# OICA PN Round Robin Test

# GRPE, 11th of June 2009

This particle number round robin programme was funded by ACEA and
the programme management contracted out to UTAC

- Test set up
    - 8 labs (1 is repeated start & en of programme)
    - 2 vehicles (Avensis & 407) Diesel with DPF
    - 3 PN equipments
        - Horiba SCPS
        - AVL APC
        - Ecomesure RS-PMP
    - Nov 2008 – April 2009
    - 58 valid tests

- Aim :
    - Check on R83 procedure for PN measurement in real use
    - Estimate the expanded uncertainty of the PN results

- Conditions
    - As much similarity as possible for the vehicles
    - Each lab measures with its own procedure
    - Regeneration of the vehicles is not taken into account in the global results

**UTAC**

URepro=4% for CO2

URepro=10% for NOx

**=> As expected for this type of round robin test**

| PM (mg/km) | | Standard deviation | | Expanded uncertainty | |
|---|---|---|---|---|---|
| | **Mean** | $\sigma$Repet | $\sigma$Repro | URepet | **URepro** |
| 407 | 0.27 | 0.15 (56%) | 0.27 (100%) | 0.31 (115%) | 0.54 (**200%**) |
| Avensis w/o reg effect | 0.51 | 0.14 (27%) | 0.23 (45%) | 0.29 (57%) | 0.46 (**90%**) |
| Background | 0.24 | 0.13 (54%) | 0.27 (113%) | 0.27 (113%) | 0.54 (**225%**) |

**=> Vehicle values close to background**

**=> Backgrounds < 1mg/km**

**UTAC**

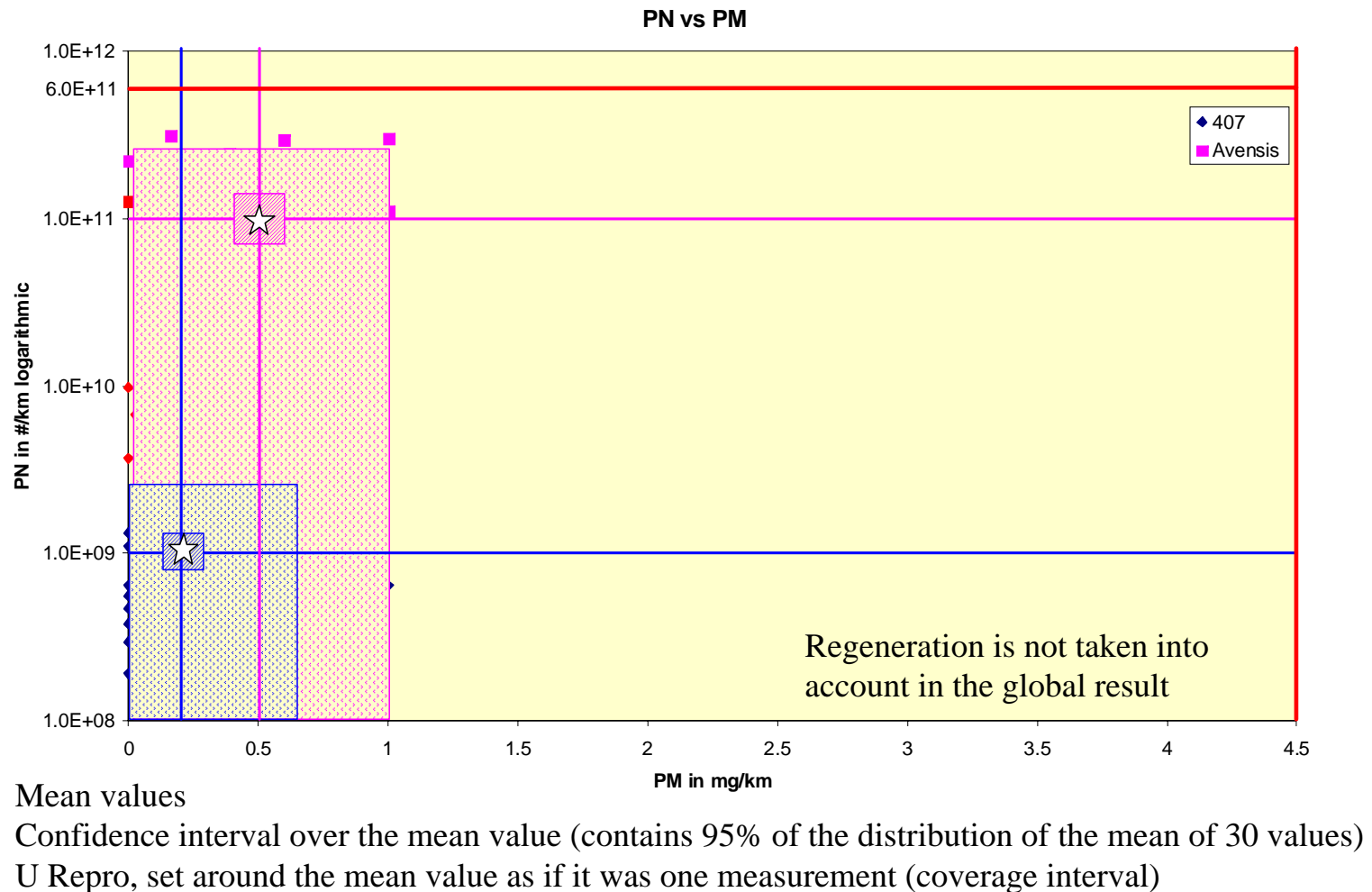| PN #/km | | Standard deviation | | Expanded uncertainty | |
|---|---|---|---|---|---|
| | **Mean** | σRepet | σRepro | URepet | **URepro** |
| 407 | 9.71$^e$8 | 5.5$^e$8 (57%) | 7.1$^e$8 (73%) | 1.1$^e$9 (113%) | 1.4$^e$9 (**144%**) |
| Avensis w/o reg effect | 3.60$^e$10 | 1.4$^e$10 (39%) | 1.4$^e$10 (39%) | 2.9$^e$10 (81%) | 2.9$^e$10 (**81%**) |
| Background | 5.14$^e$8 | 3.1$^e$8 (60%) | 4.9$^e$8 (95%) | 6.2$^e$8 (121%) | 9.9$^e$8 (**193%**) |

=>**The relative uncertainties are comparable to those of the PM.**

=>**The absolute uncertainties are in the order of the level of emissions.**

⇒**Variability remains high ~150% compared to ~5% for CO2 or ~10% for NOx.**

**Lab 7 has done tests with 2 PN equipments in parallel:**
    **=> ~ 20% difference between the two mean values for both vehicles.**

PN vs PM

☆ Mean values

▨ Confidence interval over the mean value (contains 95% of the distribution of the mean of 30 values)

▨ U Repro, set around the mean value as if it was one measurement (coverage interval)

**=>For low PM emission vehicles, the PN measurement method has the potential to differentiate the vehicles, but the PN variability needs to be improved.**

**=>Variability overwhelms PM/PN correlation.**

PN measurement

- The relative uncertainties of PN are comparable to those of PM.

- Variability remains high ~150% compared to ~5% for CO2 or ~10% for NOx.

- None of the procedure variations has shown a significant influence on the results.

- Variability overwhelms PM/PN correlation.

- For background, 17% of the variability comes from the dispersion of the PN counter in one lab

- The measurement variability needs to be improved within and between labs.


Recommendations

- Keep on improving PN measuring equipment and calibration
- Carry out a full error analysis study to further reduce variability

# Thank you for your attention.

- **Standard Deviation**

$\sigma$Repet = standard deviation in <u>repeatability conditions</u> (within labs)

$\sigma$Repro = standard deviation in <u>reproducibility conditions</u> (between labs)

- **Expanded Uncertainty** (contains 95% of the distribution of the values)

URepet = expanded uncertainty in <u>repeatability conditions</u>
$\quad$ = 2*Repet $\sigma$

URepro = expanded uncertainty in <u>reproducibility conditions</u>
$\quad$ = 2*Repro $\sigma$

Note : calculations are done according to ISO 5725 and ISO/TS 21748