Exploratory tests at JRC

Preliminary results

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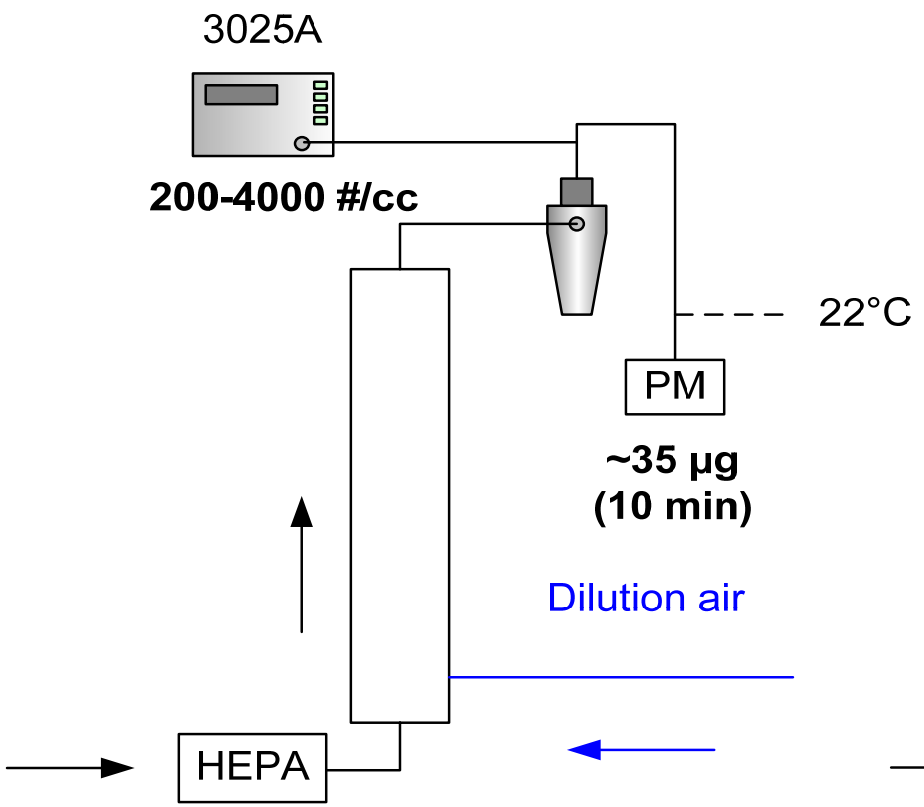
Tasks

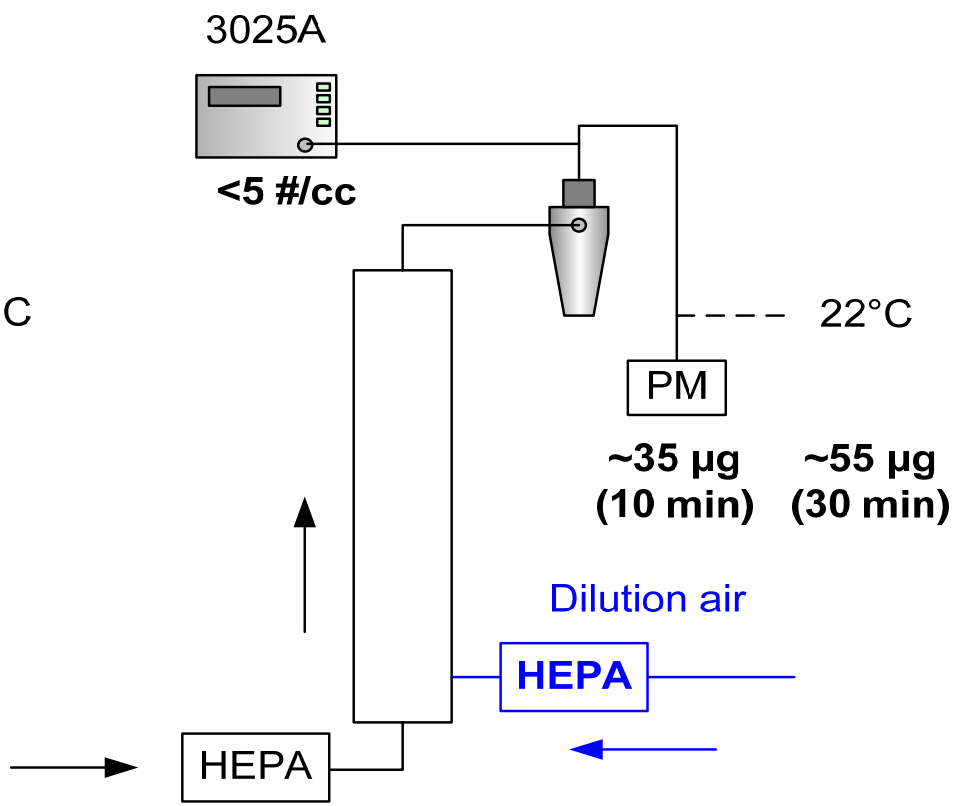
- Background mass/number
  - Primary / Secondary tunnel
  - Partial flow systems
- Mass
  - 47°C (how we achieve, dilution air, mixed flow?)
  - 47mm or 70mm filters
  - Filter material
  - Backup filter
  - Cyclone

Tasks

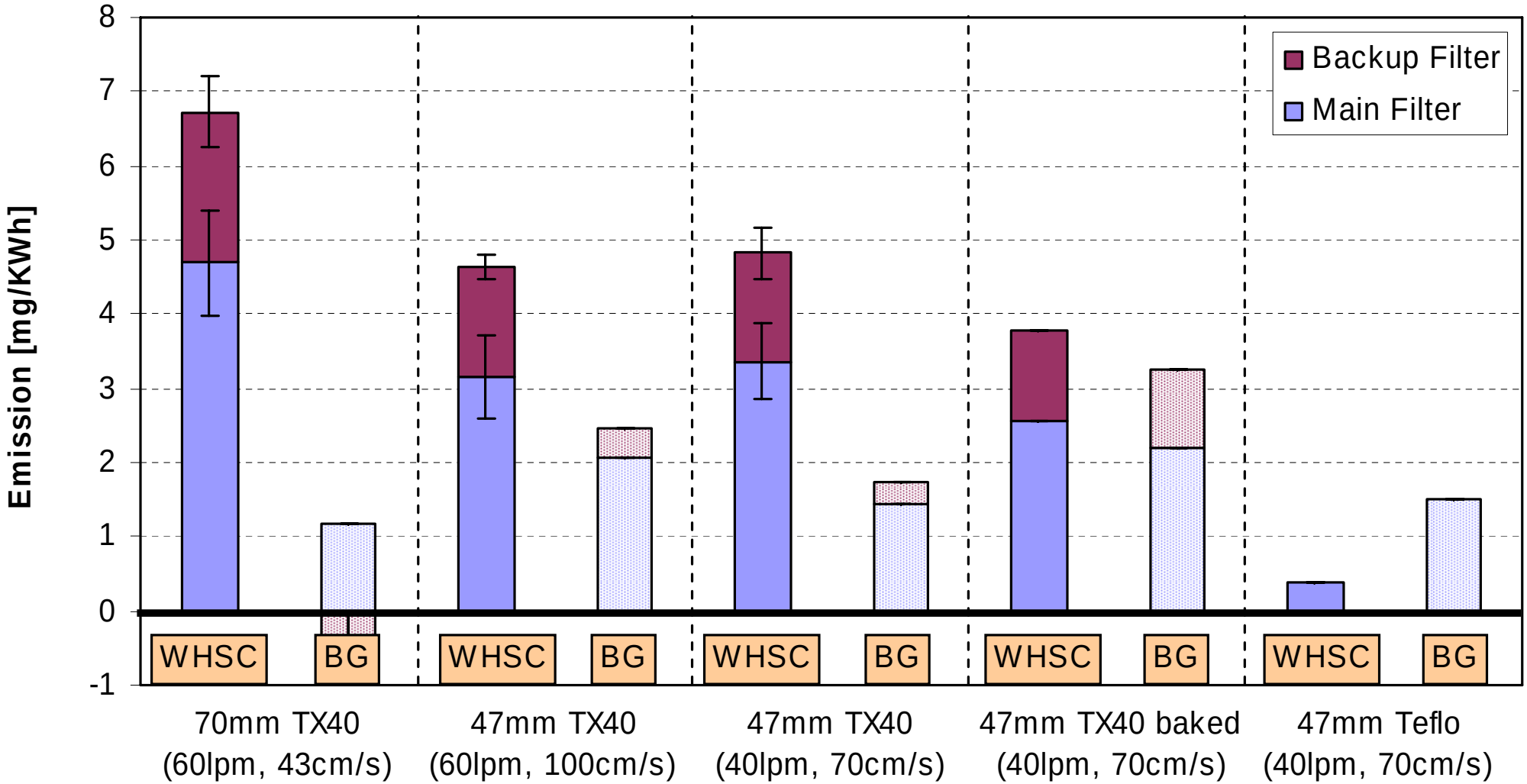
- Number
  - SPCS at the same position
  - Evaporation tube efficiency
  - Cyclone, heated transfer line
- Partial – Full flow comparisons
  - AVL Smart sampler
  - Micro Sistem PSS-20
  - Decisions on positions, flowrates etc
- Protocol, Preconditioning

Background (Smart Sampler)





Particle Mass Results



SPCS units

PMP LD exercise:

-4309947

PMP HD exercise:

-4034719

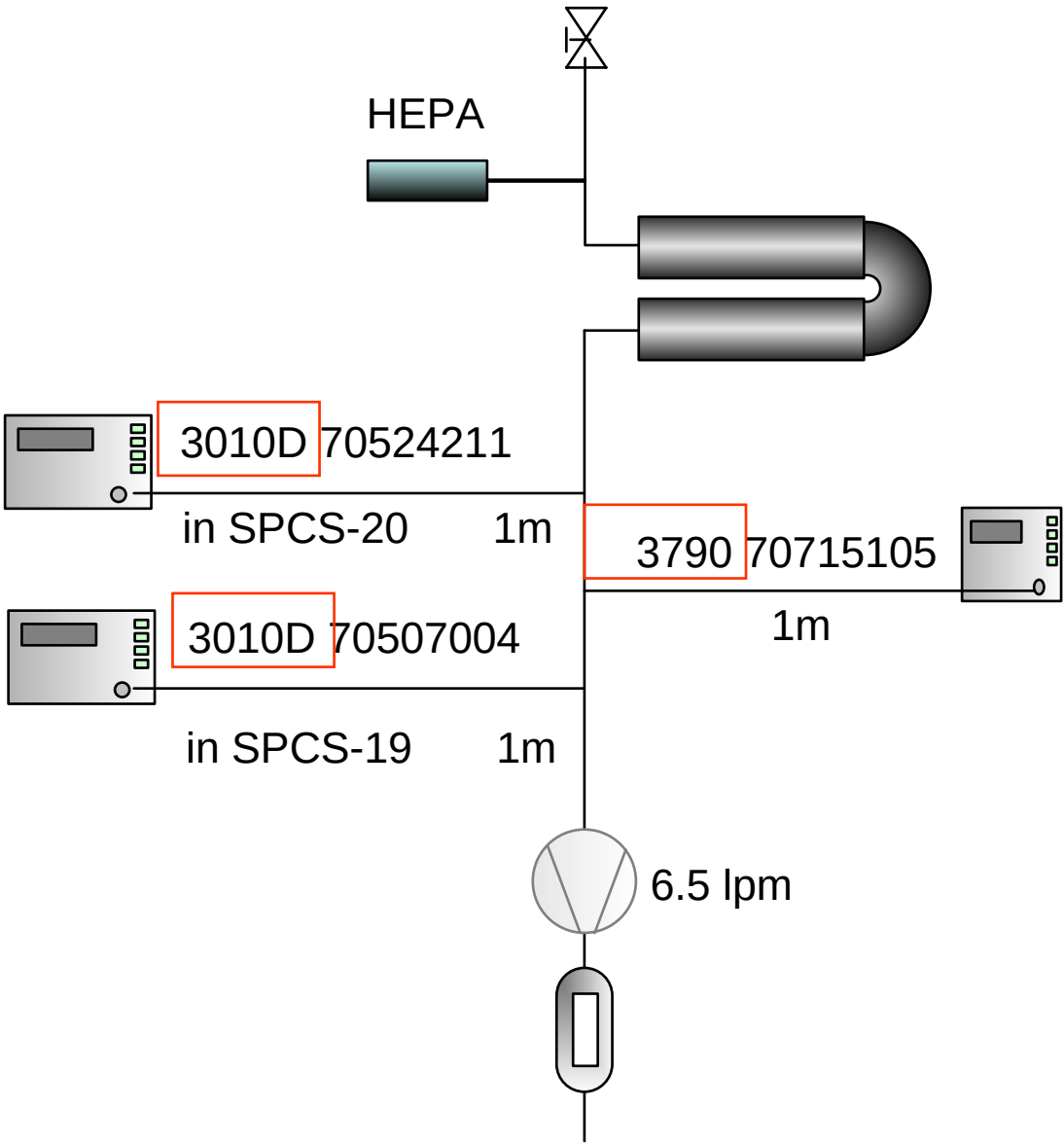
-4034720

With CPCs:

-70507004 (1.02lpm, 0.95)

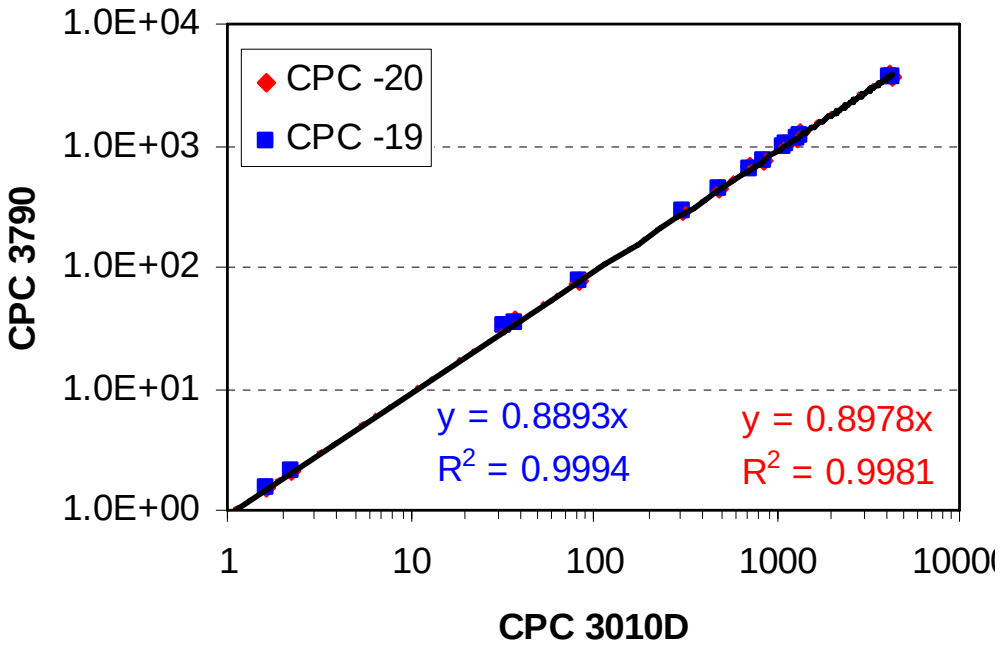
-70524211 (1.01lpm, 0.99)

Set up for CPCs comparison

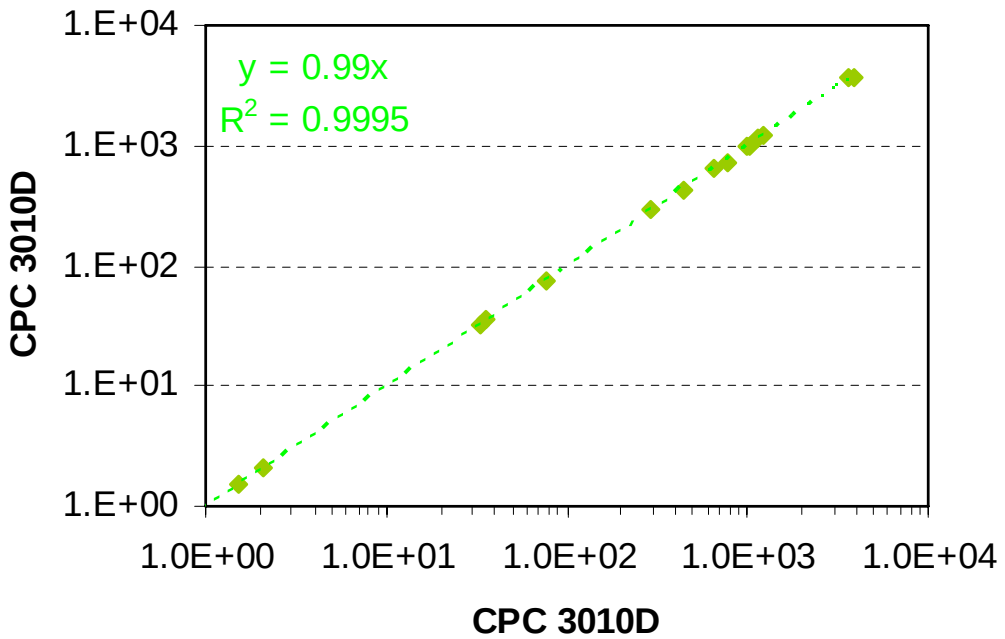


Comparison of SPCSs' 3010D CPCs with Gold 3790

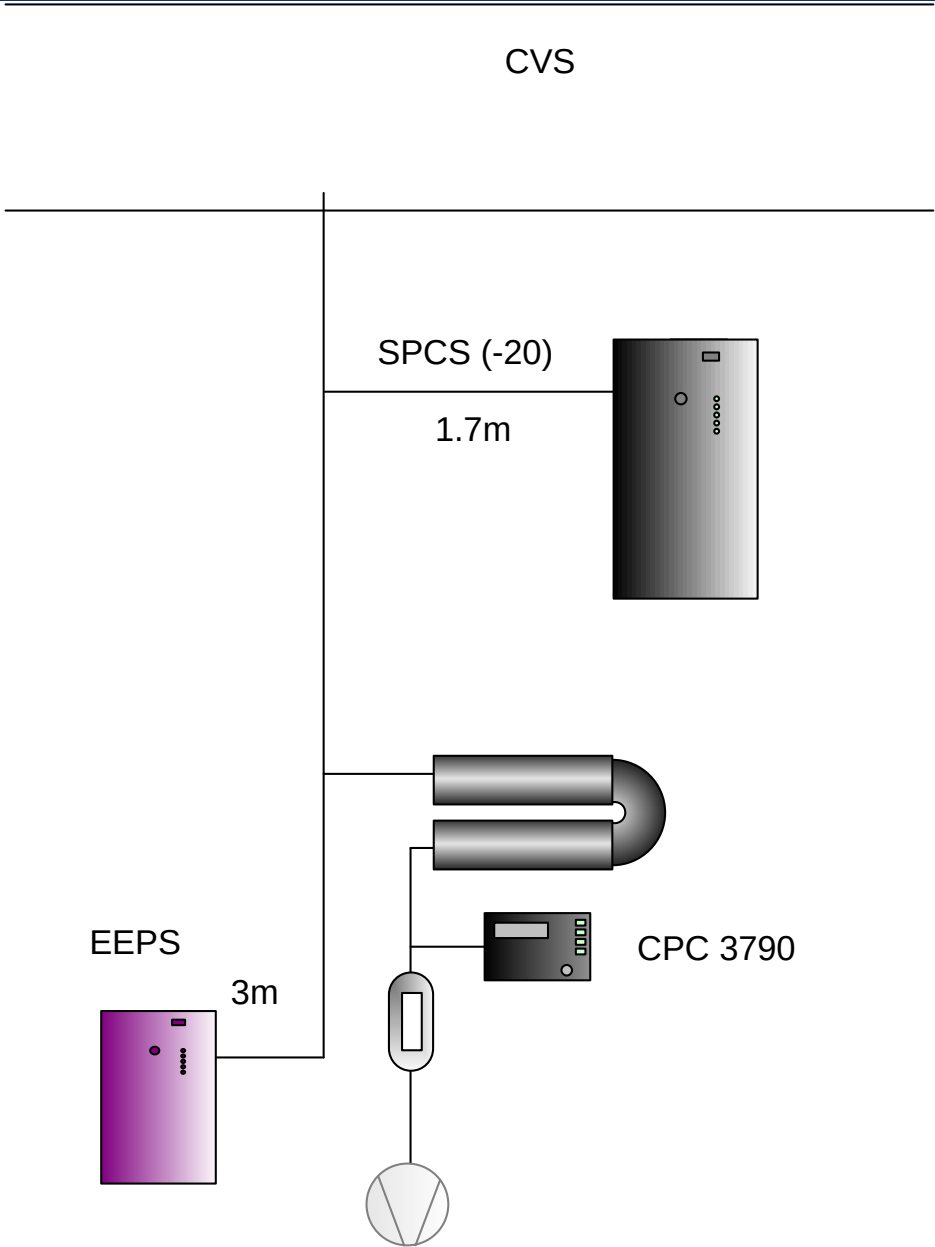
10% difference compared to CPC 3790



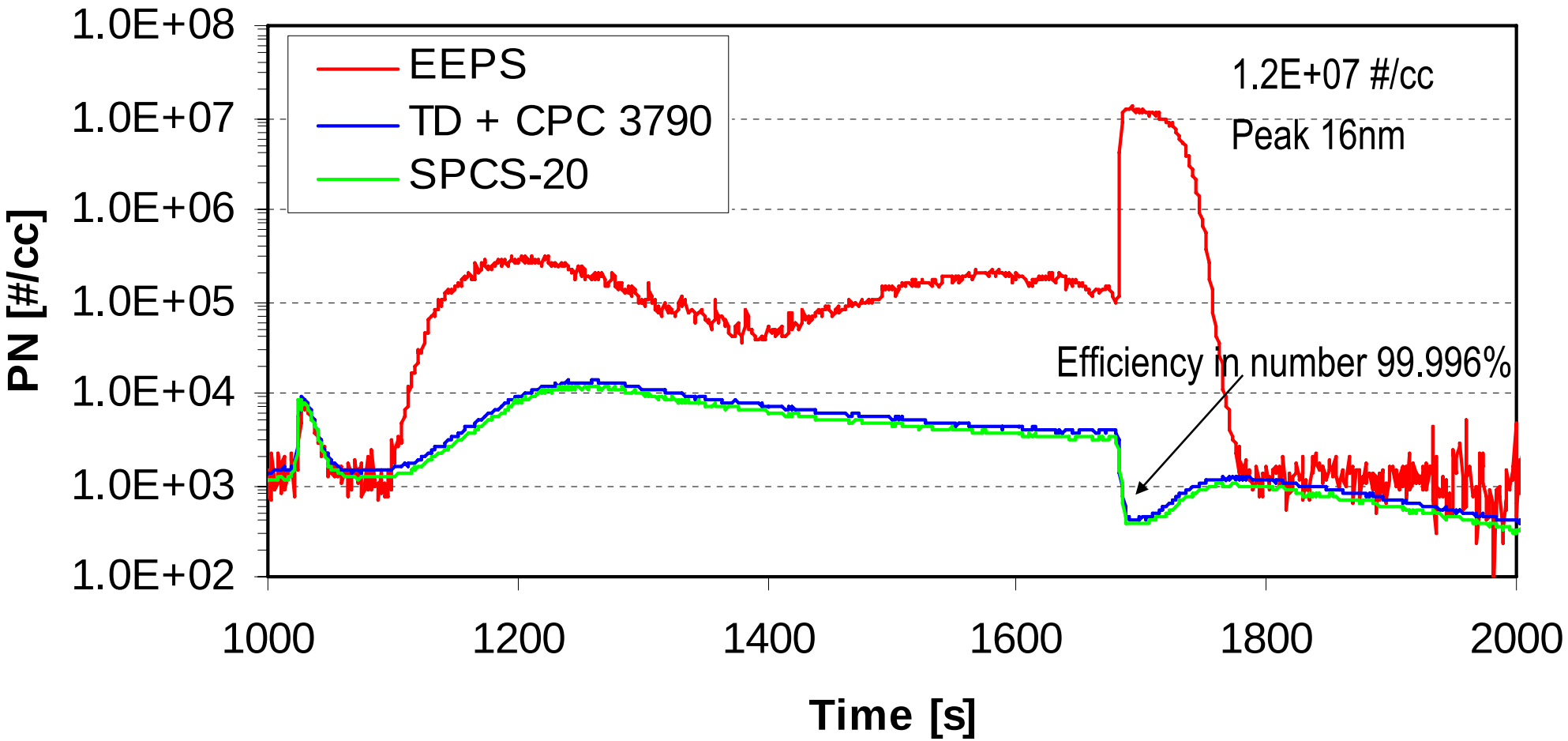
<3% difference between the two 3010D



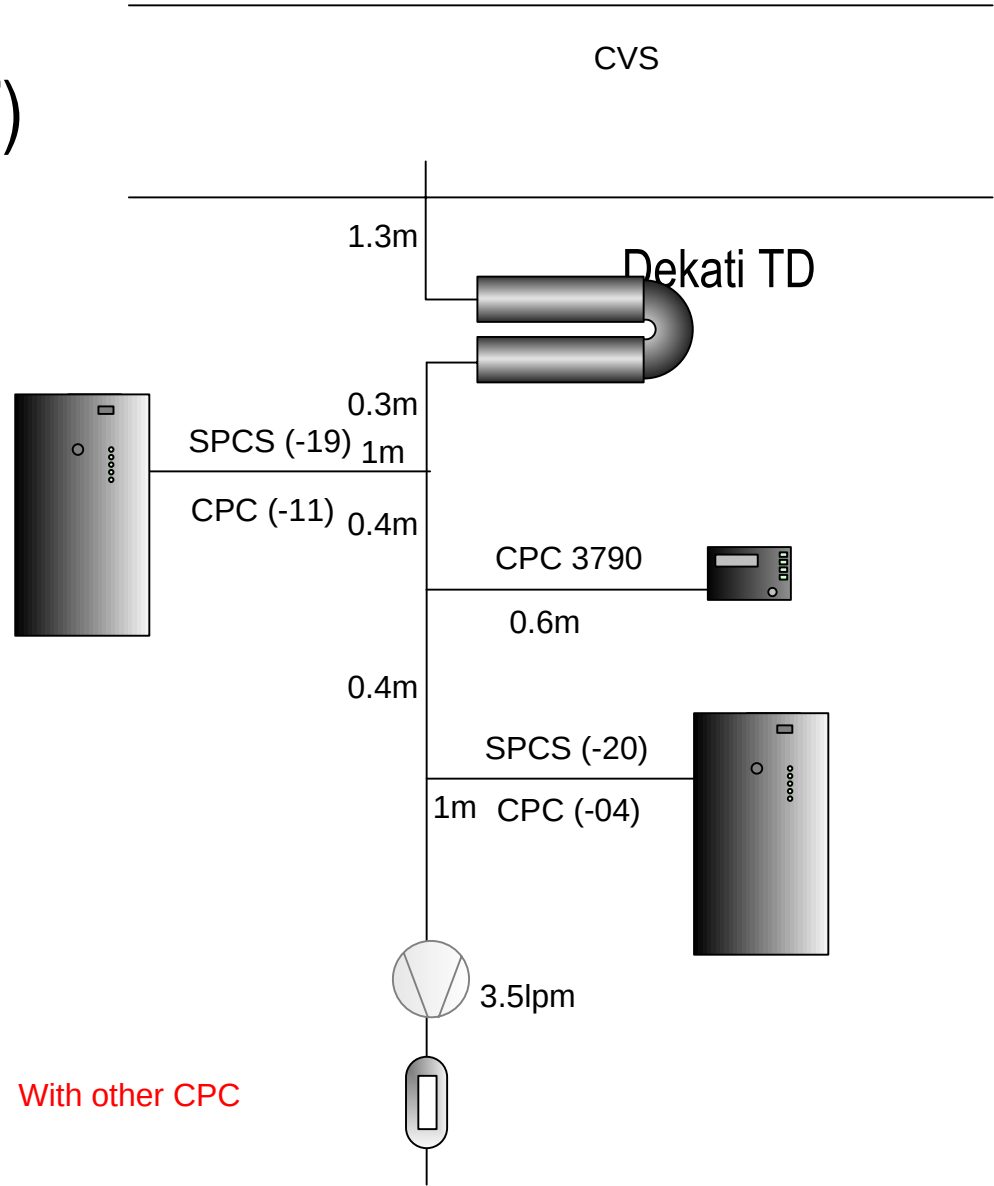
Set up for Volatile removal check Engine with aftertreatment



Volatile removal efficiency check



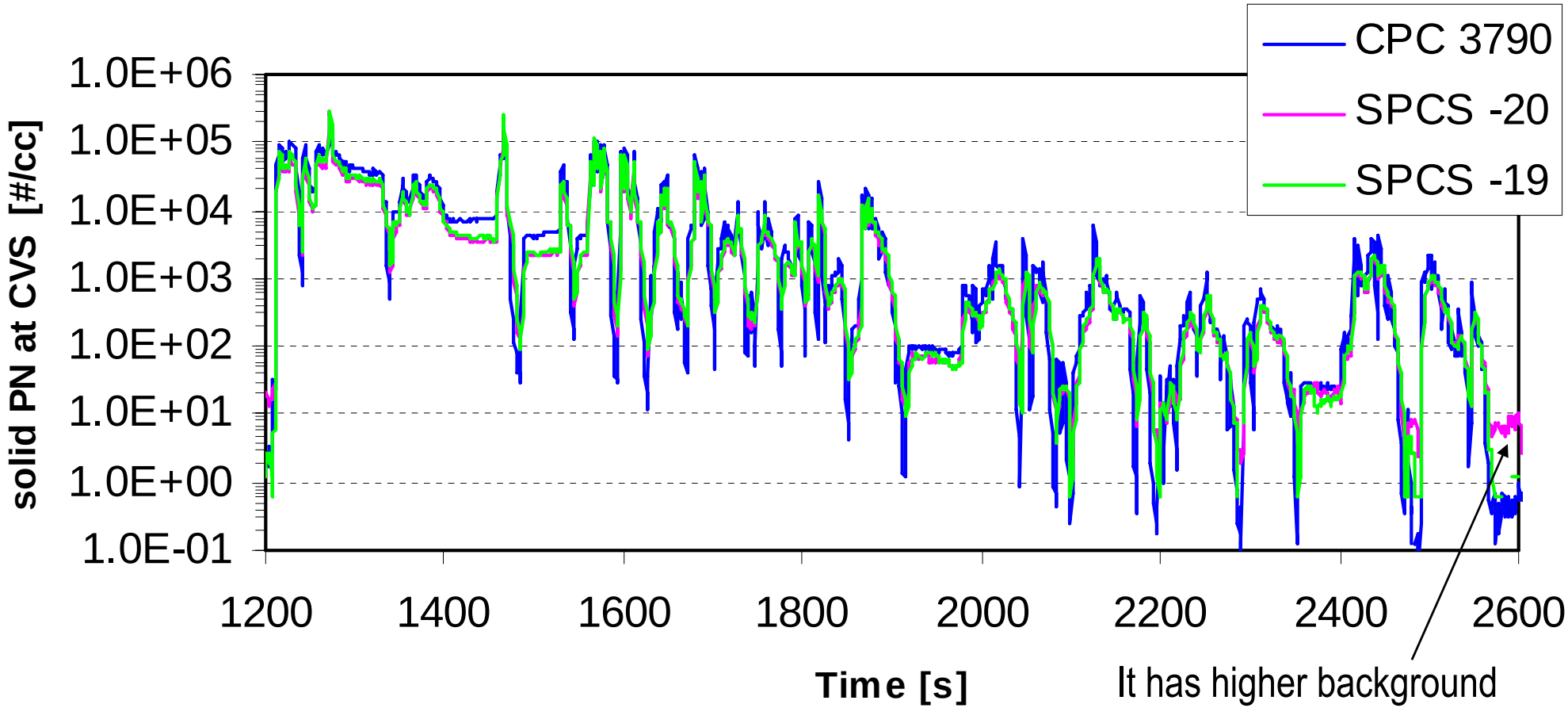
Set up for SPCSs comparison
Transient tests (Engine with CRT)



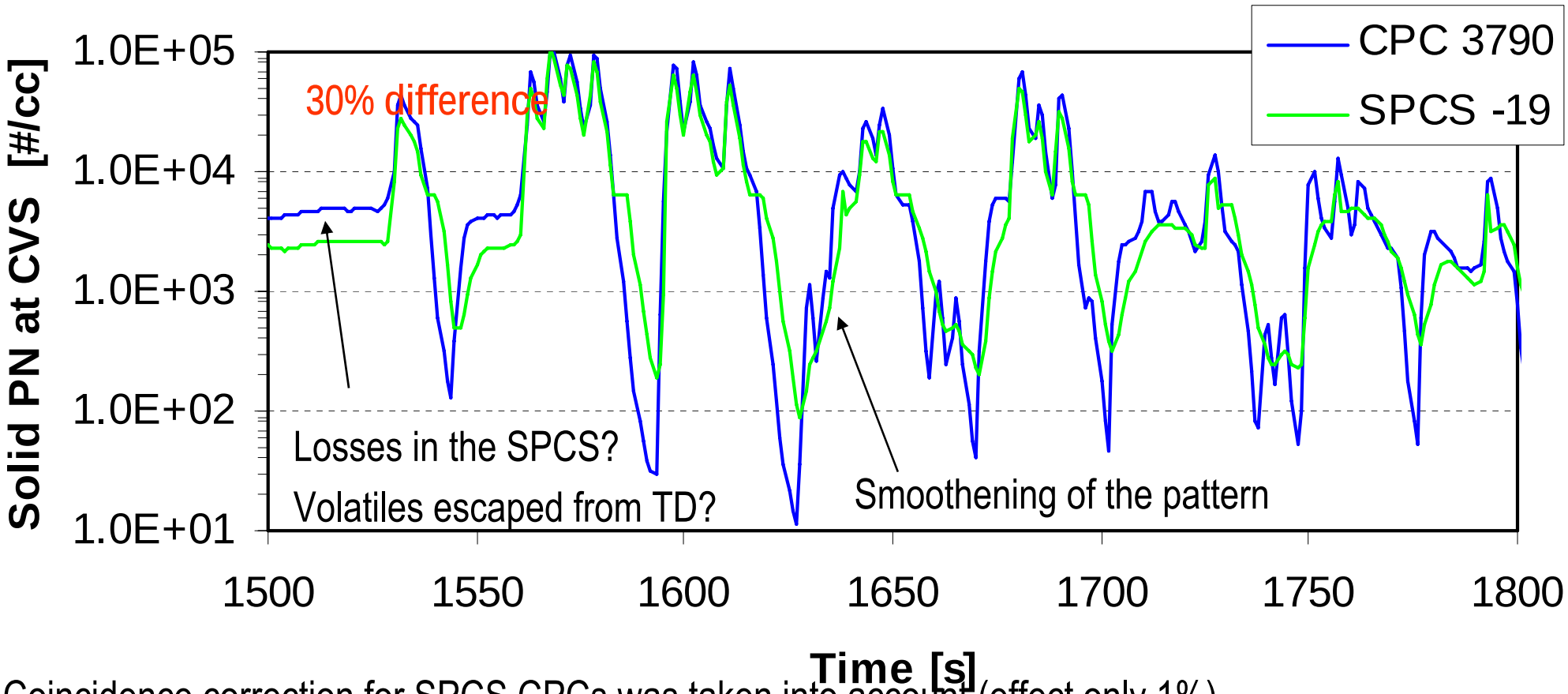
Settings

	SPCS -19 (-20)	
DR	8	8 (8)
DA	11	9 (9)
BP	2	

WHTC (first 20 min)

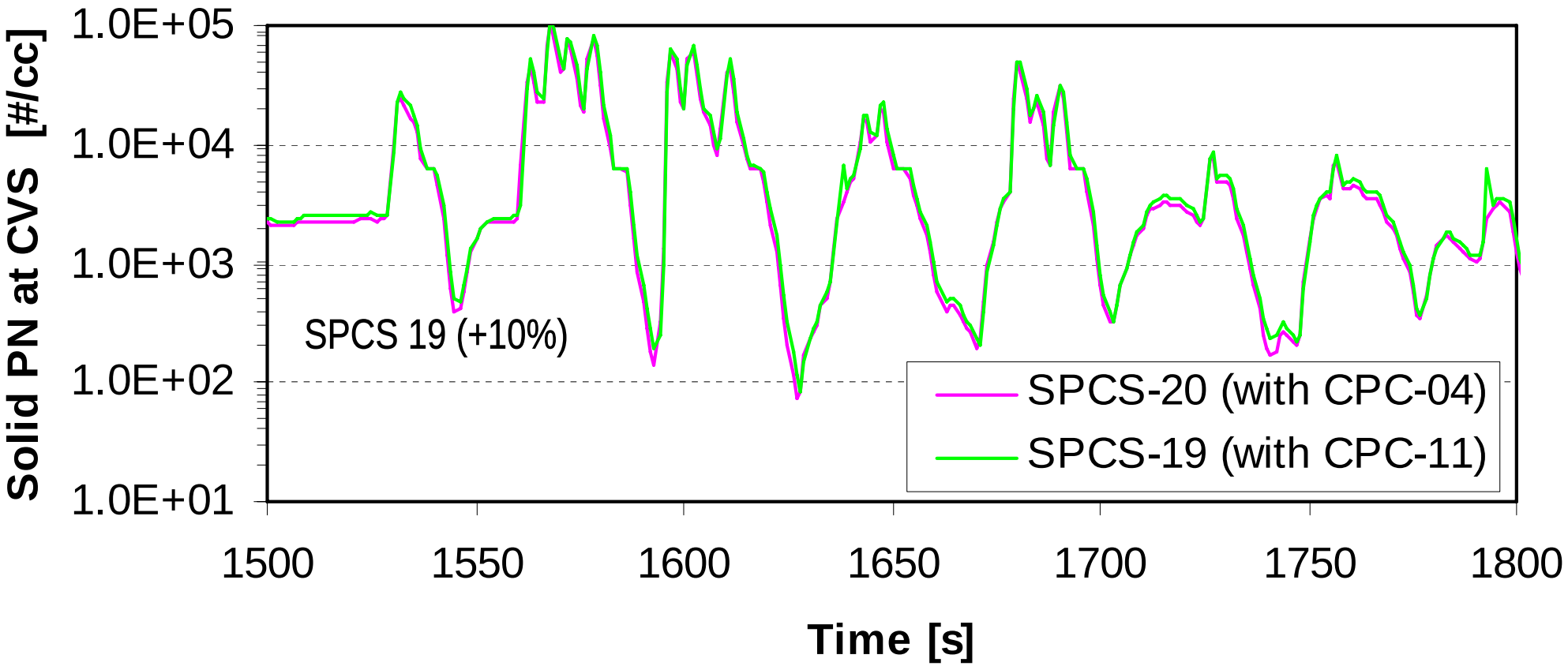


WHTC (detail)
Comparison of SPCS and CPC 3790

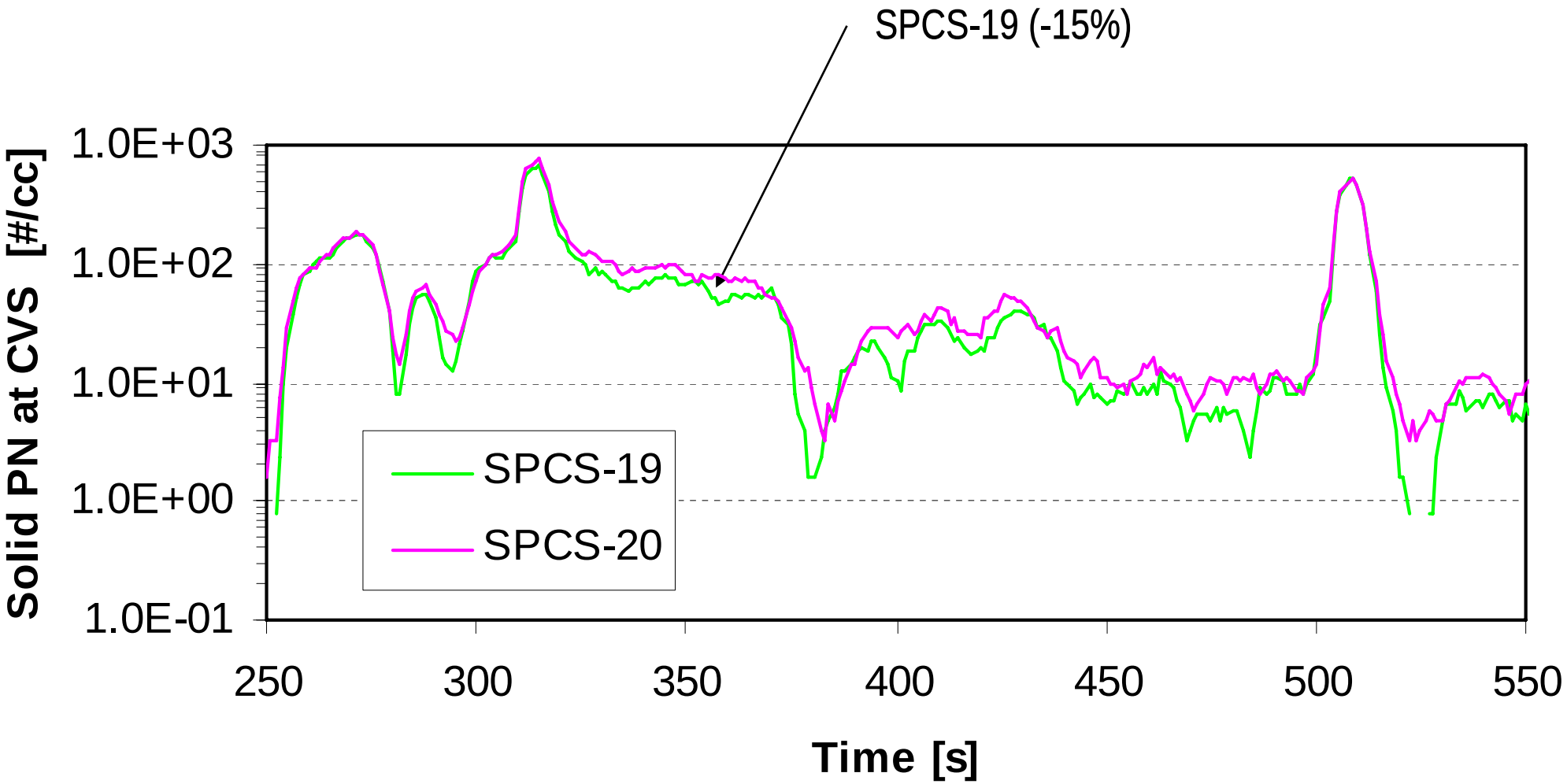


Coincidence correction for SPCS CPCs was taken into account (effect only 1%)

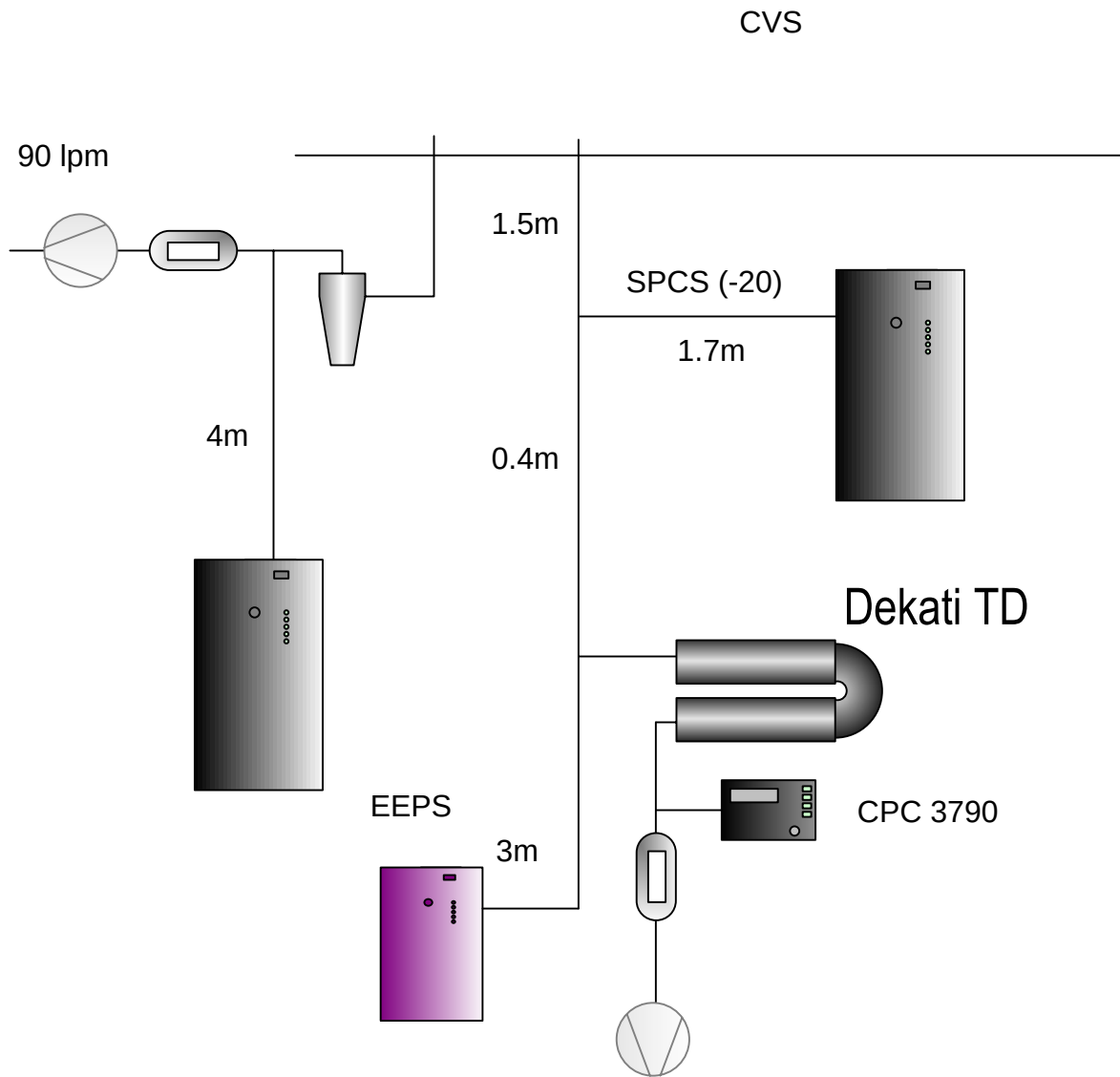
WHTC (detail)
Very good agreement between the two SPCS



SPCS-20 cold, SPCS-19 hot



SPCSs comparison with cyclone

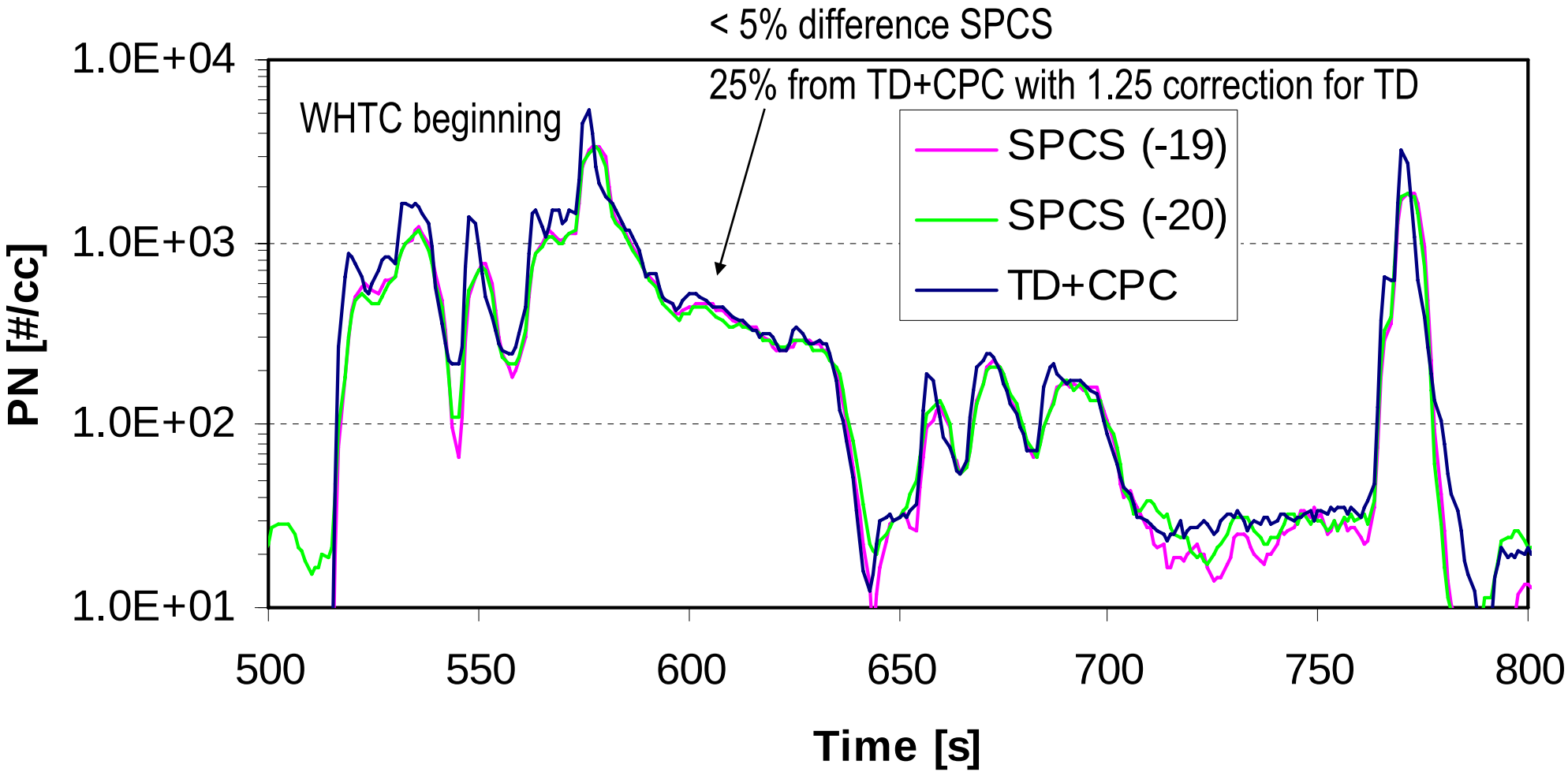


Settings

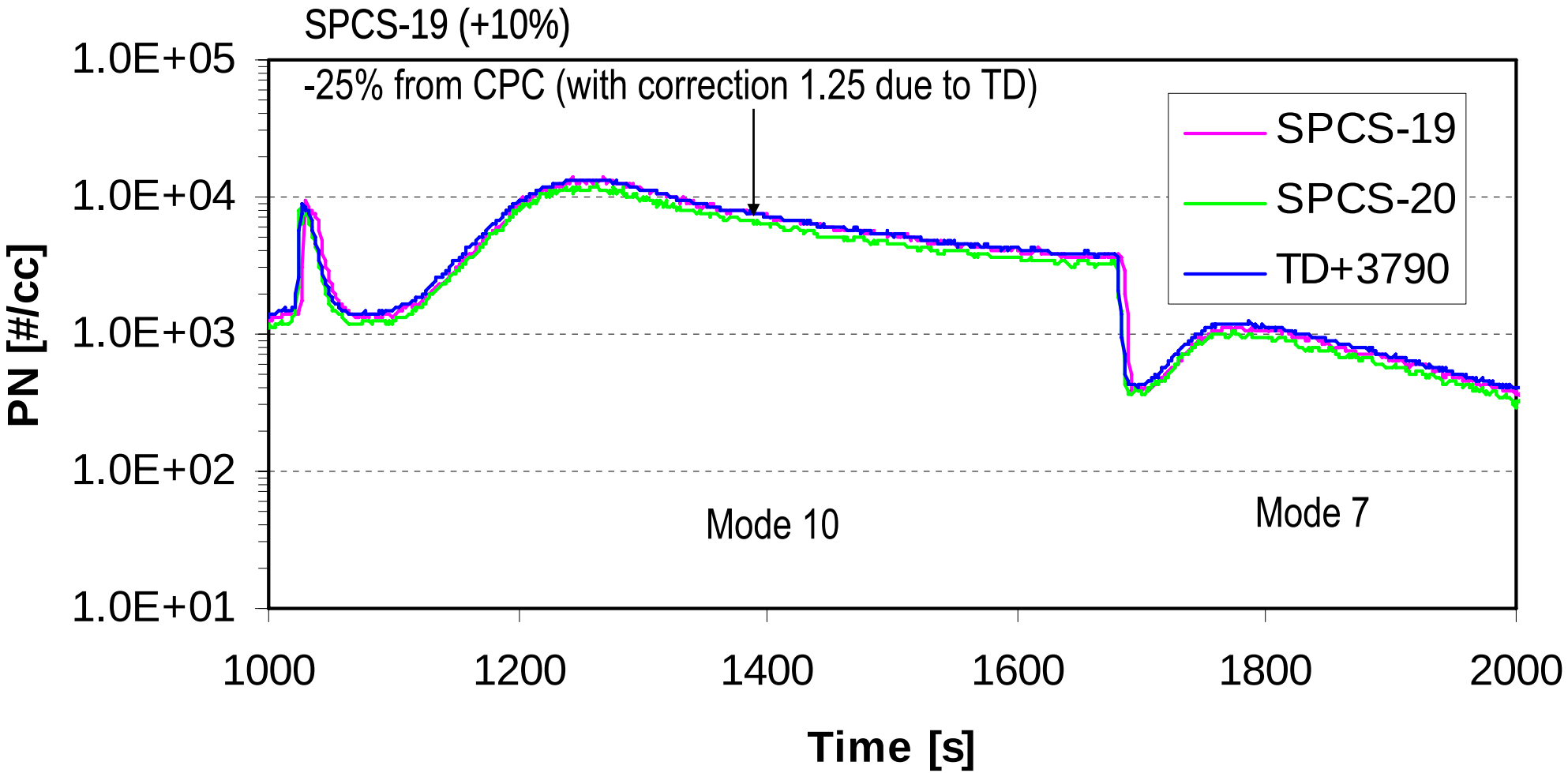
SPCS -19 and -20

DR	10	8
DA	12.5	9.5
BP	2	

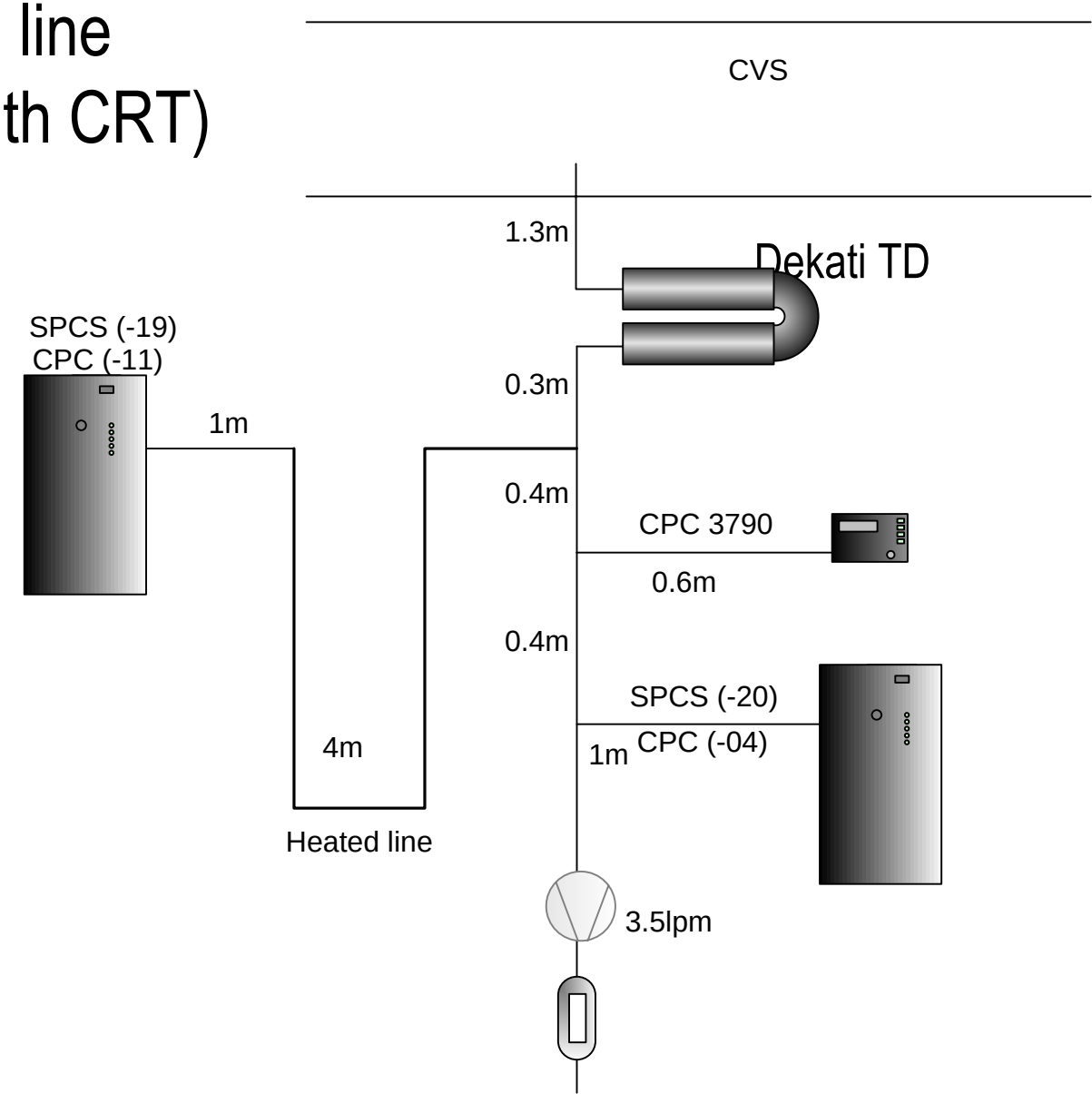
SPCS-20 from CVS, SPCS-19 with cyclone from CVS



SPCS-20 from CVS, SPCS-19 with cyclone from CVS



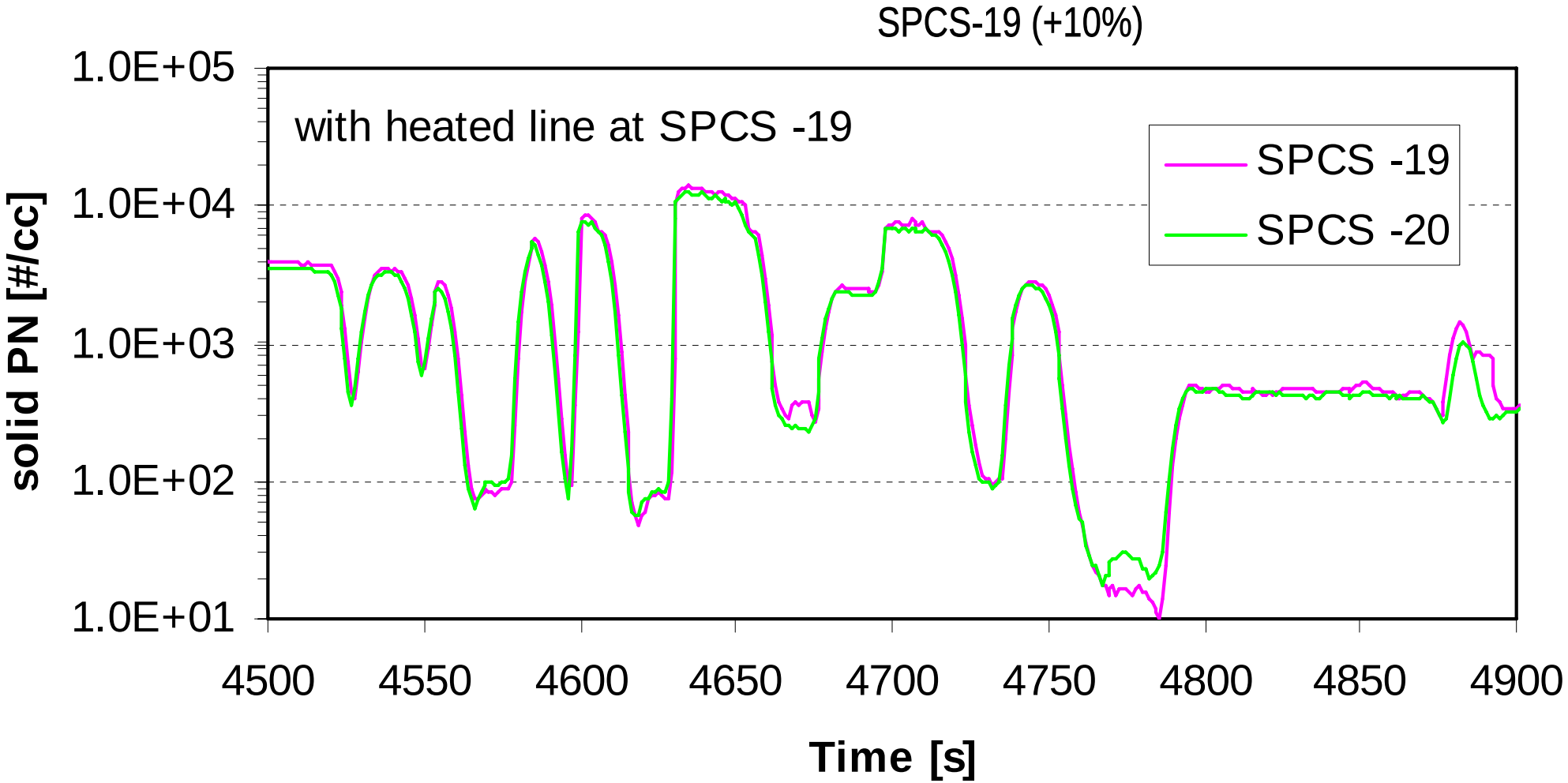
Set up for effect of heated line
Transient tests (Engine with CRT)



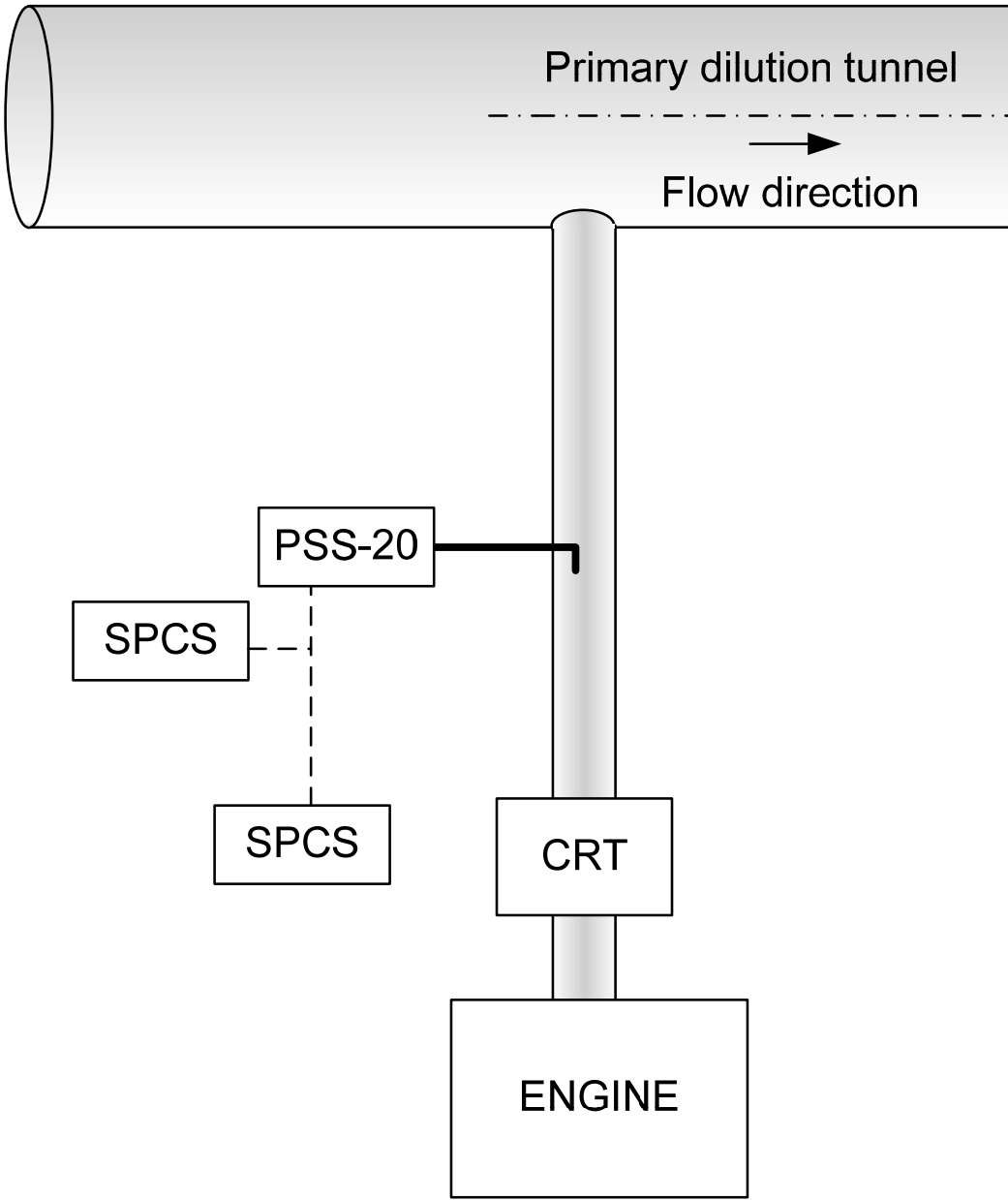
Settings

	SPCS -19 (-20)		
DR	8	8	(8)
DA	11	9	(9)
BP	2		

Transient tests



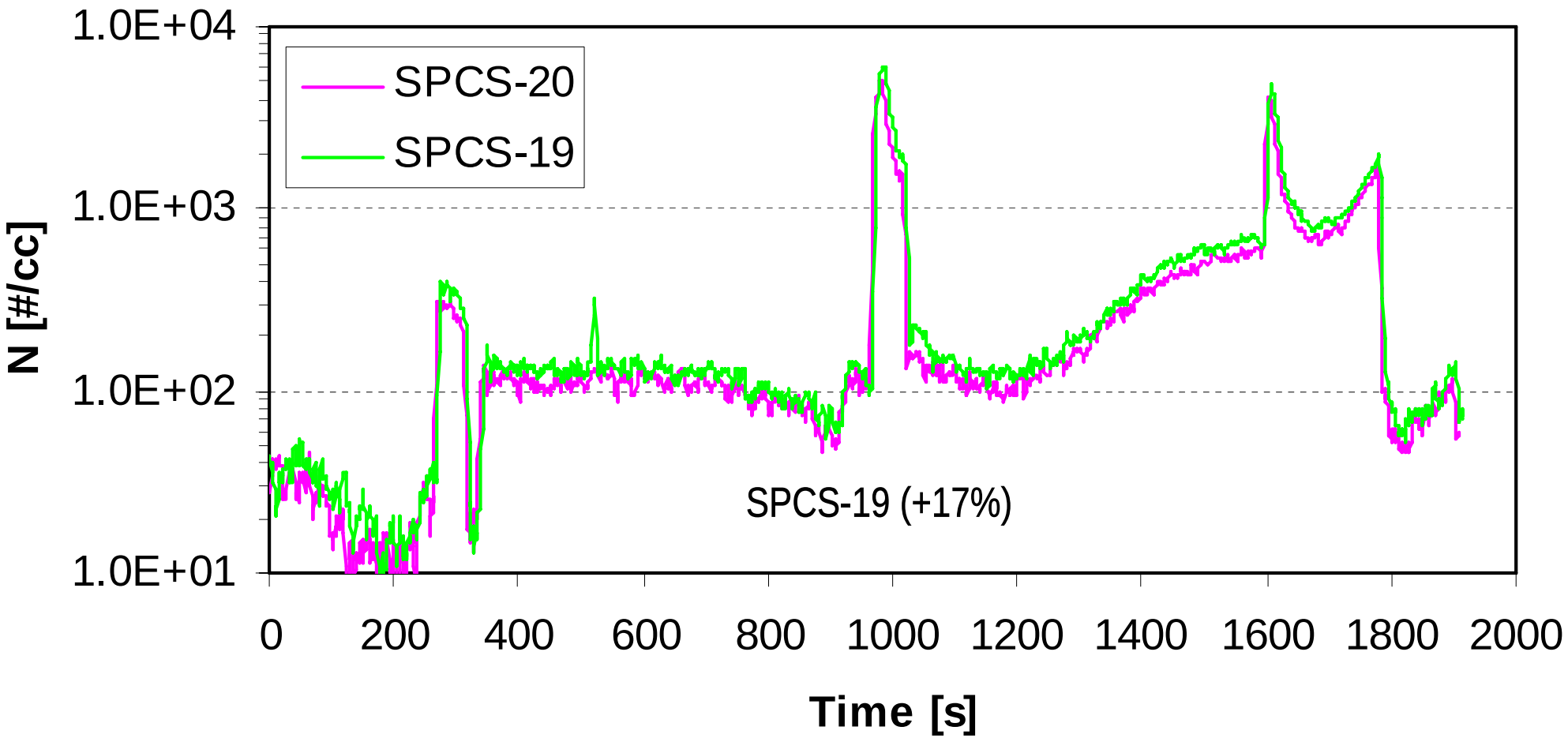
Comparisons of SPCS at Partial flow sampling systems



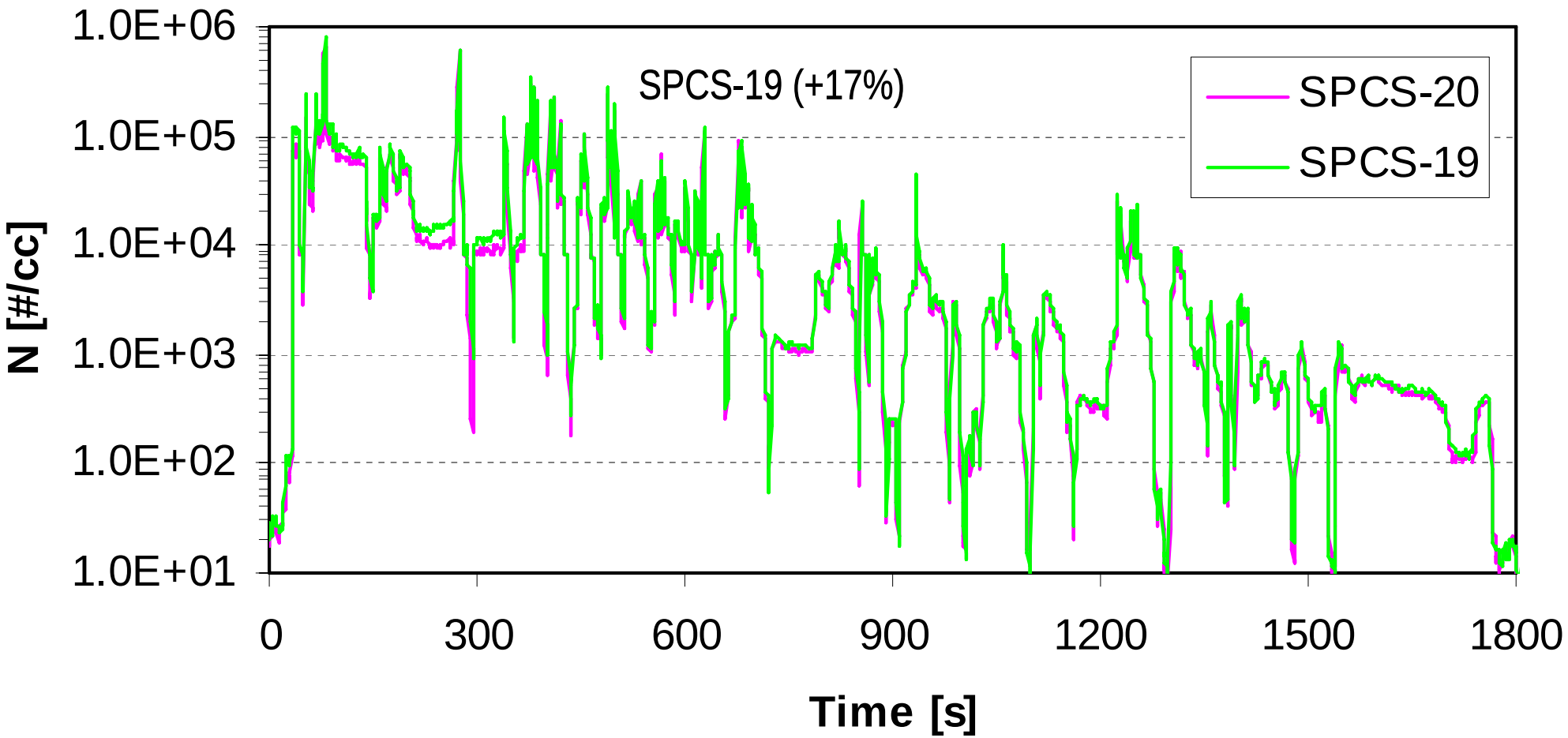
Settings

	SPCS -19 (-20)	
DR	10	8
DA	12.5	9.5
BP	3(1)	

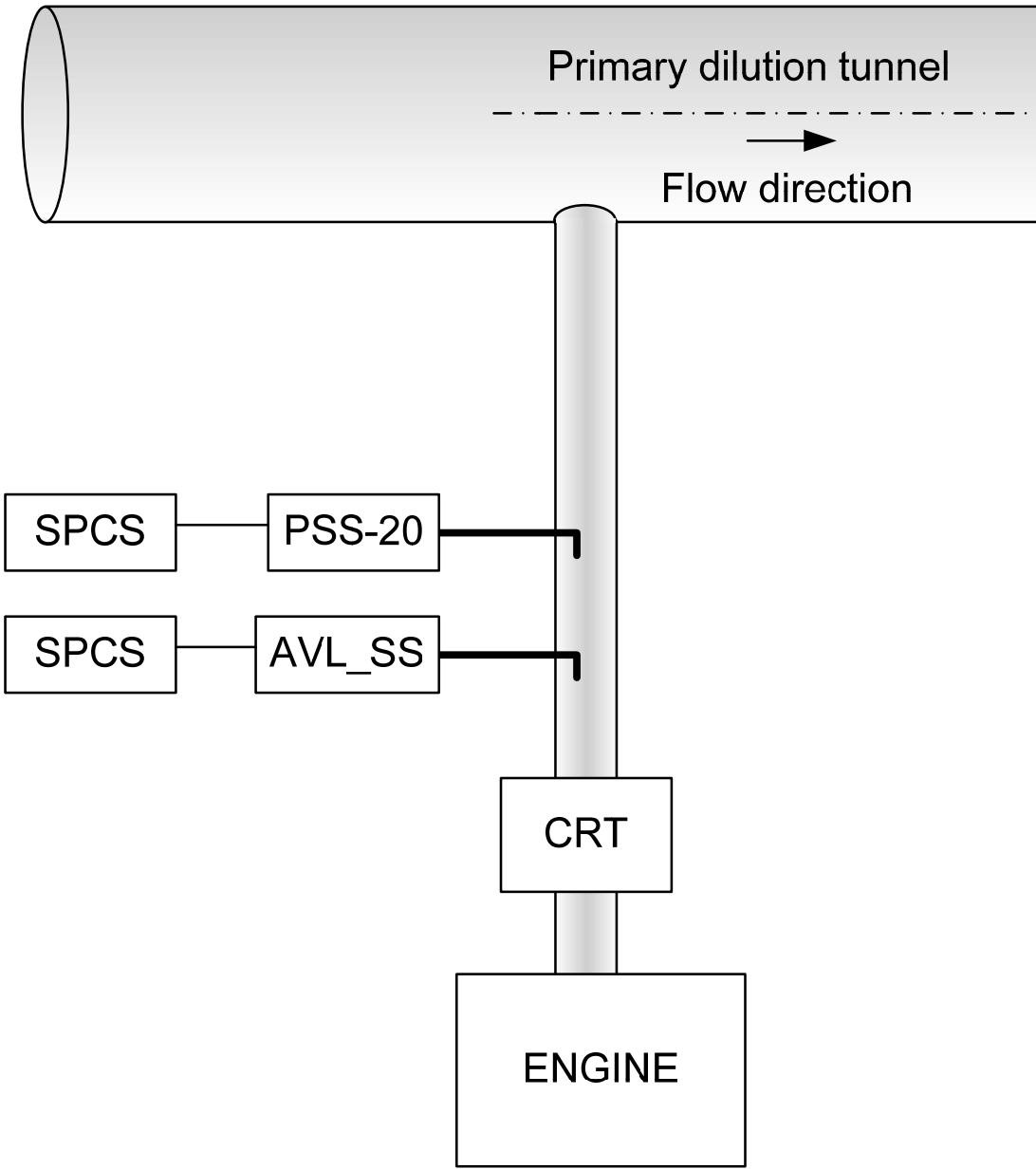
Partial flow systems: Both SPCS from PSS – steady states



Partial flow systems: Both SPCS from PSS –WHTC cold



Comparisons of SPCS at Partial flow sampling systems

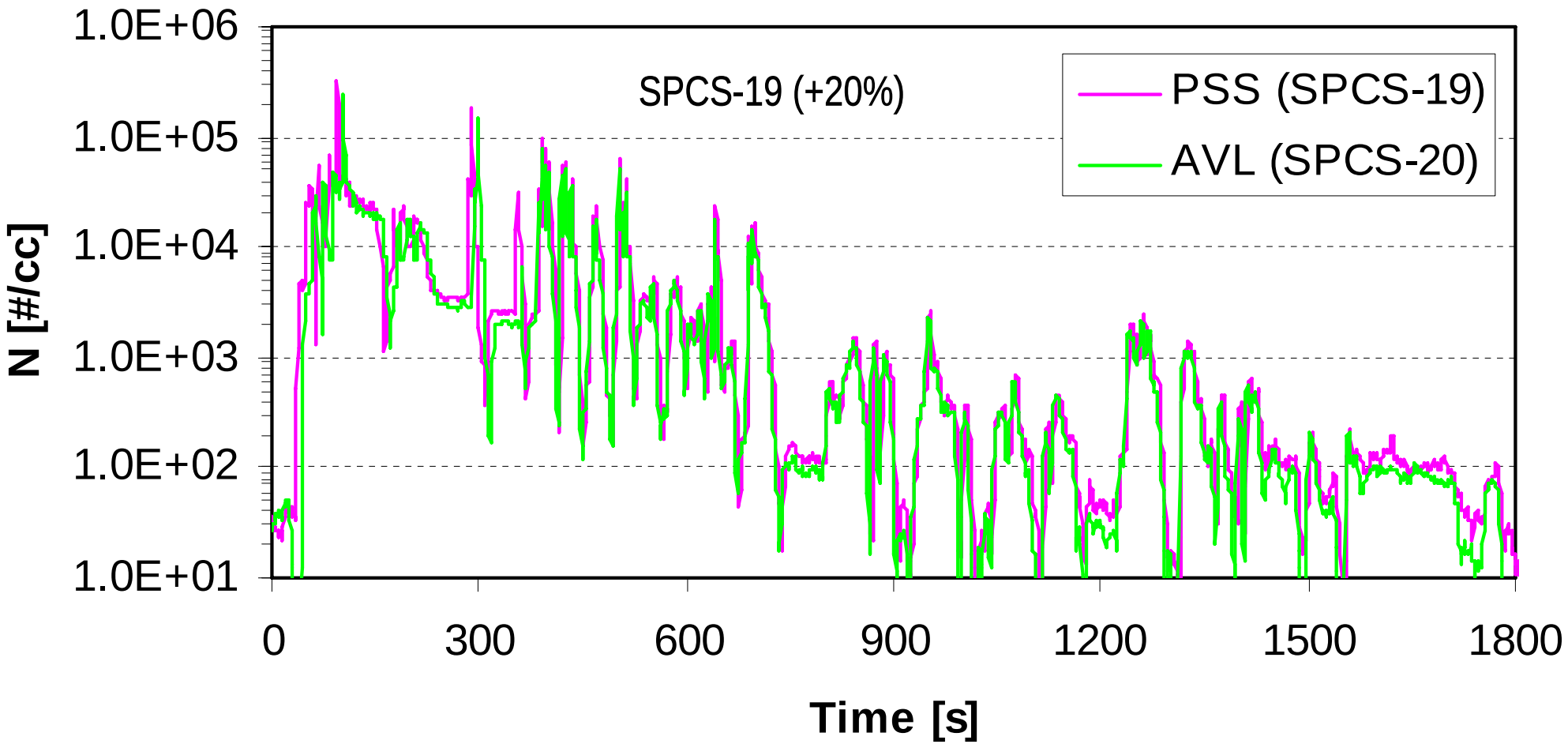


Settings

	SPCS -19 (-20)	
DR	10	8
DA	12.5	9.5
BP	2	

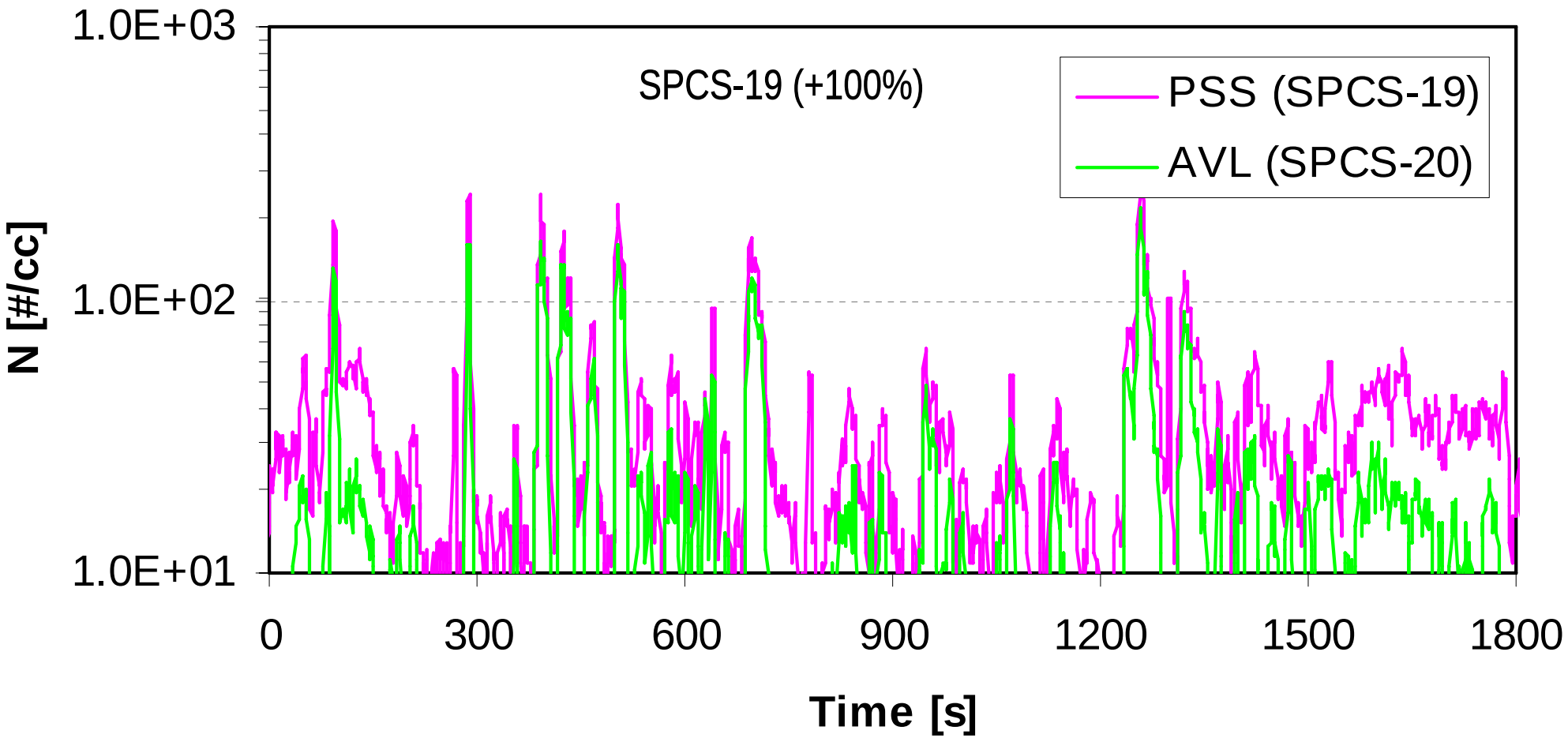
SPCS from PSS and AVL– WHTC

Same settings



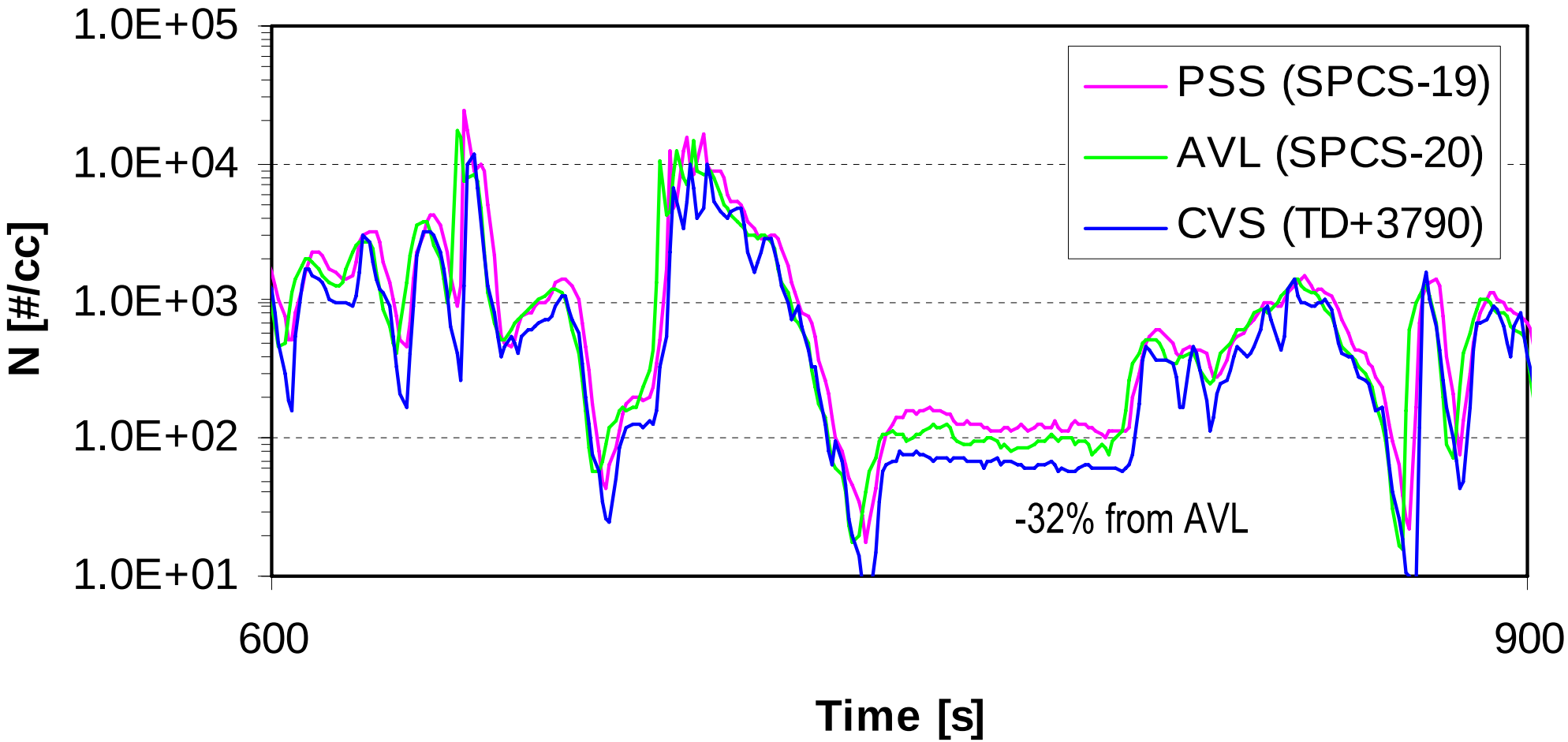
SPCS from PSS and AVL– WHTC

Same settings



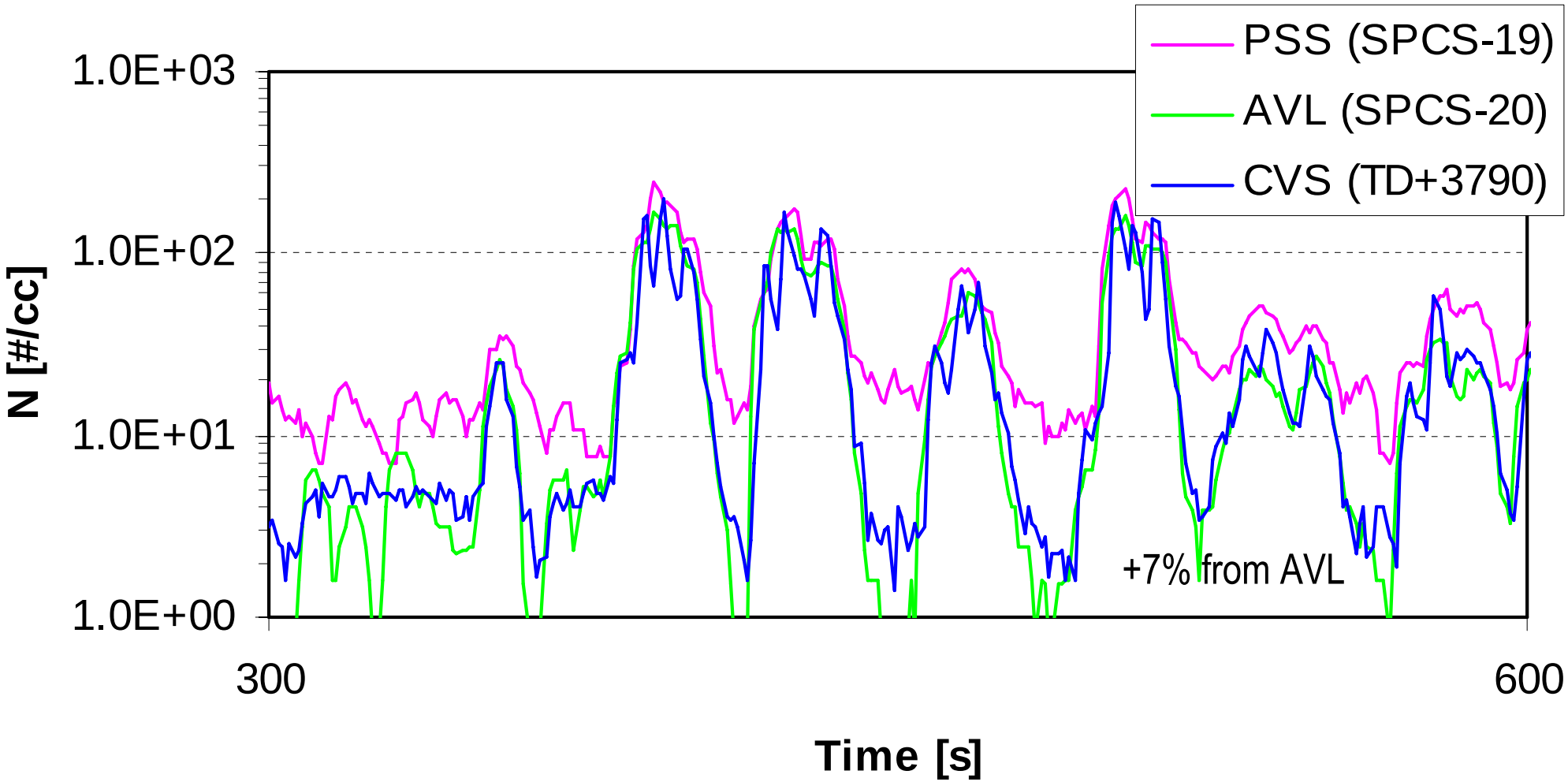
SPCS from PSS and AVL– WHTC

Same settings

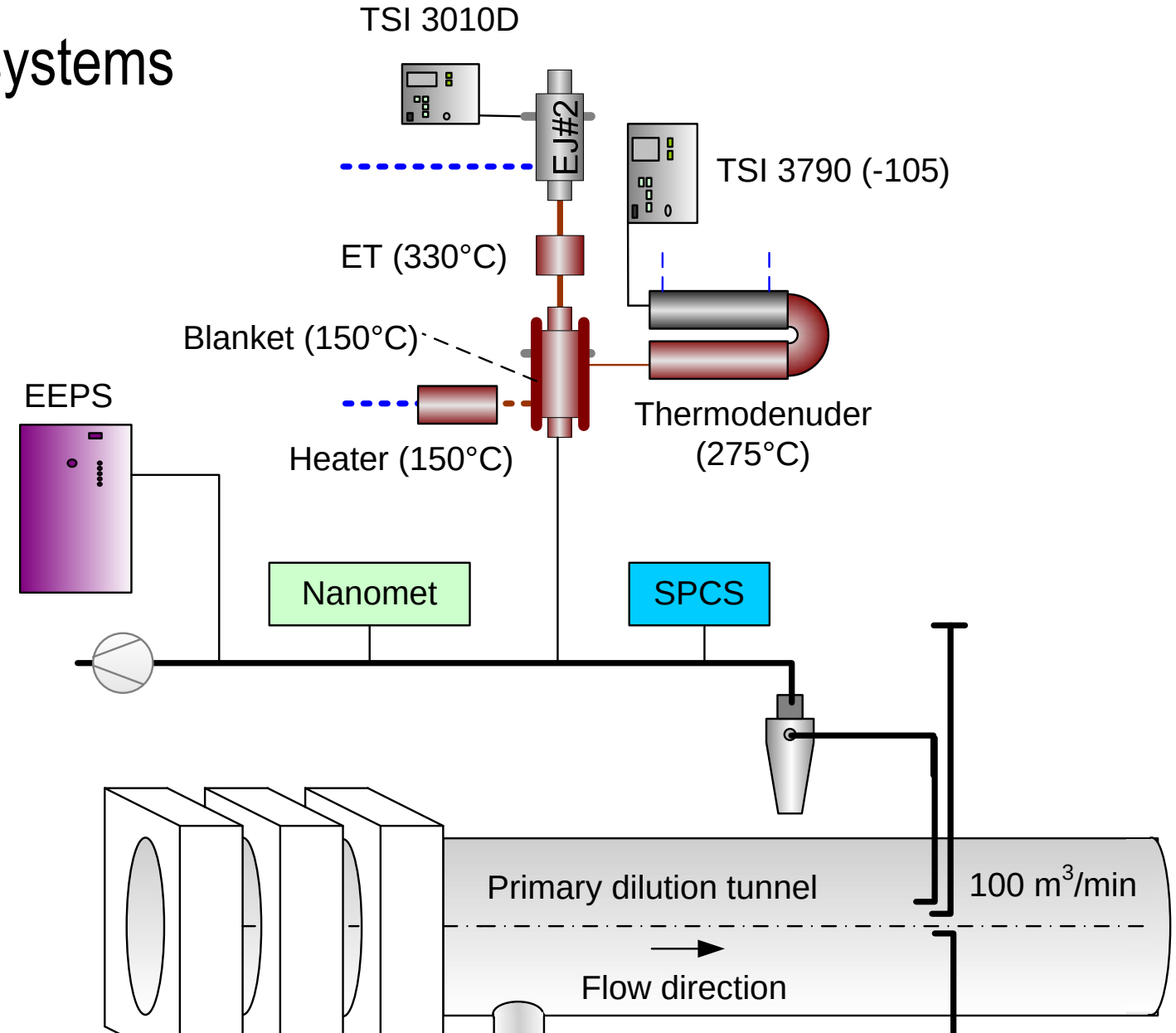


SPCS from PSS and AVL– WHTC

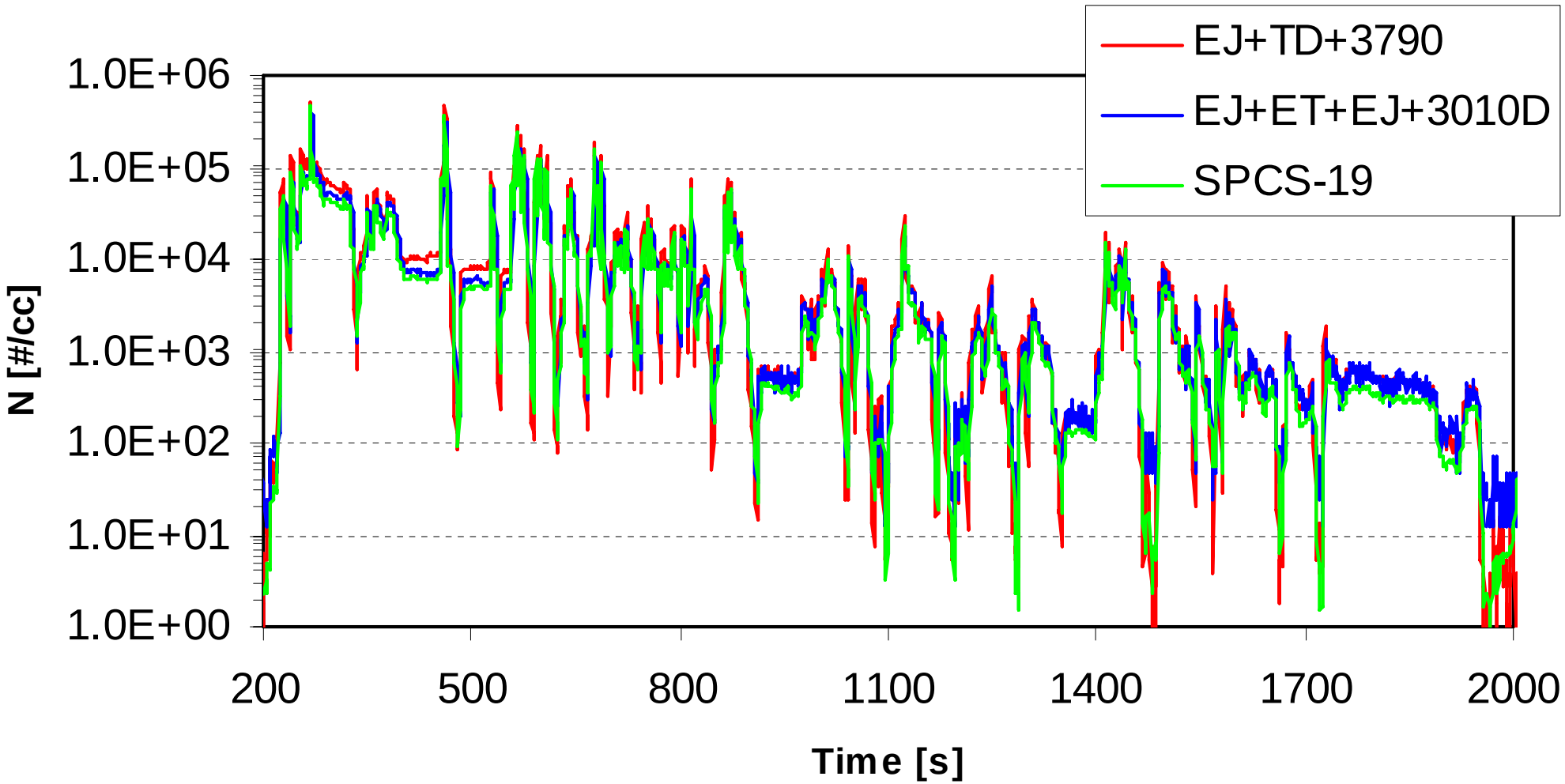
Same settings



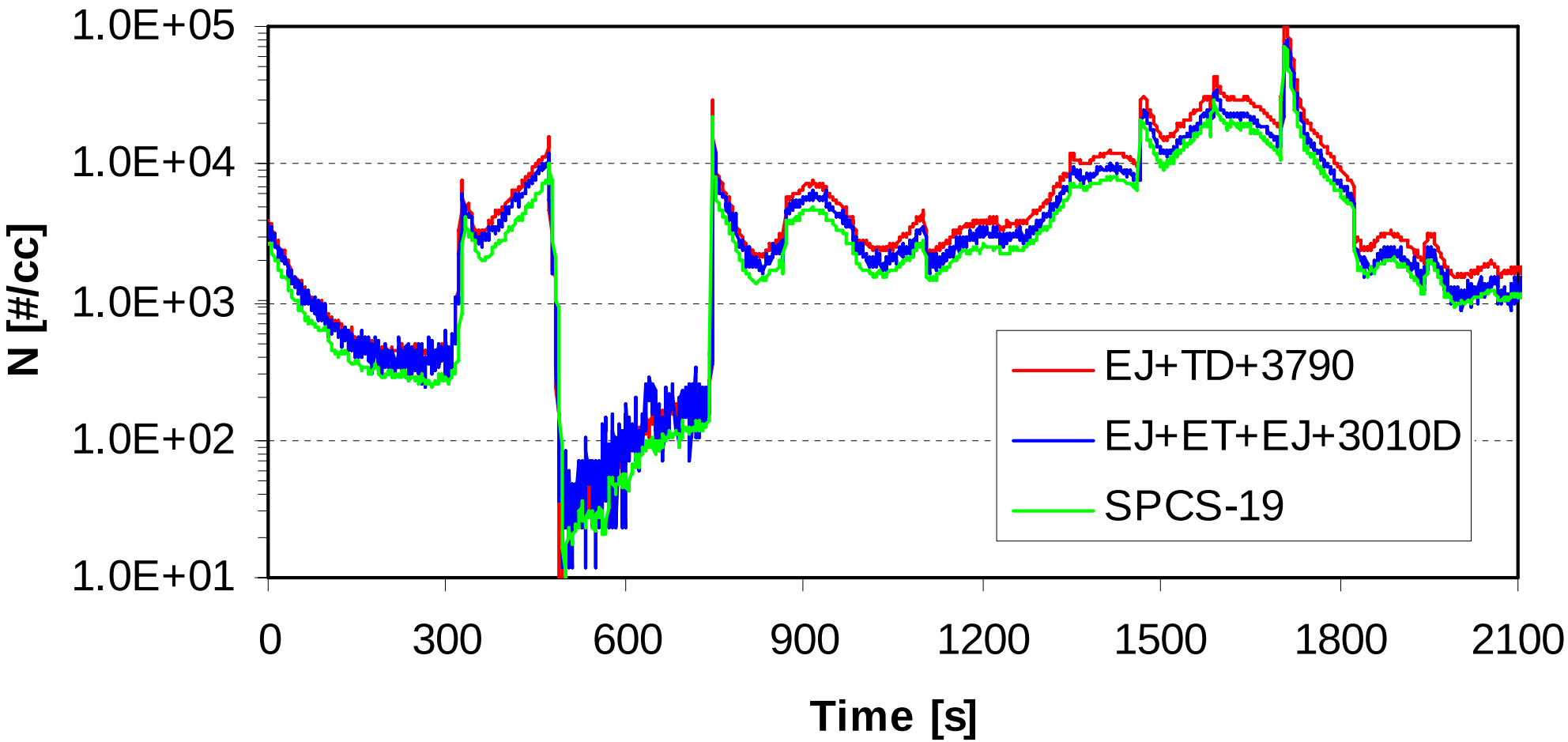
Comparison of systems



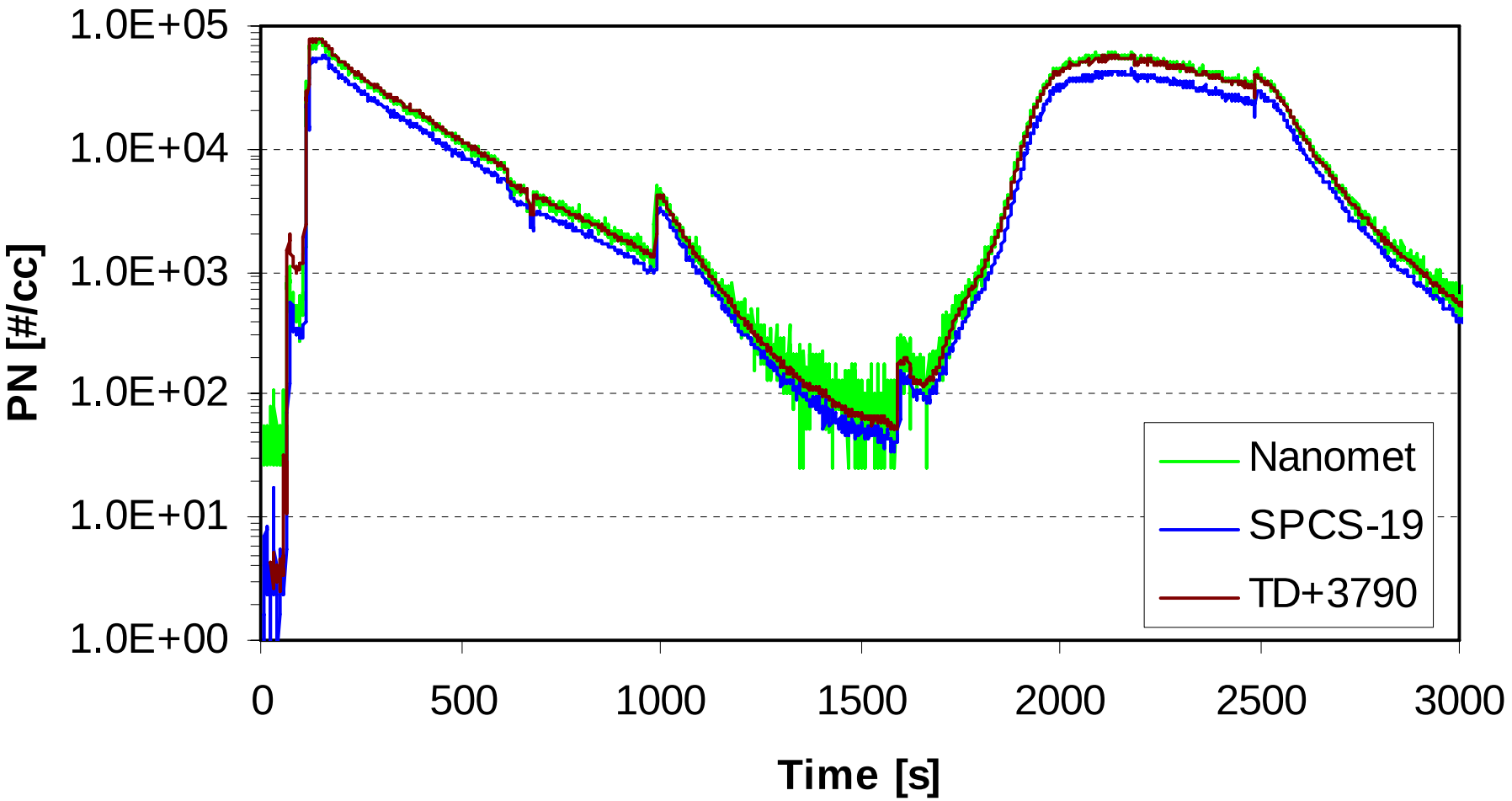
Cold WHTC emissions



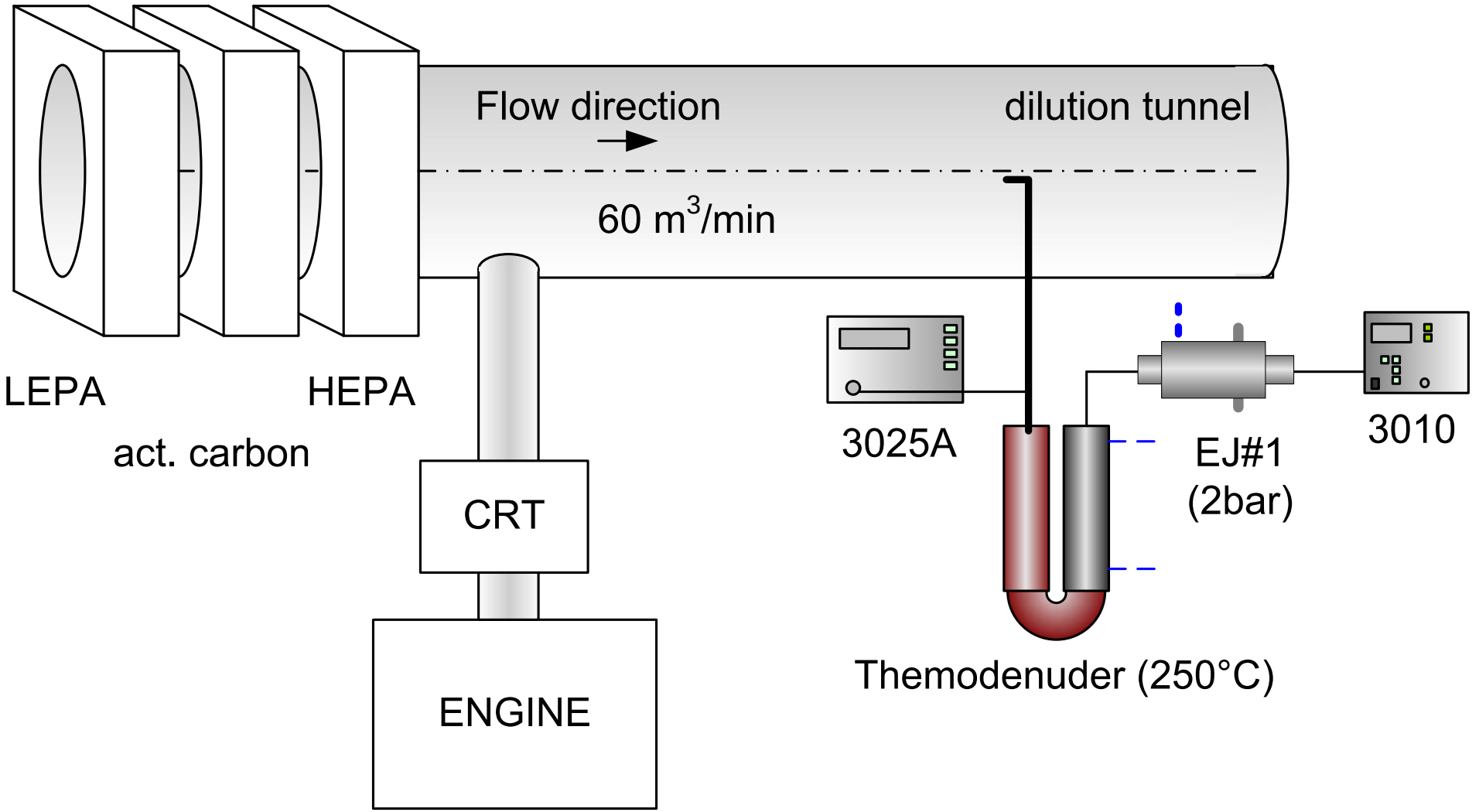
ESC emissions



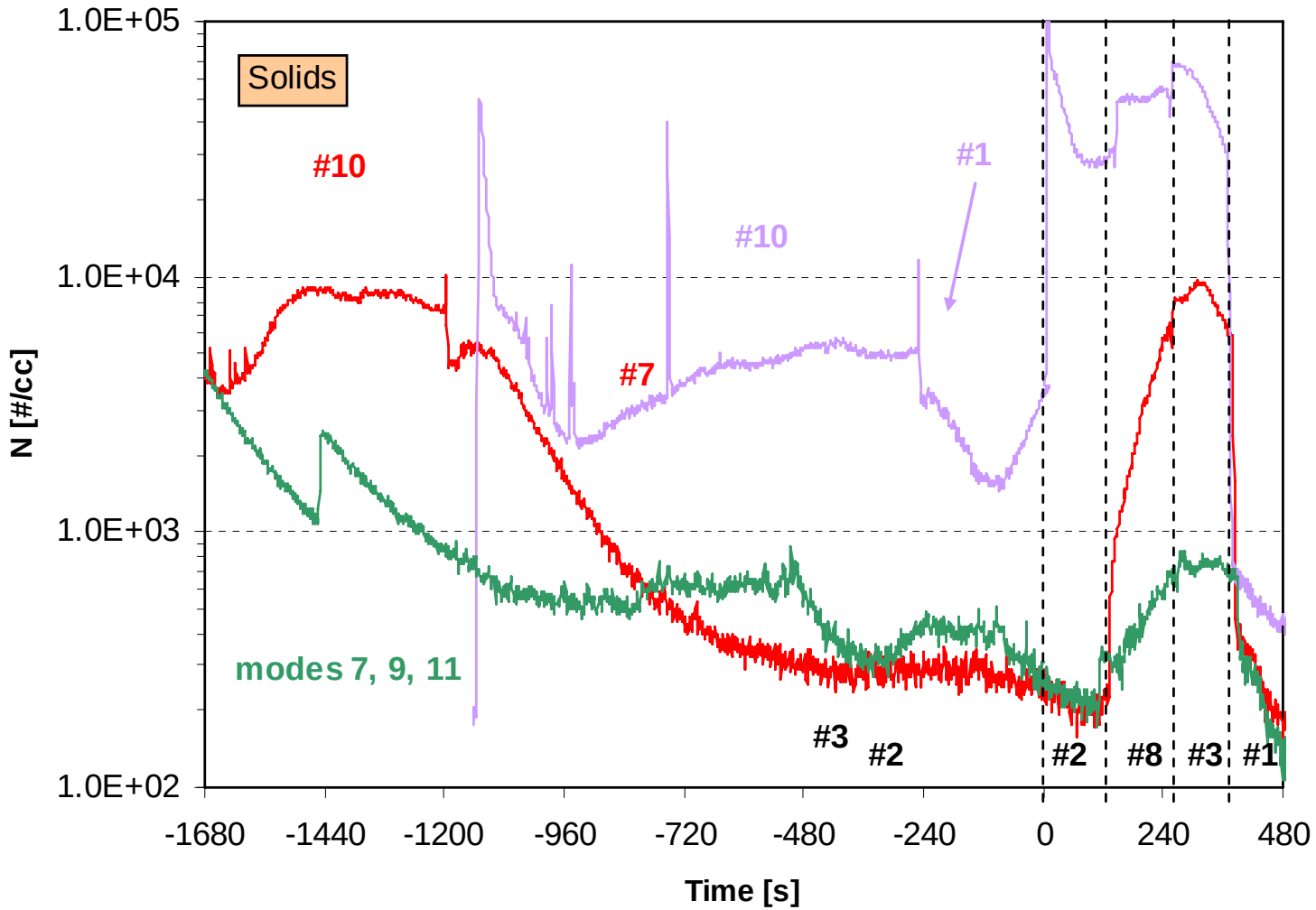
Steady states



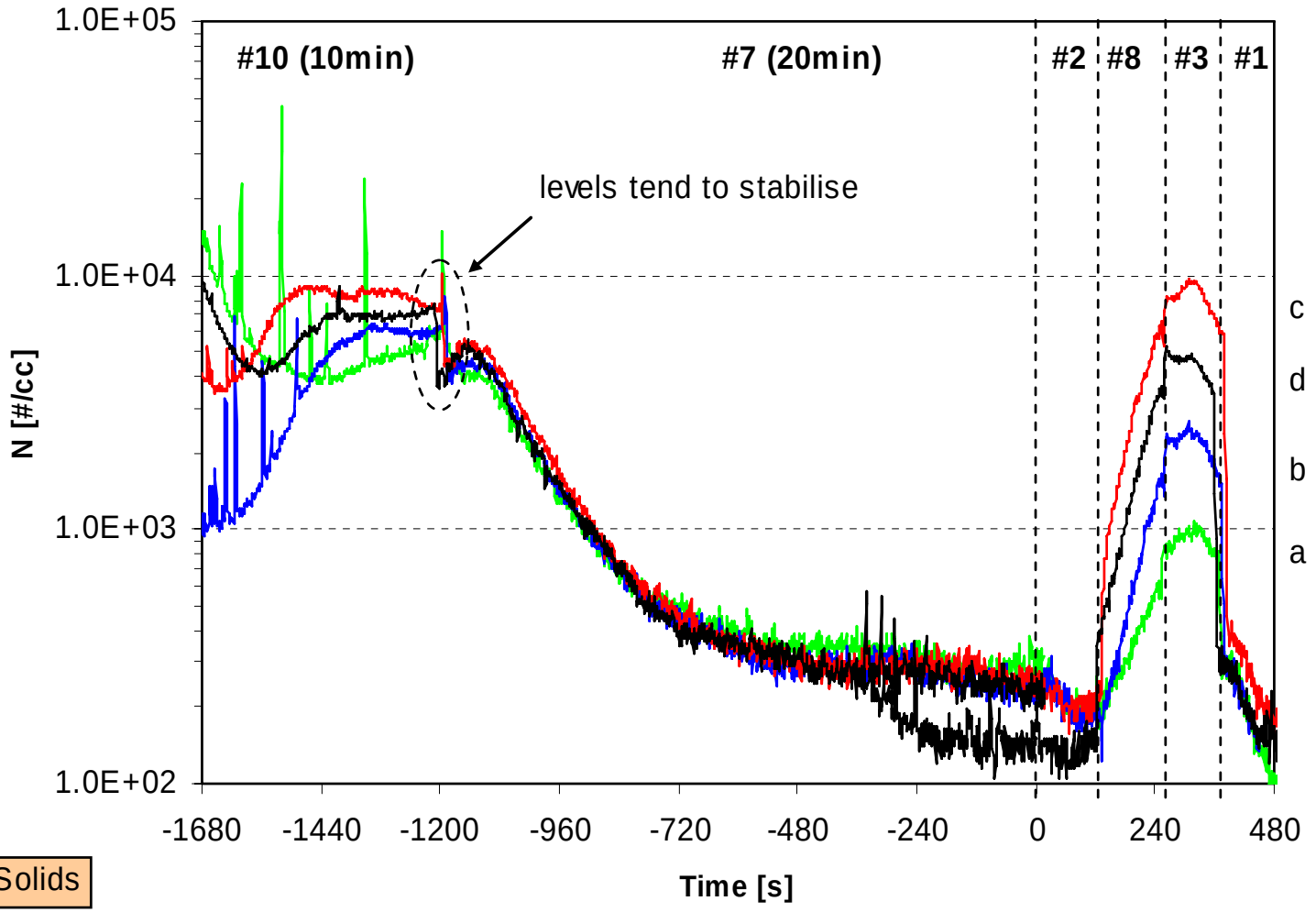
Effect of preconditioning



Importance of preconditioning

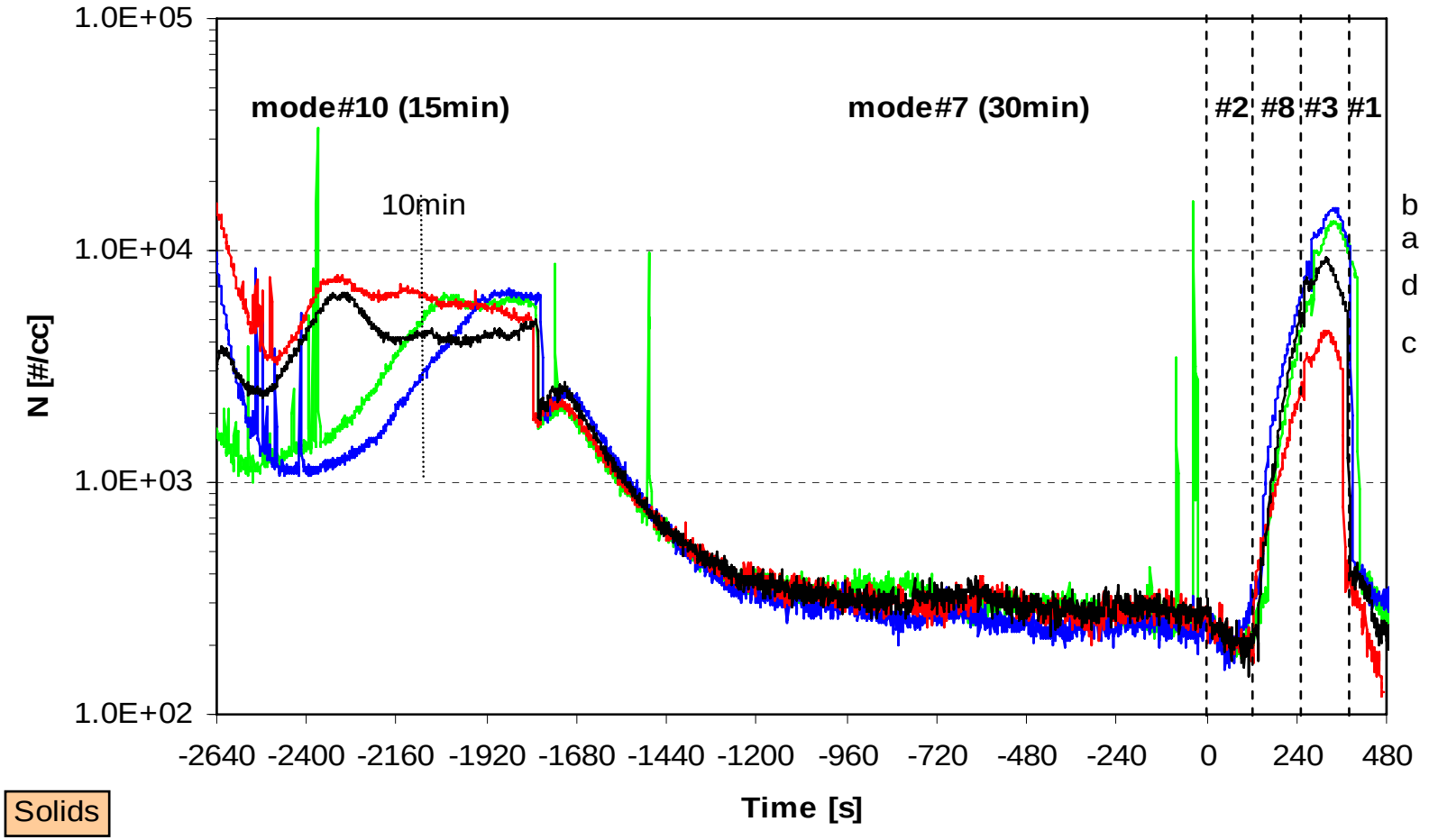


Regeneration-Loading



Solids

Regeneration-Loading



Solids

PMP HD setup

High efficiency filters at CVS and SDT

Cyclone

Heating of the filter 47±5°C RT>0.2 s

One 47mm TX40

Filter face velocity 50-80cm/s

CVS flowrate 100m3/min (RT=?)

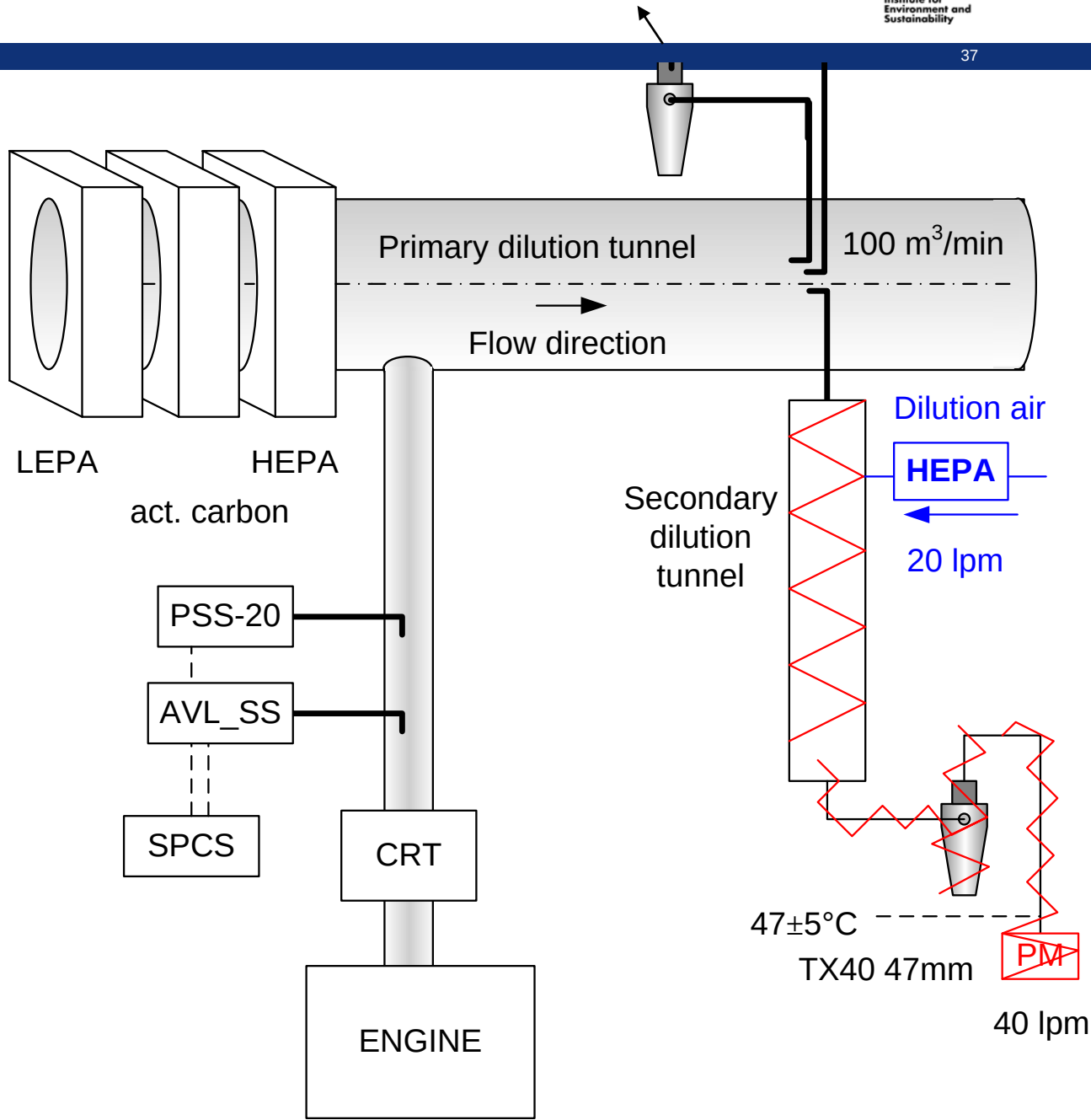
Secondary dilution: total/air 2:1

Engine CRT distance

CRT – Partial Flow systems

<u>Partial Flow systems:</u>

Filter face velocity 50-80cm/s



PMP HD setup

SPCS

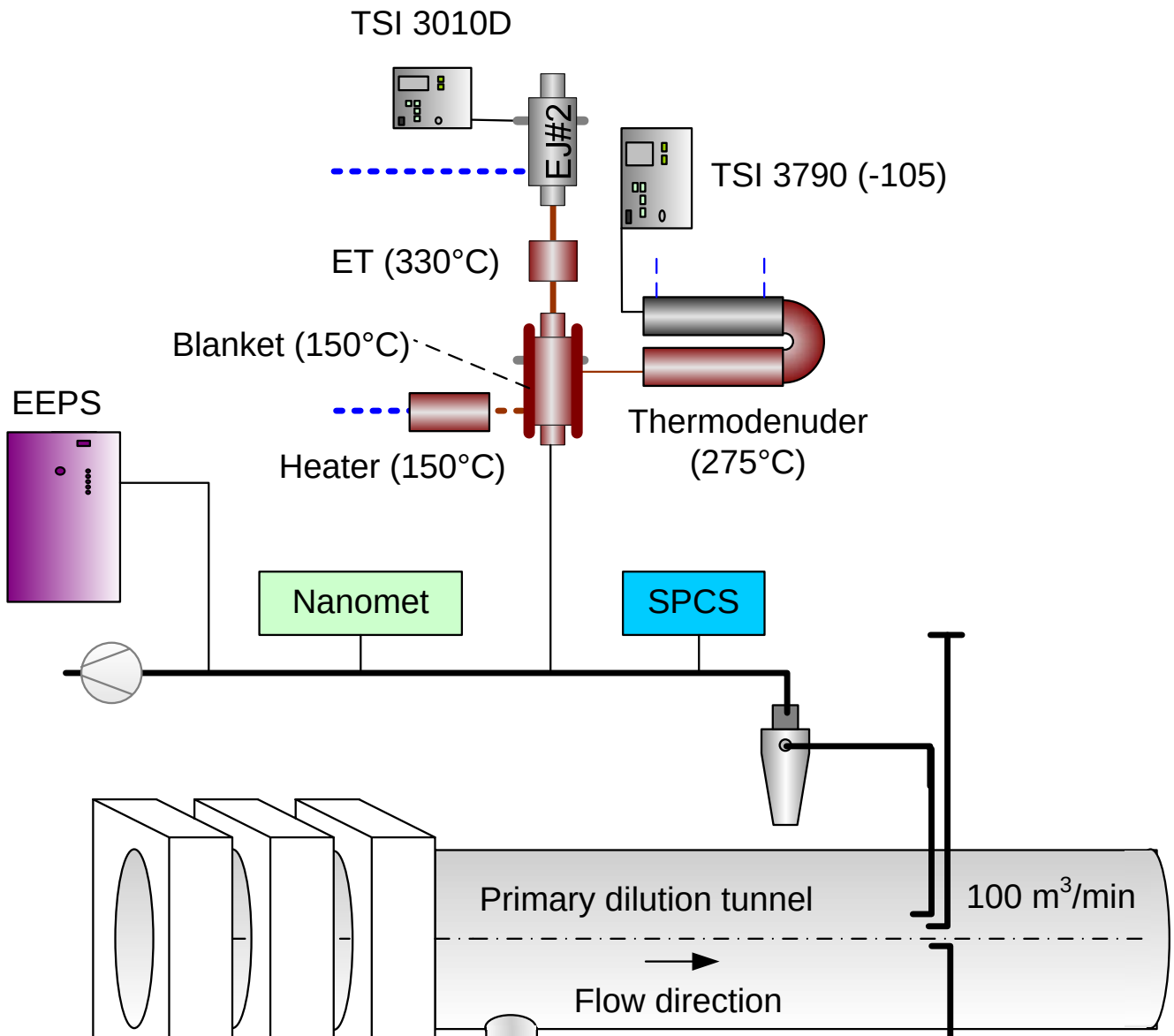
Alternative systems

<u>Partial Flow Systems</u>

Some systems

(like AVL Smart Sampler)

need filtered air feedback

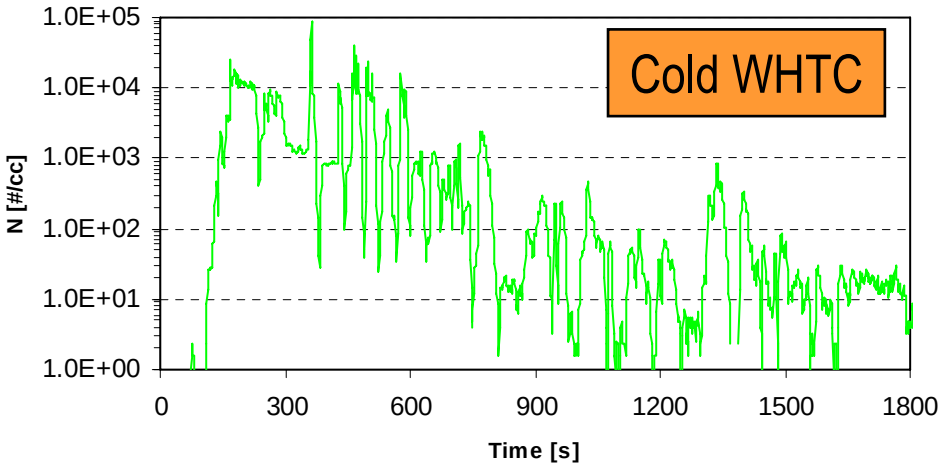


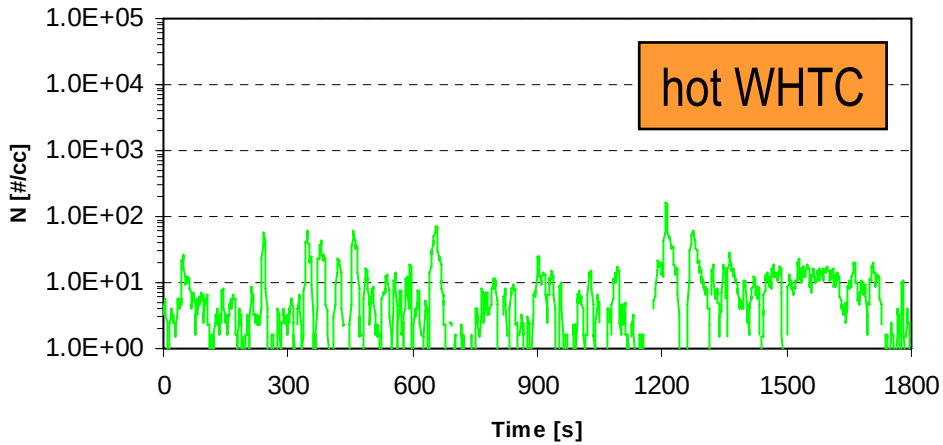
IFV	Instrument Functional Verification
C-WHTC	Cold Start World Harmonised Transient Cycle
H-WHTC_X	Hot start WHTC following x minutes soak
CP	Continuity protocol
ETC	European Transient Cycle
ESC	European Steady State Cycle
WHSC	World Harmonised Steady State Cycle

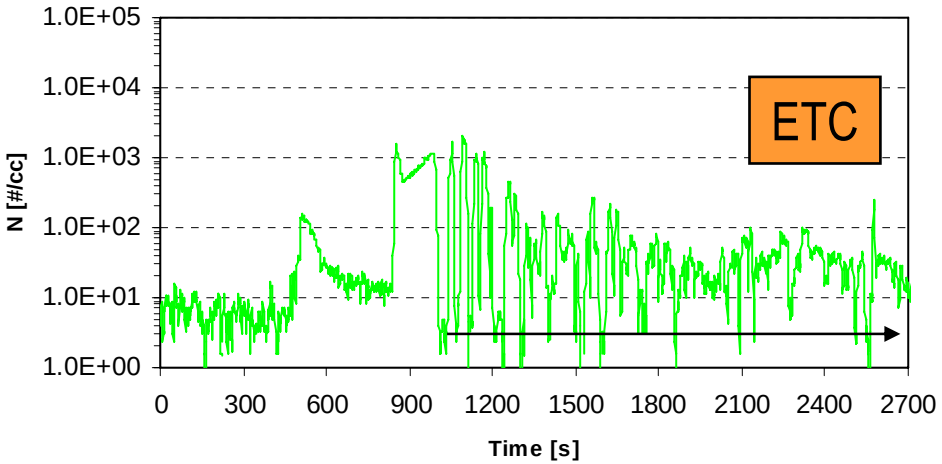
PMP HD revised protocol

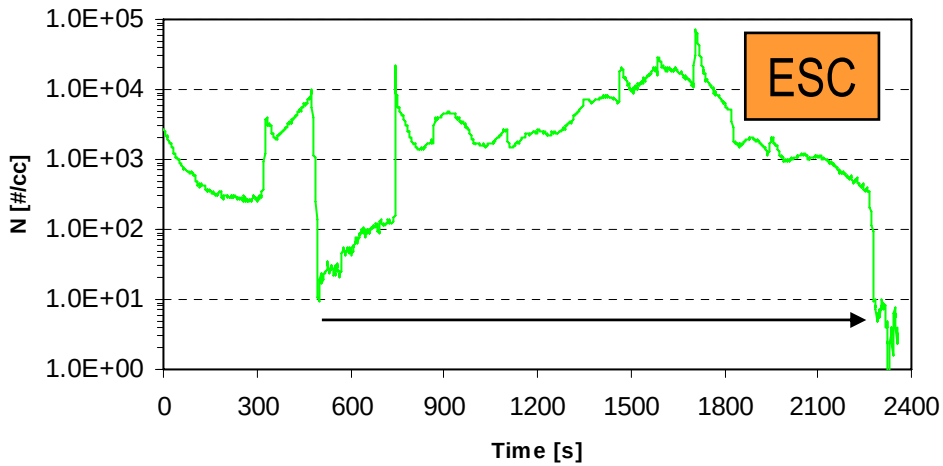
	Day 0	Day 1	Day 2
1		IFV	IFV
2		C-WHTC#1	C-WHTC#2
3		5 min soak	5 min soak
4		H-WHTC_5#1	H-WHTC_5#2
5		20 min soak	20 min soak
6		H-WHTC_20#1	H-WHTC_20#2
7		IFV	IFV
8		CP	CP
9		ETC#1	ETC#2
10		CP	CP
11	Warm-up	ESC#1	ESC#2
12	PC	PC	PC
13	SMP	SMP	SMP
14	Shut-down	Shut-down	Shut-down

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


Cold WHTC
N [#/cc]
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
0
300
600
900
1200
1500
1800
Time [s]


hot WHTC
N [#/cc]
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
0
300
600
900
1200
1500
1800
Time [s]


ETC
N [#/cc]
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
0
300
600
900
1200
1500
1800
2100
2400
2700
Time [s]


ESC
N [#/cc]
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
0
300
600
900
1200
1500
1800
2100
2400
Time [s]

Conclusions

-Weighting procedure extremely important for DPF engines

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

-Background number <10#/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.

Conclusions

- Comparison of CPCs
  - SPCS CPCS similar
  - SPCS CPCs and 3790 difference 10%
- SPCS Volatile Removal efficiency
  - Ok with NM 16nm 1.2E+07
- SPCS comparison
  - SPCS-19 and SPCS-20 have a <10% difference
  - The absolute levels are underestimated 15% (differences of CPCs taken into account)
    - DF uncertainty or thermophoretic losses (more possible)

Conclusions

-Satisfactory agreement of SPCS at partial flow systems

-Satisfactory agreement between SPCS at different partial flow systems

-Satisfactory agreement between partial and full flow systems

-Satisfactory agreement between different measurement systems

Conclusions

-The cyclone (laminar or turbulent flow) has negligible effect on the emissions measured

-The heated line has minor effect on the emissions <5%

-There are a lot of volatiles even with low sulfur fuel, especially during regeneration

-Preconditioning important for particle measurements

-Suggested minimum preconditioning 15min at mode 10 and 30 min at mode 7

Outlook (Validation exercise)

-What will be sent to labs

>SPCS (x2)

>cyclones (?)

>Lubricant, filter

>TX40

-What labs will need

>LAN, RS232 (x2)

>Pressurized air 6 bar (>50 lpm)

>Power (380V 32 A, 220V 16A) (x2)

>Feedback filtered air at partial flow systems (3.5lpm)

>Pump for CVS cyclones (validation exercise)

>Butanol (2 l)