DOWN TO 10

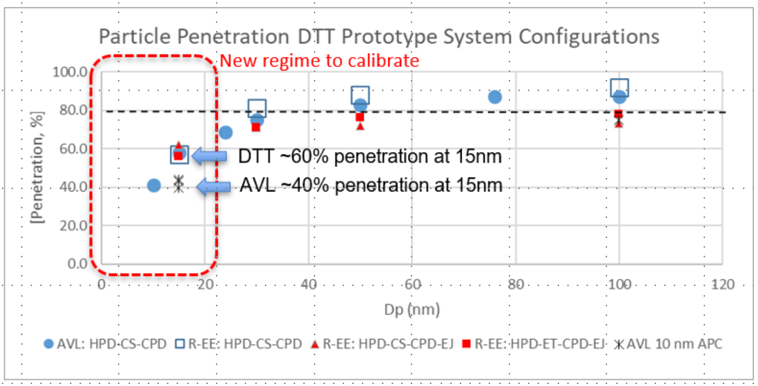
Action:

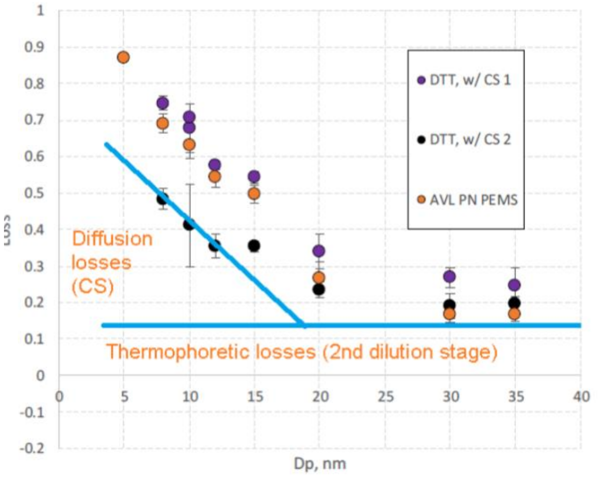
"Sub-23 nm particle measurement methodology"

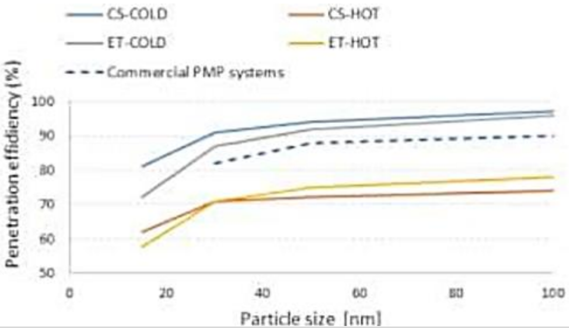
Particle losses

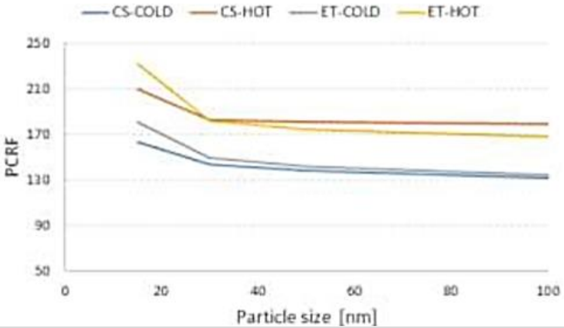
With CS DTT system does not have appreciably higher losses than with ET

- The penetration performance of the DTT prototype system when equipped with a CS as VPR is not appreciably different to that seen when an ET-based VPR is used
- The benefits of the CS in eliminating potential volatile artefacts justify its selection in preference to ET and prioritization in this study



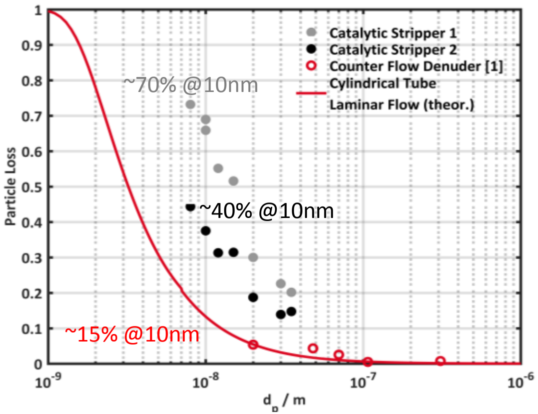




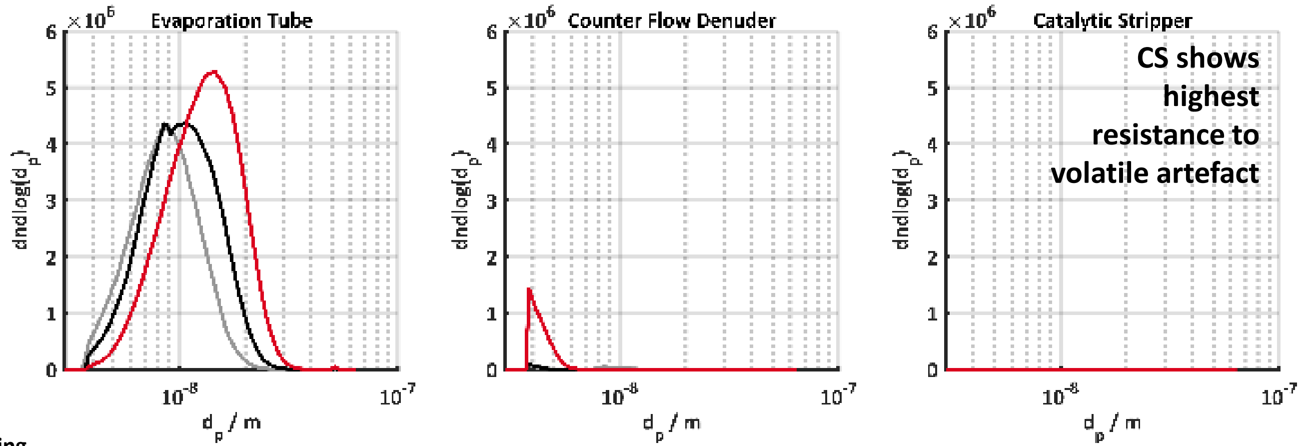


Volatile Particle Removal

Optimisation of catalytic stripper advisable; volatile elimination and inhibition of particle growth possible with several approaches



Particle losses in the three different sample conditioning systems



Nucleation mode artefact prevention test for different aerosols: ET (left); CCFD (center); CS (right)

Particle growth experiments (Table) showed that artefact formation is very low for all systems tested, including hot dilution and catalytic means

Sampling system	Concentration / 1/cm3	Fraction counted	Growth/ nm
Primary	NA	8.3E-04	0,0
ED + ED	990	2.5E-02	1,4
PTD + ED	2200	5.4E-02	1,7
PTD + CS1 +ED	65	1.6E-03	0.3
PTD + CS2 +ED	130	3.3E-03	0.5

Calibration challenges

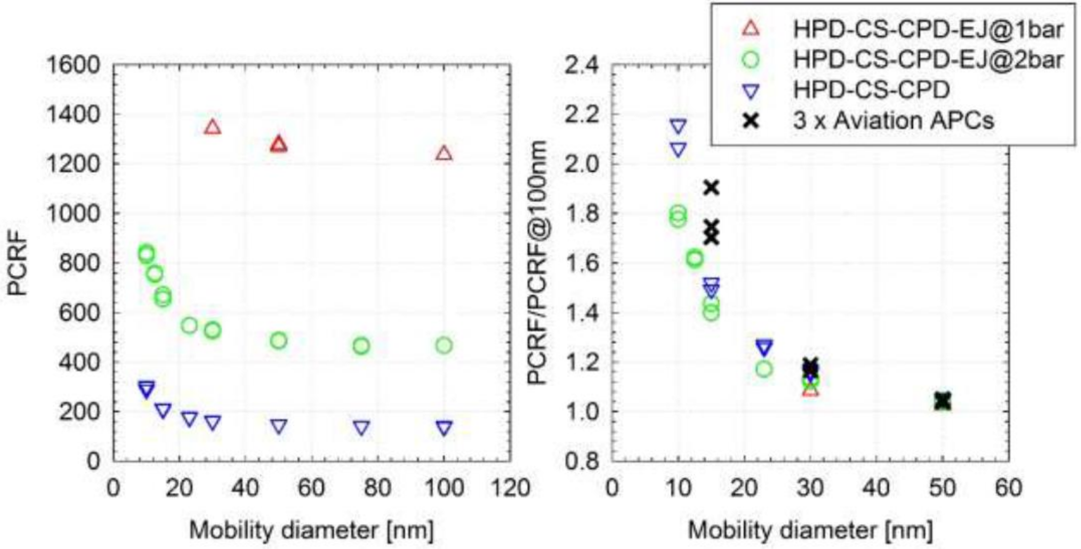
Calibration below 30nm needs study; d50 material?; thermal conditioning; functional stability in real operation (and additive factor...)

Below 30 nm, measurement uncertainty is elevated and this is a clear area for development of <23nm PN systems' calibrations.

Other areas for calibration and development were identified for continuing study in the project, and outside, including:

- Selection and standardization of calibration material for PNC d50;
- Ensuring that thermal conditioning of calibration aerosols is adequate;
- Development of an environment to test functional robustness (temperature/vibration etc) for the PEMS environment;

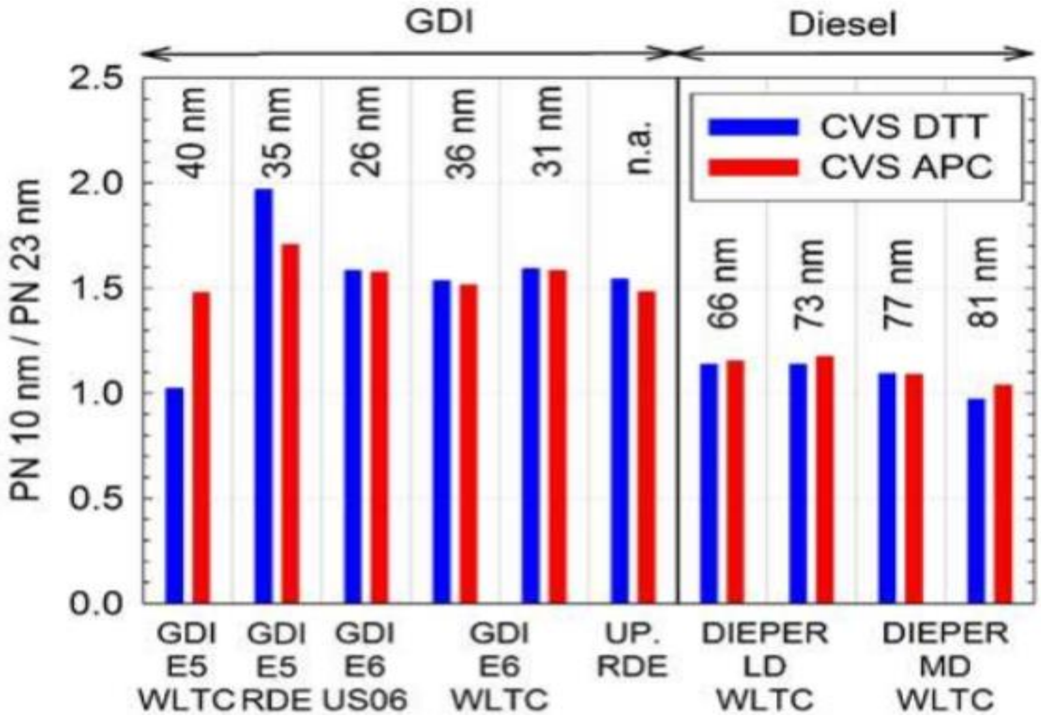
Extension of current performance requirements of calibration equipment to encompass the extended size range required by the DTT system



Measured PCRFs at different mobility diameters (left) and PCRFs normalized to the PCRF at 100 nm (right).The performance of the DownTo10 prototype is compared to that of a commercial AVL Particle Counter (APC) for aviation applications which also incorporates an AVL catalytic stripper.

Verification Study

As diluter and sample conditioner at the CVS, DTT is equivalent to commercial 10nm CS-based systems



Cycle-averaged ratios of particle number emission rates determined by the DTT prototype (blue bars) and an AVL Particle Counter with a Catalytic Stripper (red bars) for different vehicles and test cycles. The number on top of the bars illustrate the cycle-average mean particle diameter measured with the EEPS

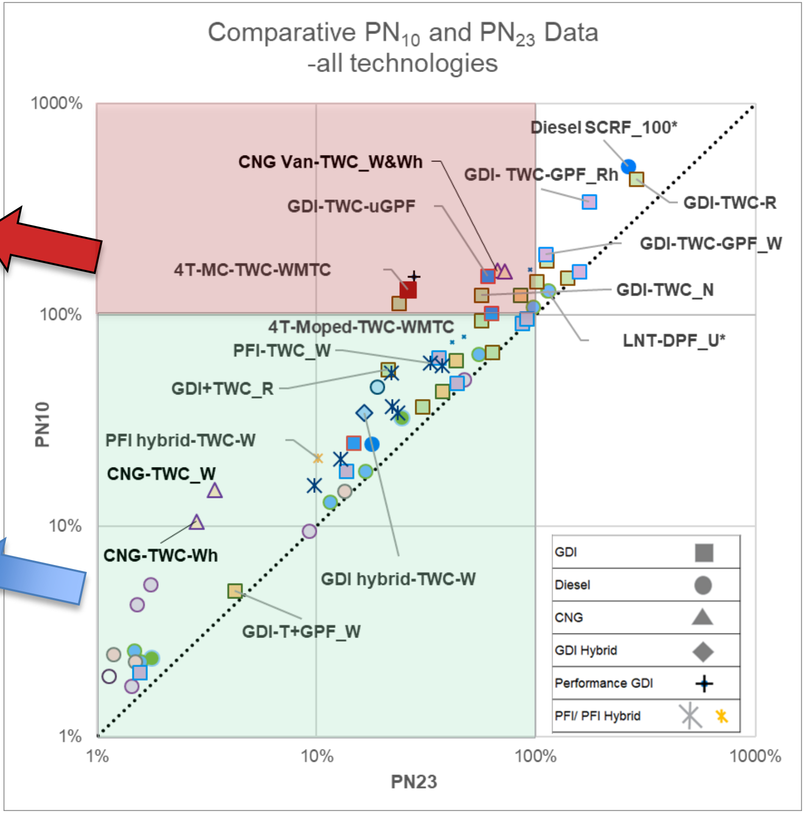
- Good correlation between DTT & APC at the CVS

Presence of 10nm PN emissions above the current Eu6 limit

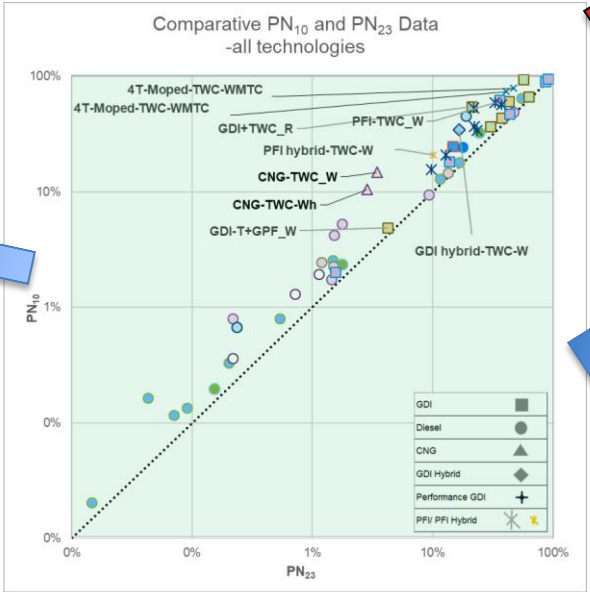
Different fuels & engine technologies

Some technologies may have PN emissions that are compliant with the current limit value (PN23 range), but would exceed the regulatory threshold if PN10 were measured instead

- includes a 4-stroke motorcycle with a three-way catalyst on the WMTC, a CNG van with a TWC on WLTCs and a GDI with an uncoated GPF (red area)

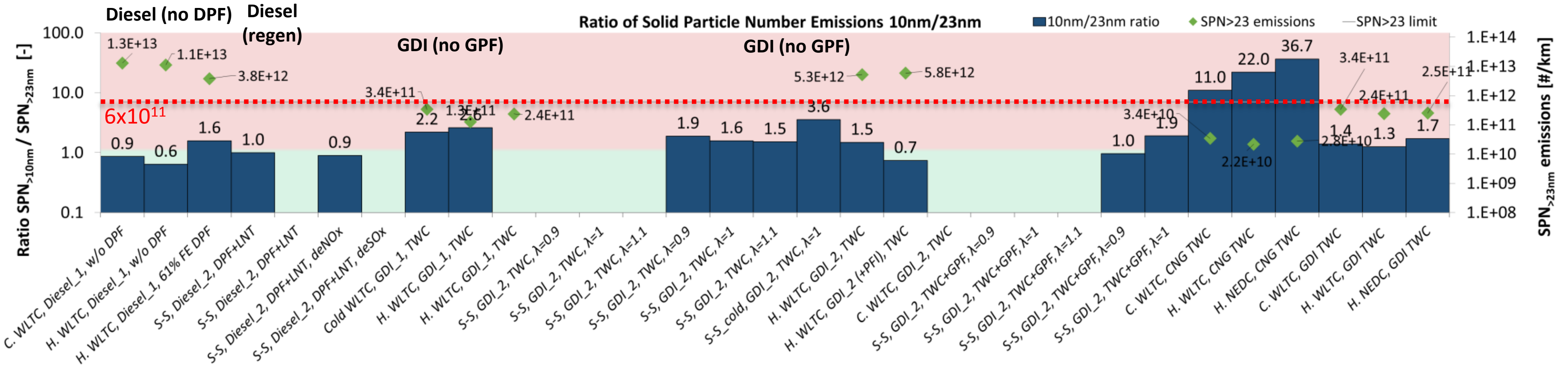


- Most technologies compliant with $6x10^{11}$#/km for both >23nm AND >10nm ranges



PEMS 10nm

Lab measurements



- PEMS 10nm lab measurements confirms initial finding of higher particle emission performance in SPN>10nm region
- High SPN 10nm/23nm ratios, particularly for GDI and CNG vehicles, but not necessarily above 6×10^{11} #/km!