CCQM IAWG APRIL 2019

CCQM-P194: Number concentration of colloidal particles in solution

ES-DMA measurements

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8 April 2019

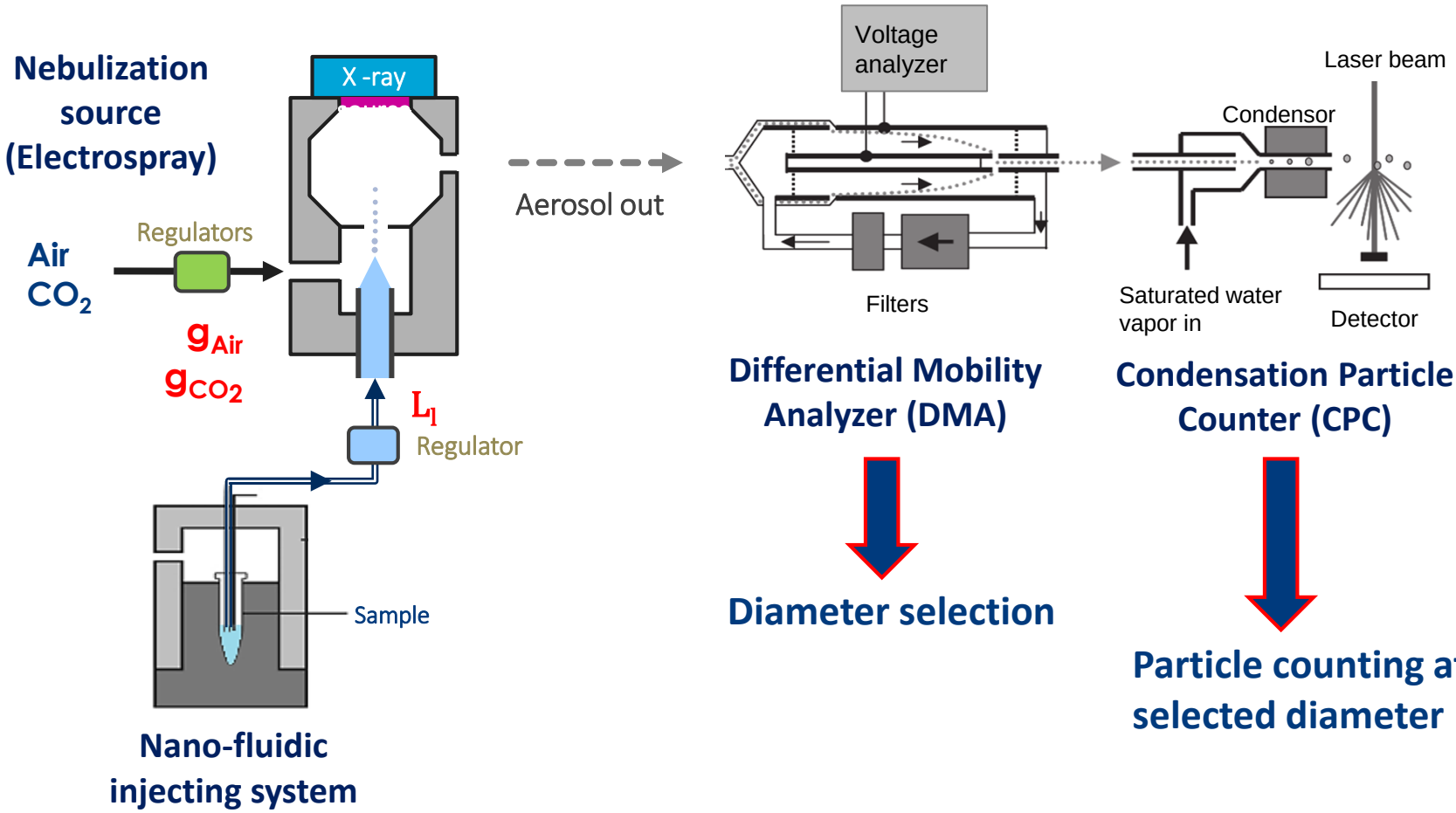
LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS

ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Principle

Liquid phase

Aerosol phase



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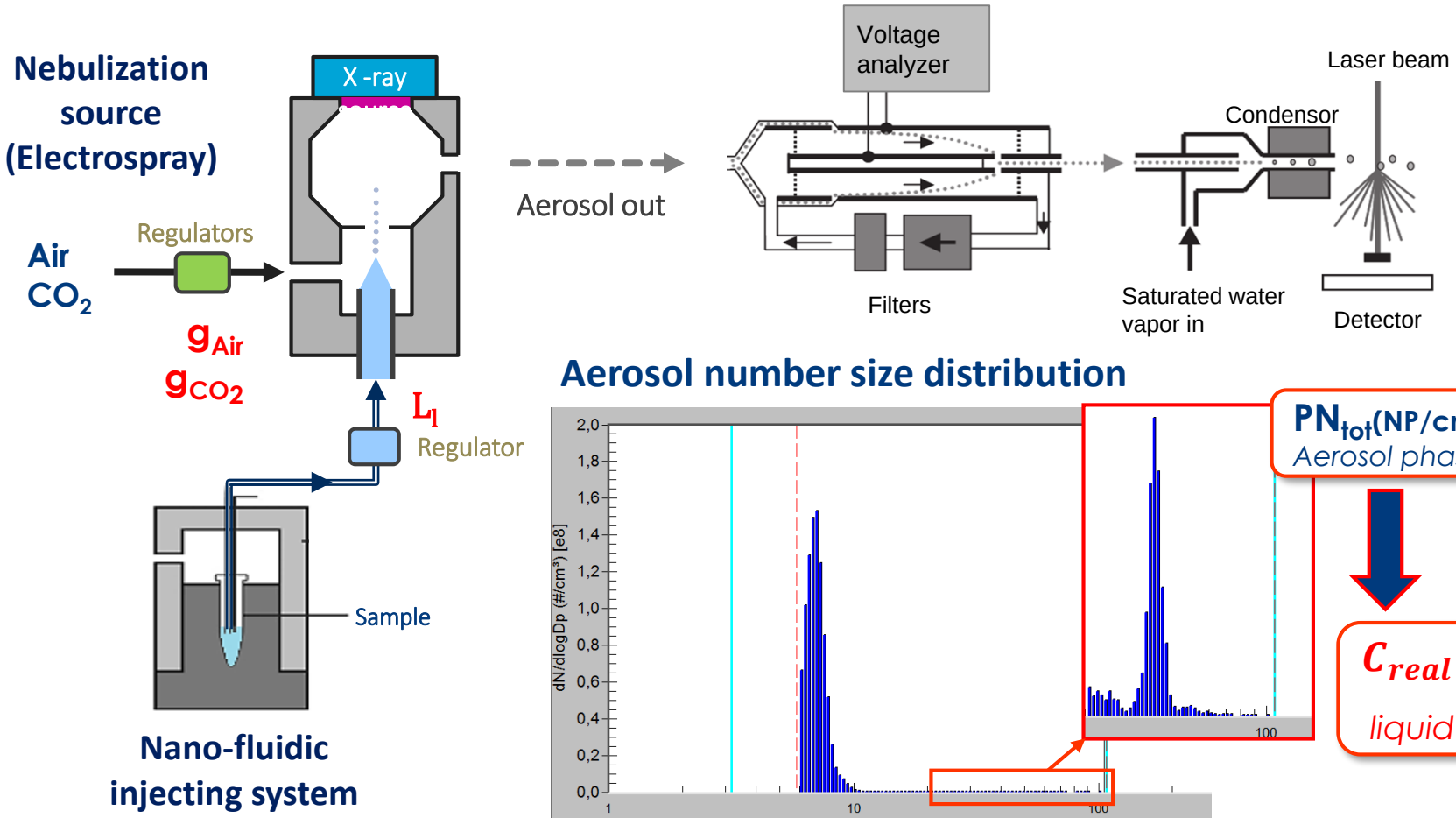

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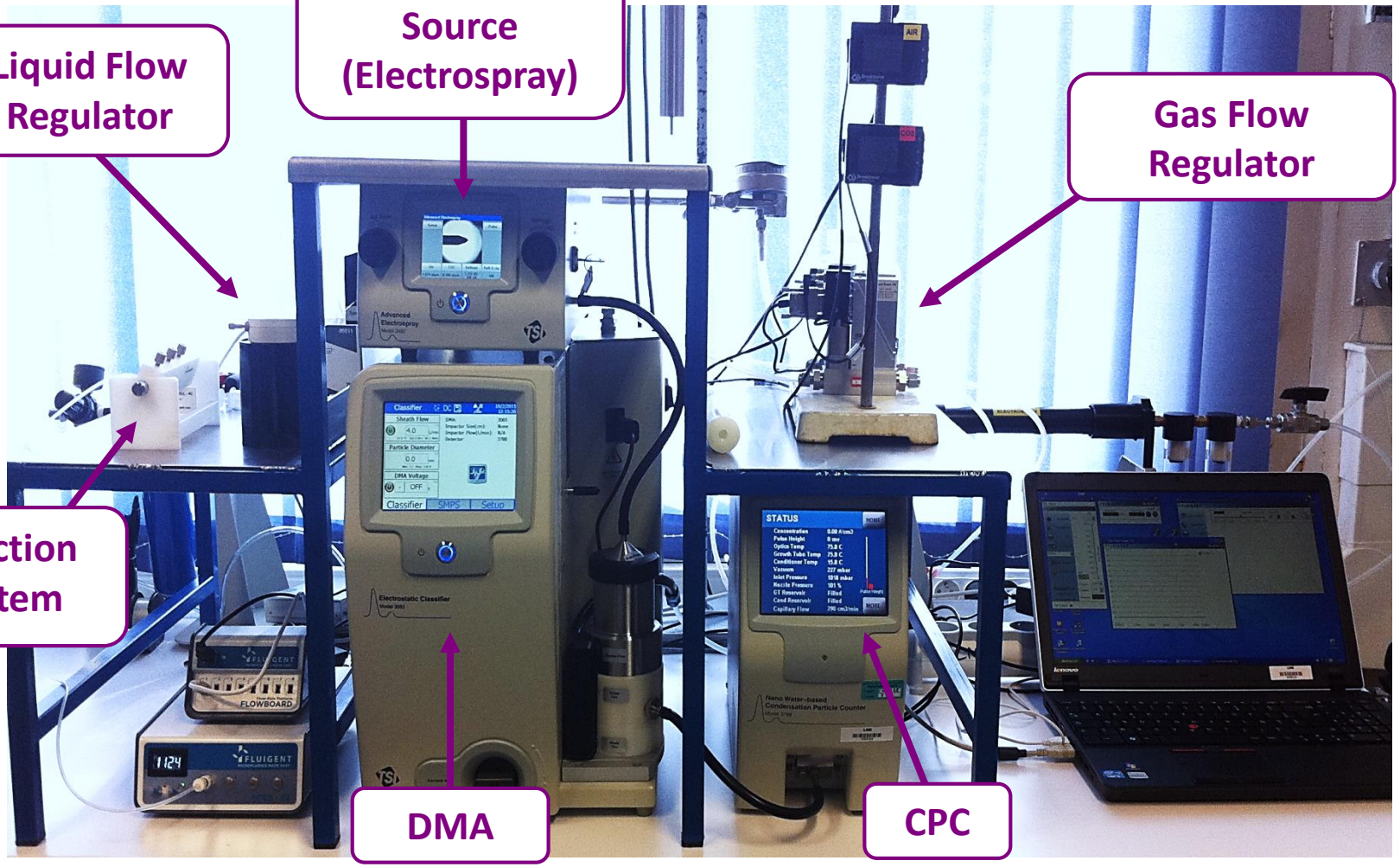


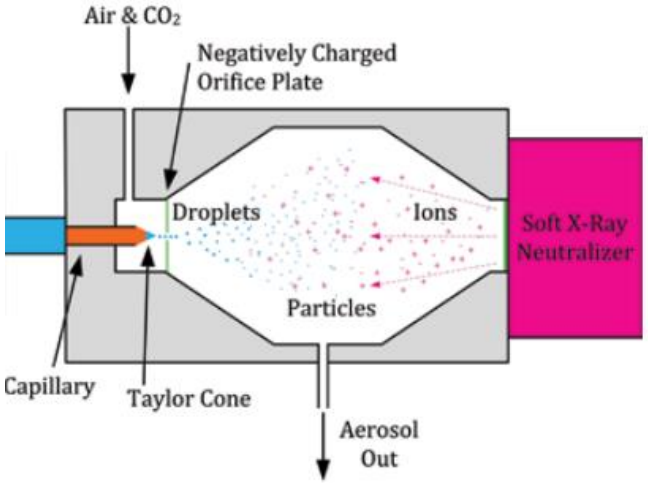
ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Sample and QC preparation

- Samples and QC (NIST RM 8012) stored in the fridge from reception until analysis (2 months)
- Return to room temperature before opening and used within one day after opening
- Aerosolization by electrospraying

  ➡ Formation of a Taylor cone due to the application of a high voltage to a conductive liquid exiting a capillary

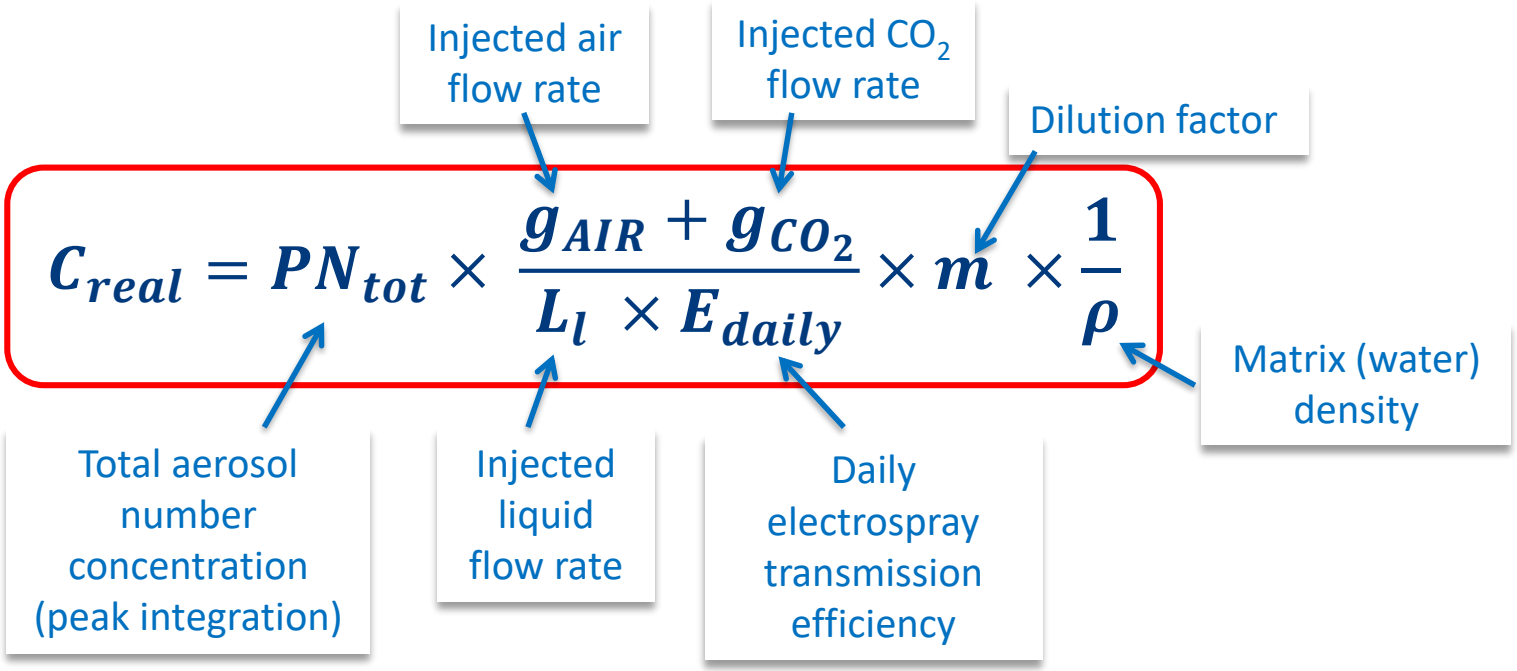
  ➡ Gravimetric dilution of samples and QC in a high conductivity buffer (20mM Ammonium Acetate)



ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Post-analytical data processing

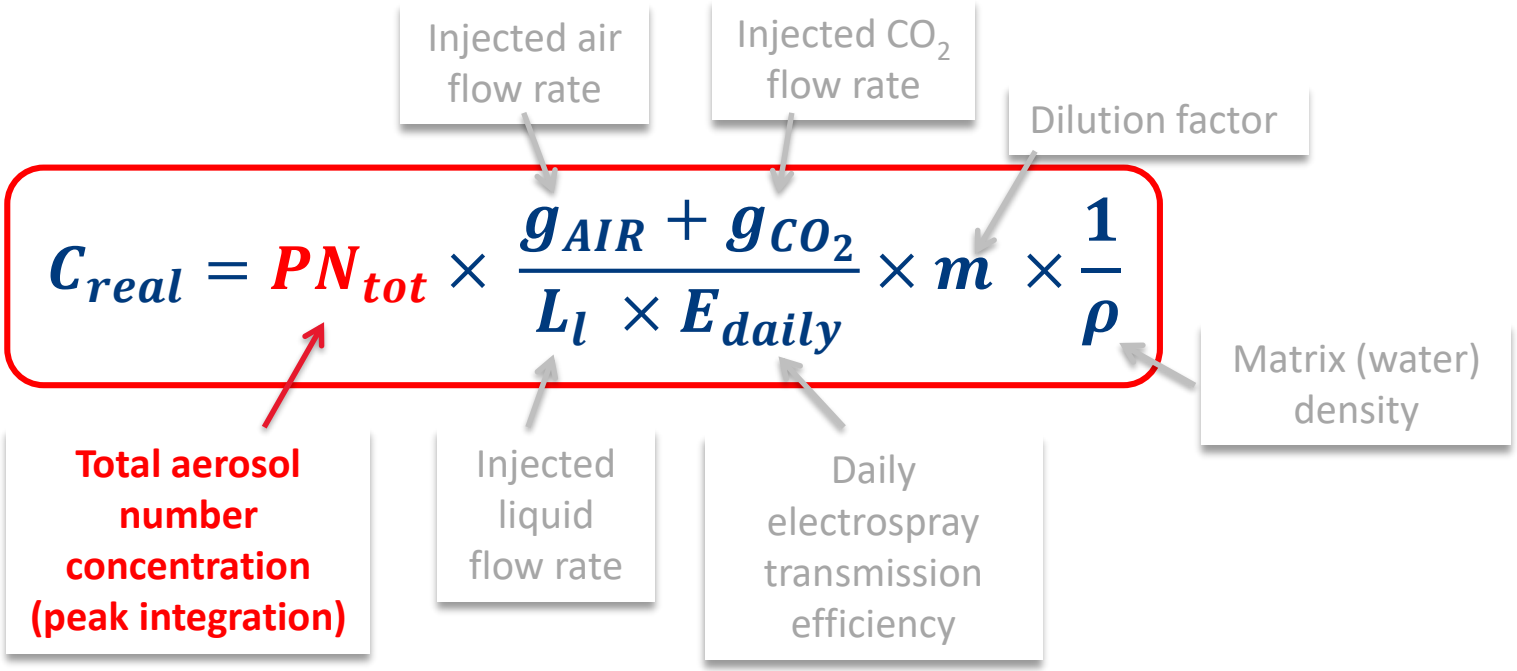
Particle concentration in the liquid sample, C_{real} :



ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Post-analytical data processing – aerosol phase PN_{tot}

Particle concentration in the liquid sample, C_{real} :

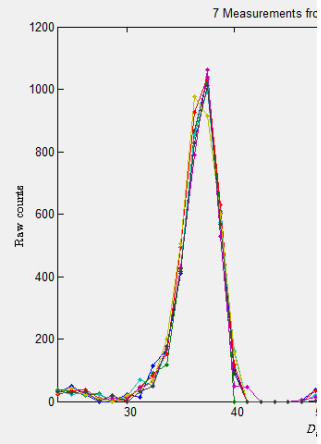


Step 1 : processing of the number size distribution to obtain the aerosol phase particle concentration

ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

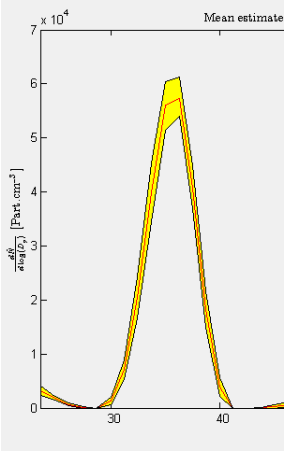
Post-analytical data processing – aerosol phase PN_{tot}

Raw aerosol number size distributions



In-house software

Mean number size distribution and associated standard deviation calculated on the basis of Monte-Carlo simulations



Determination of PN_{tot} by peak integration

Coquelin *et al.*, 2015

ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Post-analytical data processing – daily electrospray transmission efficiency E_{daily}

$$C_{real} = PN_{tot} \times \frac{g_{AIR} + g_{CO_2}}{L_l \times E_{daily}} \times m \times \frac{1}{\rho}$$

Daily electrospray transmission efficiency

Step 2 : Determination of E_{daily}

$$E_{daily} = \frac{C_{ES-DMA}^{QC}}{C_{Certificate}^{QC}}$$

- Yield of aerosolized particles later measured by the SMPS system
- Made daily before sample analysis
- Calculated as the ratio between QC measured concentration and QC concentration from the certificate

ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Post-analytical data processing – daily electrospray transmission efficiency E_{daily}

$$E_{daily} = \frac{C^{QC}_{ES-DMA}}{C^{QC}_{Certificate}}$$

- $C^{QC}_{Certificate}$ **RM 8012**

Measurement	Value
Au mass fraction (µg g^{-1}) [b]	48.17 ± 0.33

$$C^{QC}_{Certificate} = 2.47\text{x}10^{+11} \pm 1.25\text{x}10^{+10}\ \text{NP/g}$$

- $C^{QC}_{ES-DMA} = PN_{tot} \times \frac{g_{AIR}+g_{CO_2}}{L_l \times 1} \times m \times \frac{1}{\rho}$

- **Limited quantity of QC** (300µL), sufficient for only 3 days of measurements
- **QC not stable in ammonium acetate**, had to be used in less than an hour after preparation
- Time between QC/sample reception and analysis : 2 months
  → **Impact on QC ?**

ELECTROSPRAY DIFFERENTIAL MOBILITY ANALYSIS (ES-DMA)

Post-analytical data processing – daily electrospray transmission efficiency E_{daily}

$$C_{real} = PN_{tot} \times \frac{g_{AIR} + g_{CO_2}}{L_l \times E_{daily}} \times m \times \frac{1}{\rho}$$

$0{,}75 < E_{daily} < 0{,}96$

Key parameter in C_{real} determination

Step 3 : Determination of C_{real}

$C_{real} = 1.18 \times 10^{11} \pm 1.71 \times 10^{10}$ NP/g (k=2)

Uncertainty budget :