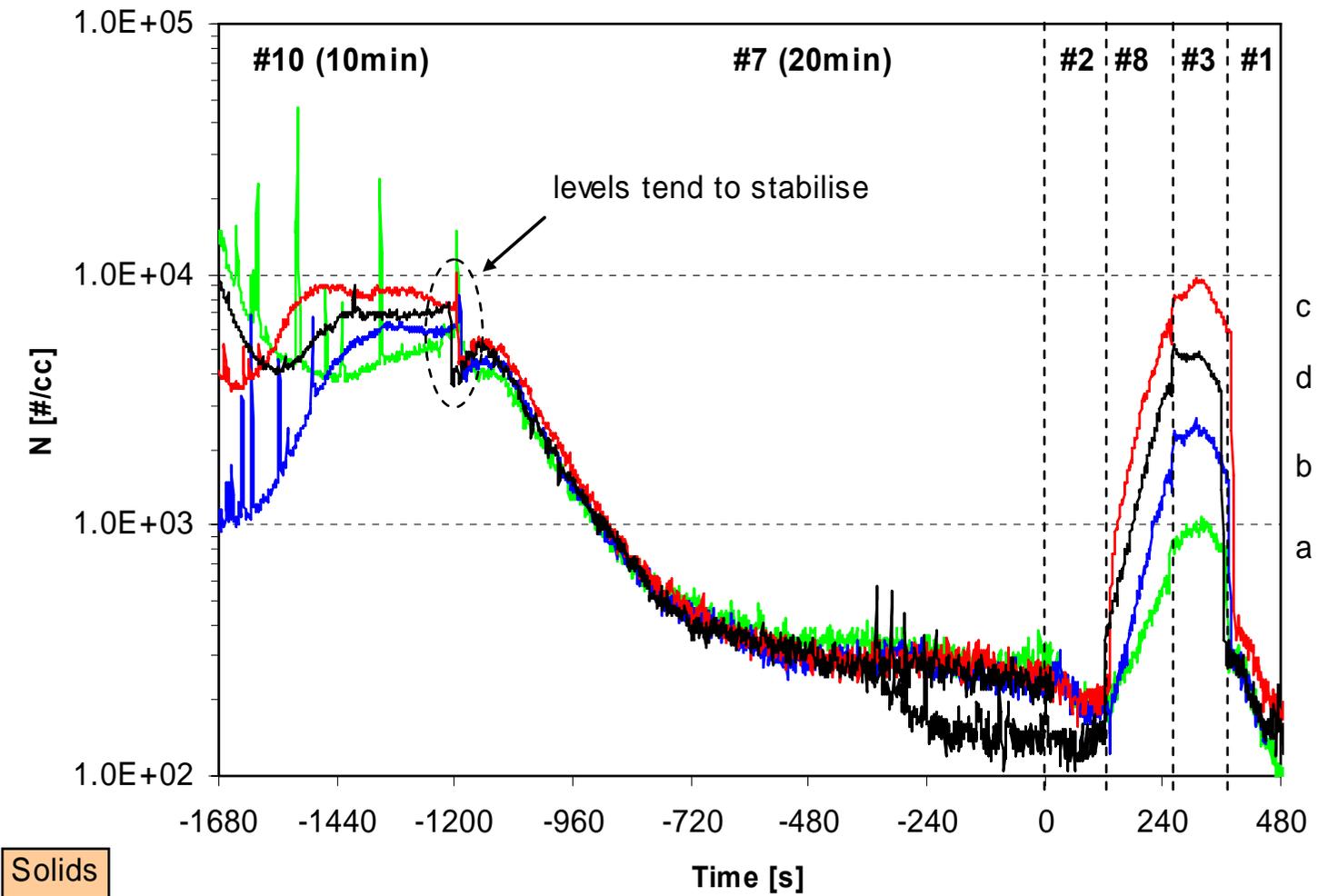
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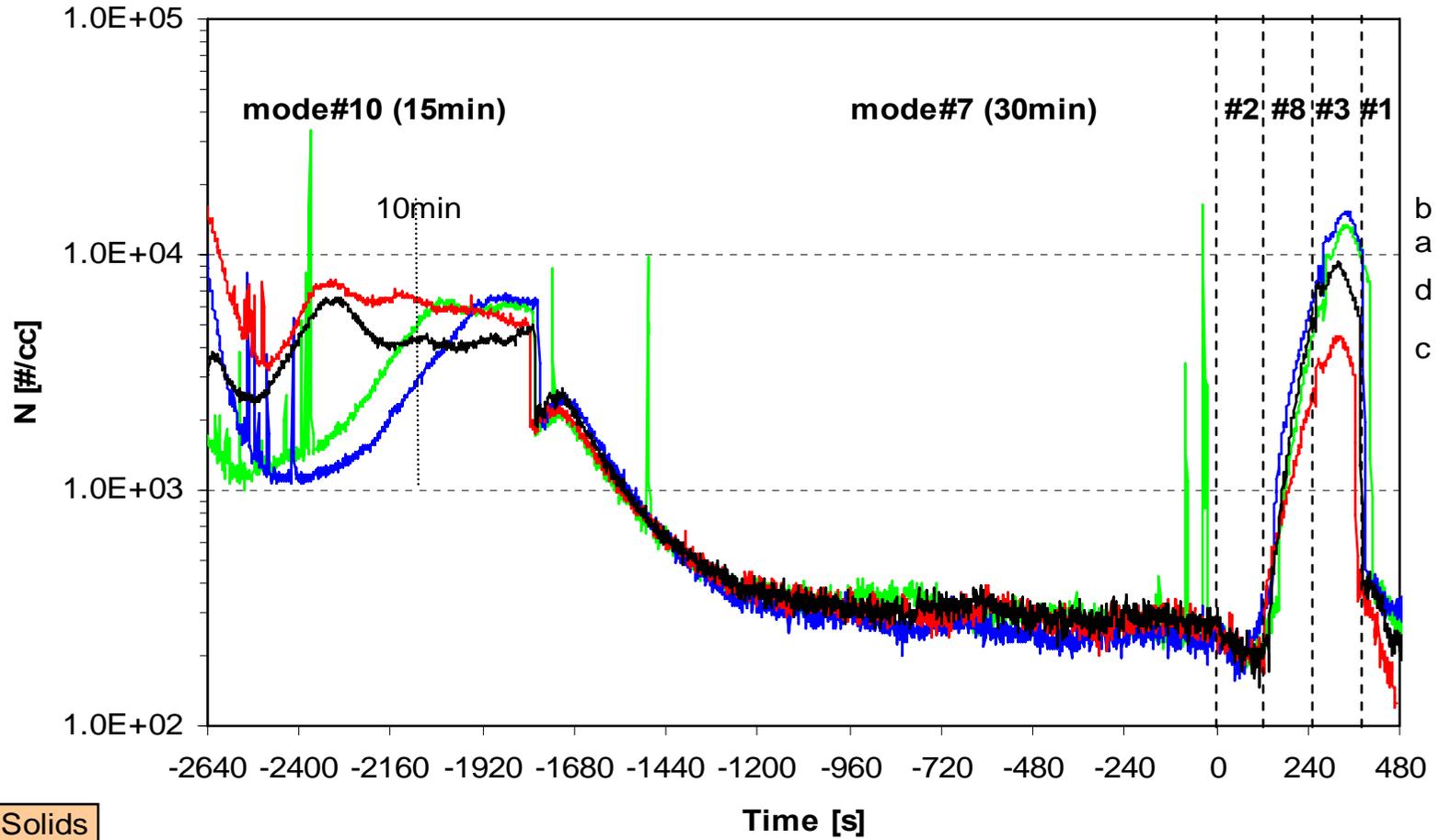
Solids

Total - Solids
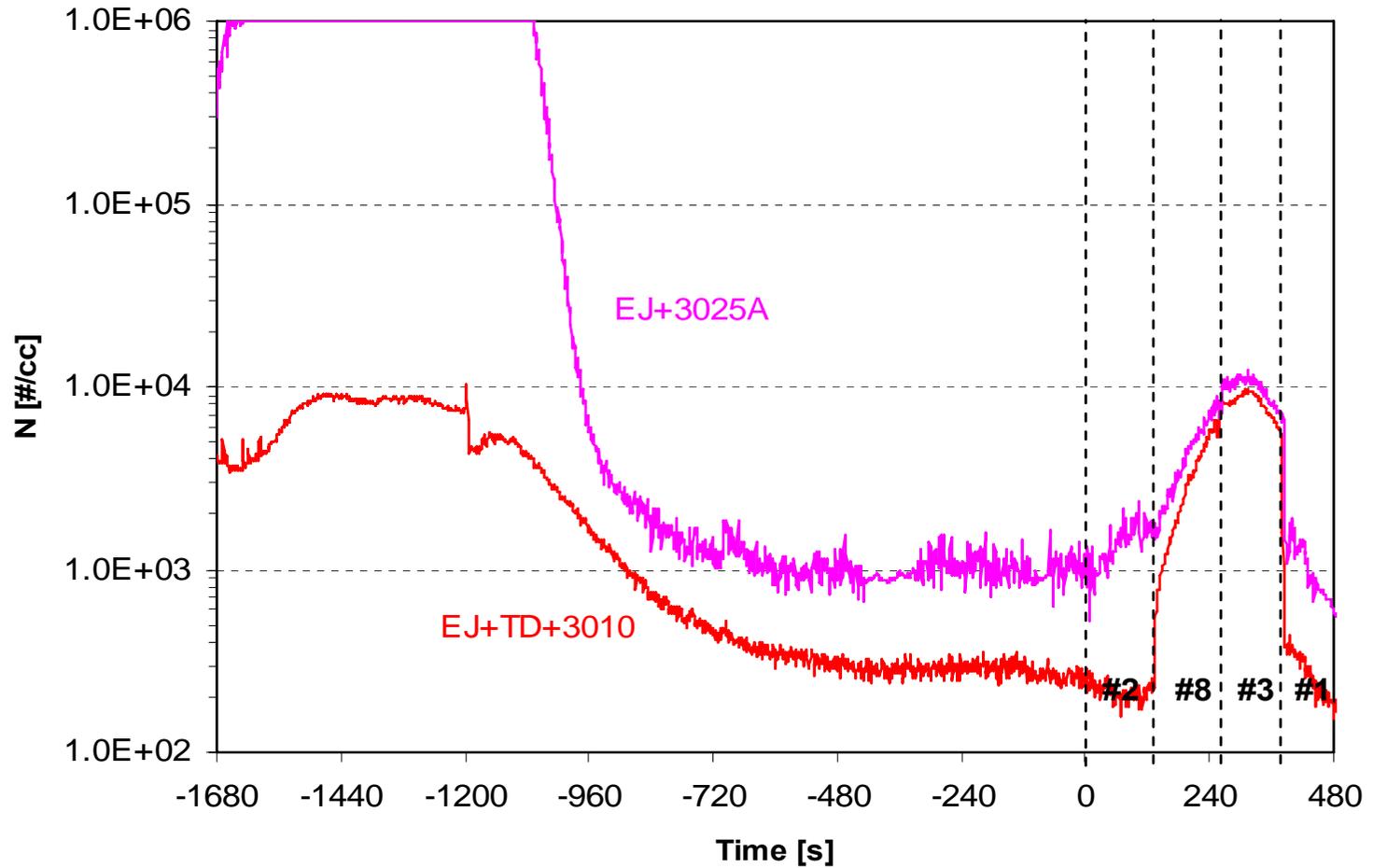
ESC

ETC

Conclusions

-Weighting procedure extremely important for DPF engines

-Background mass in the order of 20µg (30min)

-Background number ~1#/cc

-Lower PM emissions with 47mm compared to 70mm (due to higher filter face velocity)

-No effect of 40 to 60 lpm flows on mass emissions

-Mass results close to background levels although low DRs were used.

--Preconditioning important for particle measurements

-There are a lot of volatiles even with low sulfur fuel

Acknowledgements

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-Stefano Alessandrini and Forni Fausto for their excellent work and long hours put in during the tests in the laboratory

Thank you for your attention!