"Capacity Building and Strengthening Institutional Arrangement"

Analysis and sampling of air and air pollution

Quality control for air monitoring equipment

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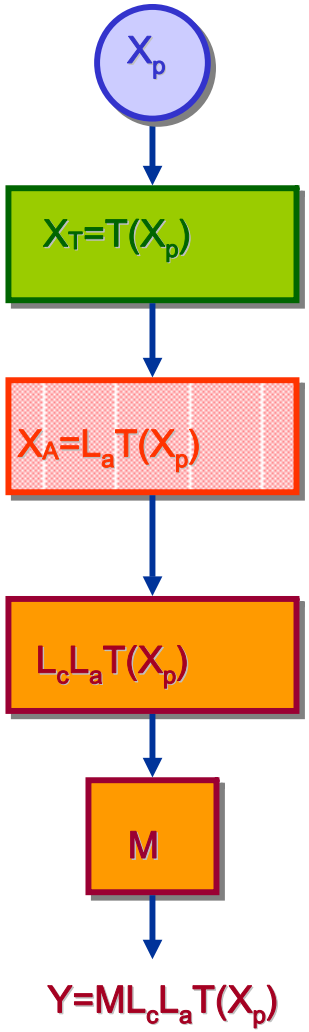
APAT

Agency for Environmental Protection and Technical Service

MEASUREMENT TECHNIQUES FOR PARTICULATE MATTER EVALUATION CRITERIA

- Intercomparison of instrument and methods
- Data interpretation principles
- Explaining the experimental deviations (in terms of particles composition and sources, pollution events, meteorological situation and instrumental technical characteristics)
- Determining criteria for planning field experiments in sites characterized by very different environments
- Providing to harmonise monitoring activity



T operator: Penetration efficiency of fractionator device

L_a operator: Enrichment mode mass losses

L_c operator: Filter conditioning mode

M operator: Mass measurement

X_P - Atmospheric particulate matter sample (TSP)

X_T - Particulate matter sample PM_X

X_A - Collected PM_X particulate matter sample

Conditioned PM_X particulate matter sample for mass measurement

Mass measurement

Datum of PM_X mass concentration

Methods and systems evaluation

- *Accuracy determination*
- *Explaining and quantify the experimental deviations*

$$Y = X_{PMx} + \delta T + \delta L + \delta M + \varepsilon$$

PM_x expected value

Penetration efficiency deviation

Artefact in the enrichment mode

Mass measurement accuracy

Theoretical Reference: $\delta T \rightarrow 0$, $\delta L \rightarrow 0$, $\delta M \rightarrow 0$

In real conditions
δT , δL, δM and ε must be quantitatively and qualitatively evaluated

Intercomparisons of methods

- *Equivalence determination*
- *Explaining and quantify the experimental deviations*

$$Y_A - Y_B = \delta(T_A,T_B) + \delta(L_A,L_B) + \delta(M_A,M_B) + \varepsilon$$

Penetration efficiency differences

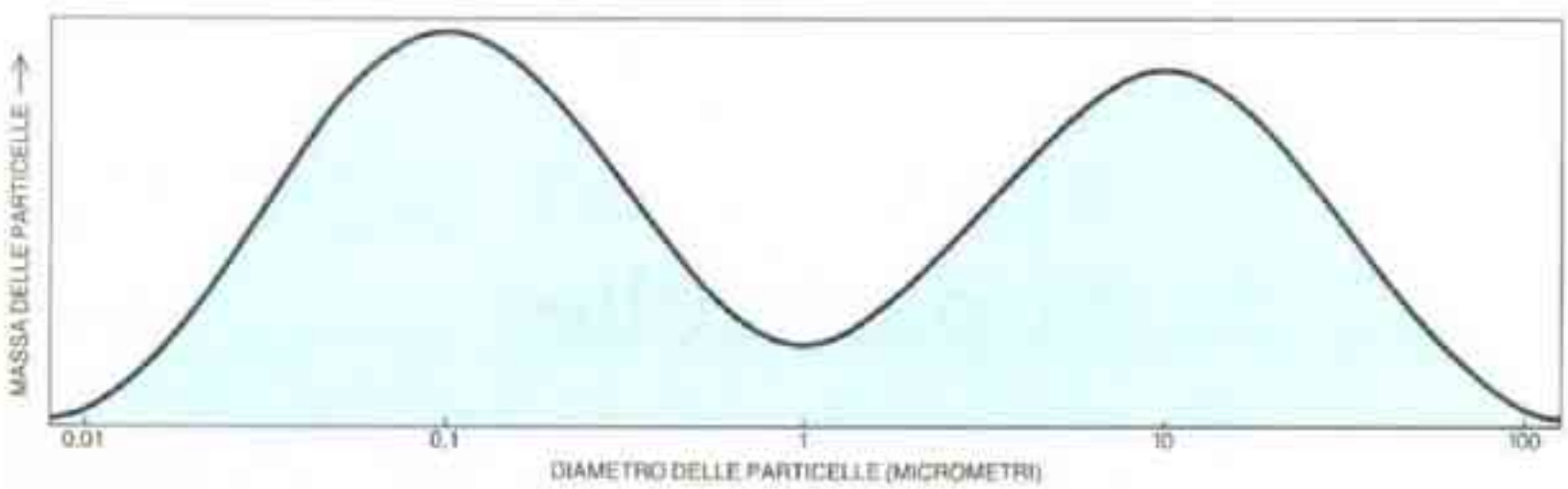
Enrichment mode differences

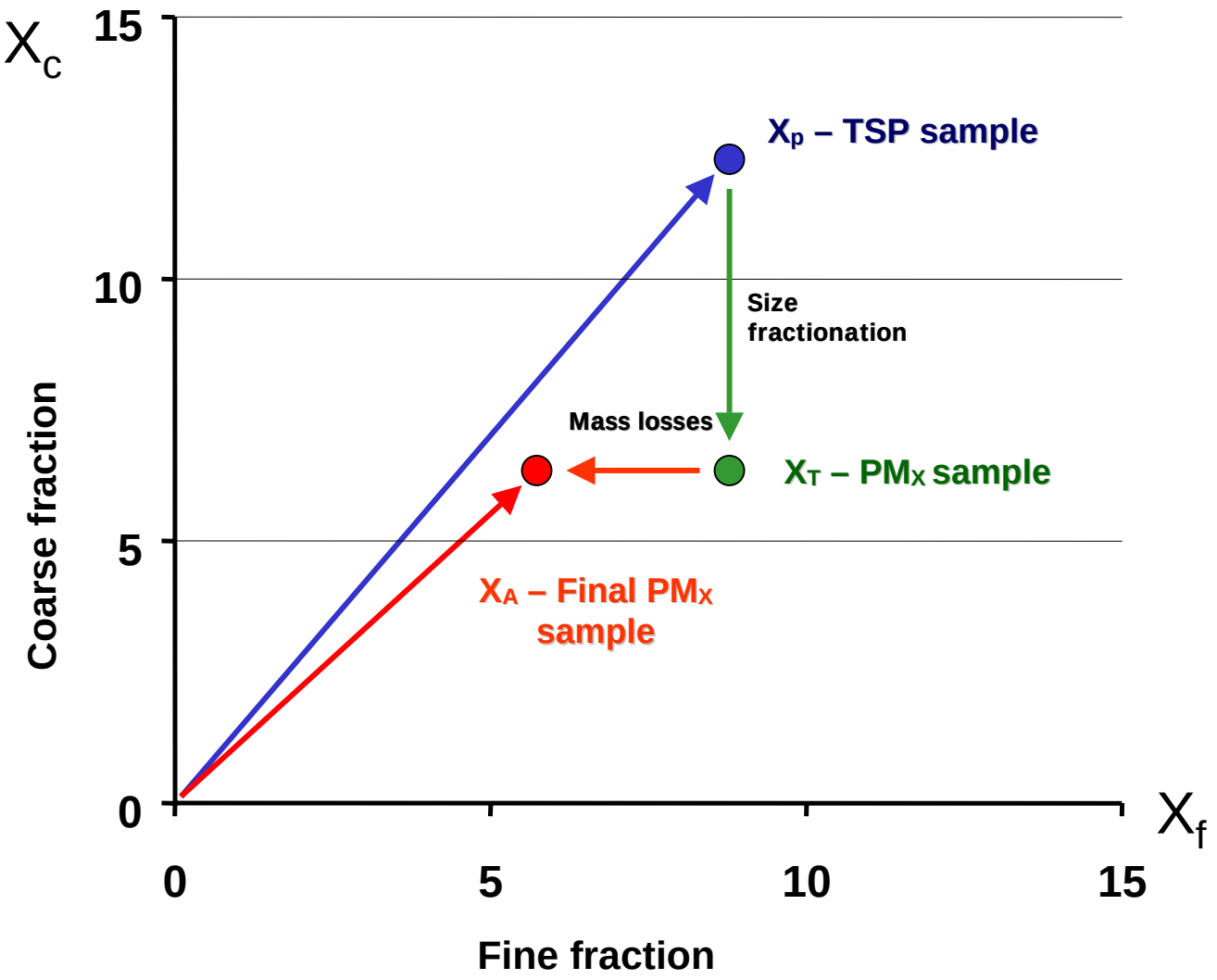
Mass measurement accuracy differences

Equivalence : $\delta(T_A,T_B) \rightarrow 0$, $\delta(L_A,L_B) \rightarrow 0$, $\delta(M_A,M_B) \rightarrow 0$

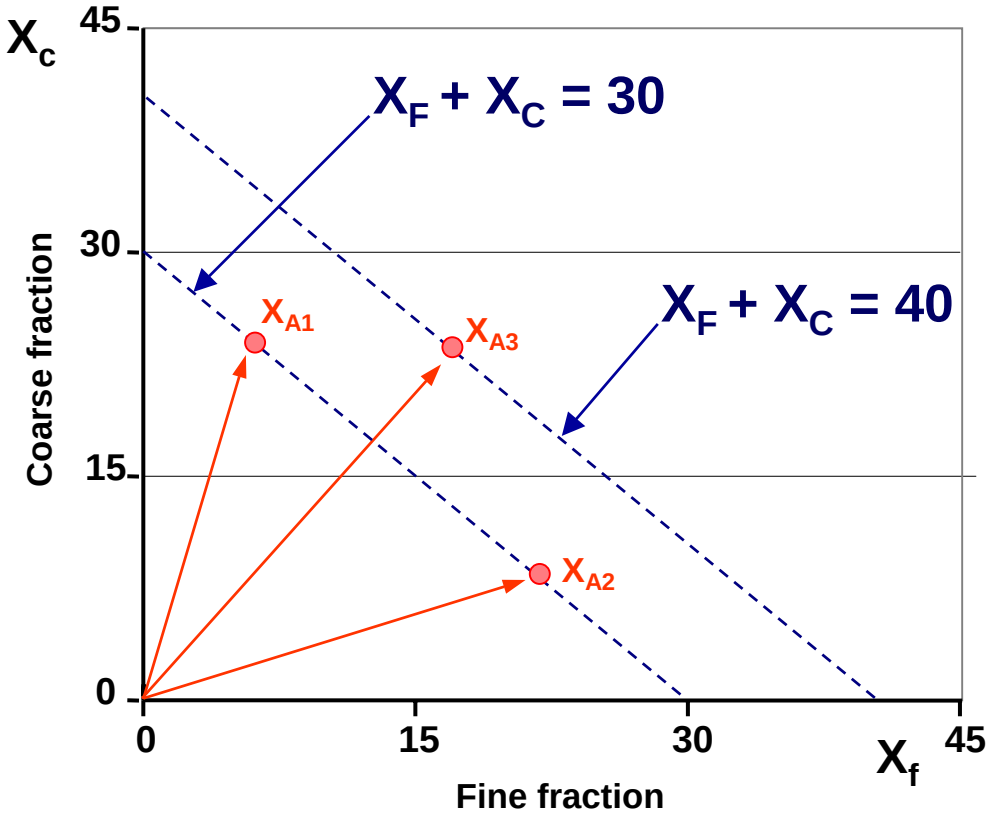
Two methods are equivalents if and only if they are equivalent in any process step

Idealized distribution of ambient particulate matter




X_c
15
10
5
0
Coarse fraction
X_p – TSP sample
Size fractionation
Mass losses
X_T – PM_X sample
X_A – Final PM_X sample
0
5
10
15
X_f
Fine fraction

MASS EQUIVALENCE



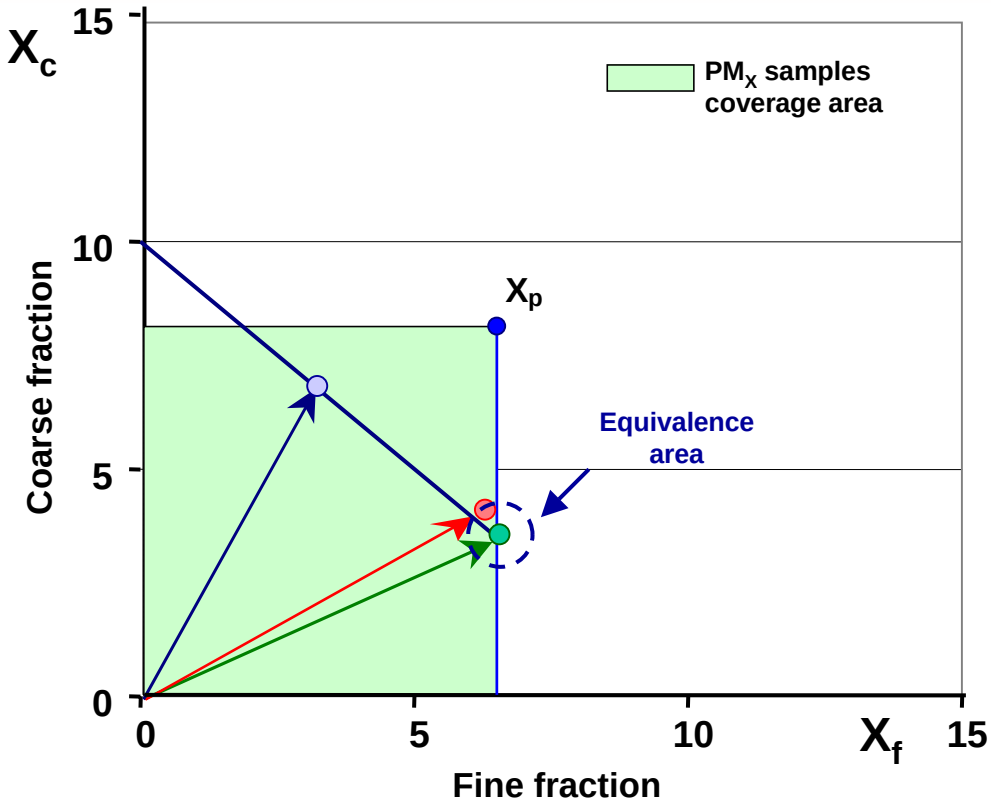
Final sample mass, X_A, is:

$$M(X_A) = X_{FineA} + X_{CoarseA}$$

for instance

$$M(X_{A1}) = M(X_{A2}) < M(X_{A3})$$

- **X_{A1} e X_{A2} samples have equivalent masses but they are not equivalent**



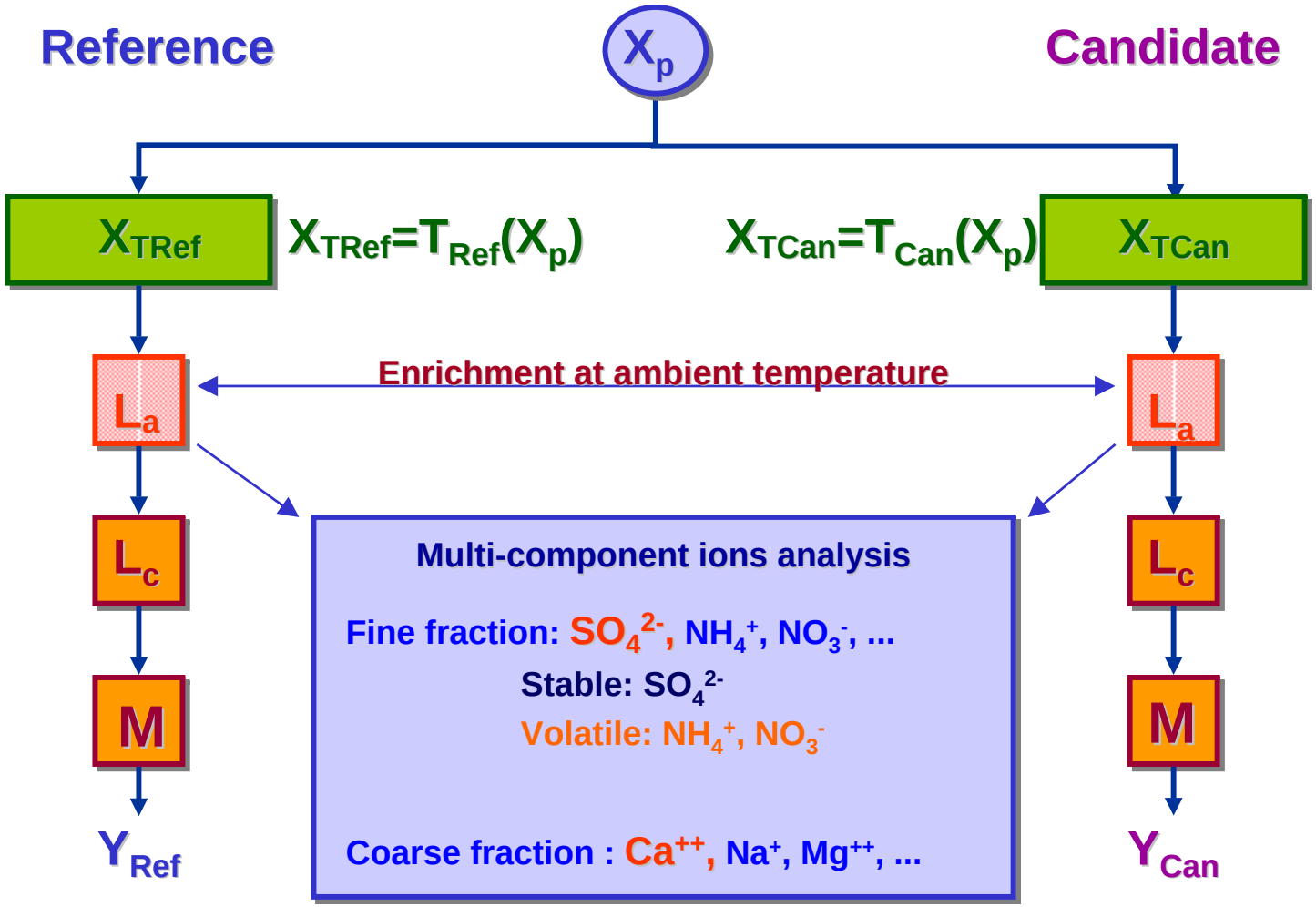
$$M(X_{A1}) = M(X_{ARef}) \approx M(X_{A2})$$

$$X_{A2} \text{ EQUIV } X_{ARef}$$

Equivalence of sampling heads and fractionator devices

(LV)

Multi-Component Ions Analysis



Equivalence of sampling heads and fractionator devices

(LV)

EN 1234.1 norm

Reference

$Y_{Ref}=ML_cL_aT_{Ref}(X_p)$

Candidate

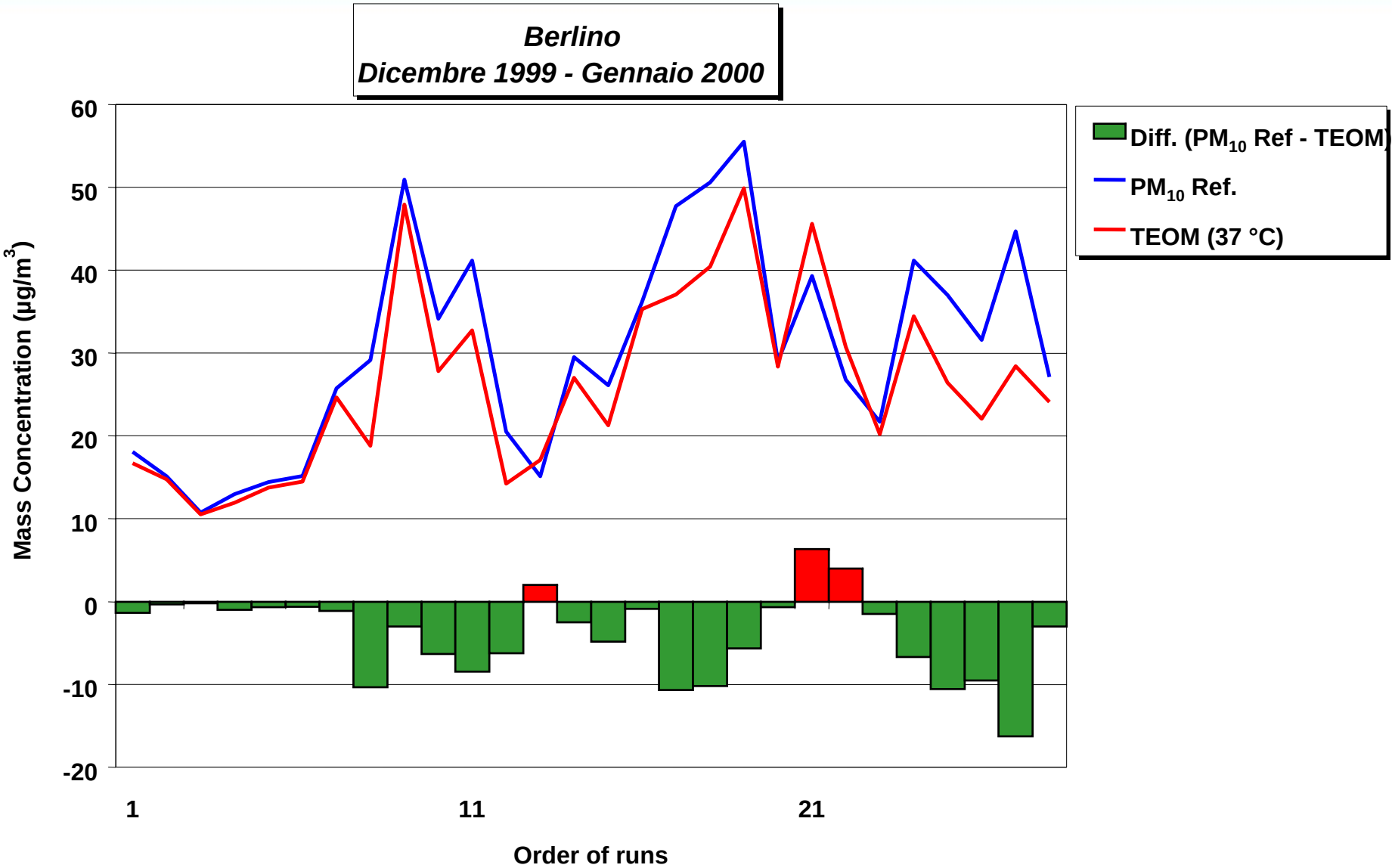
$Y_{Can}=ML_cL_aT_{Can}(X_p)$

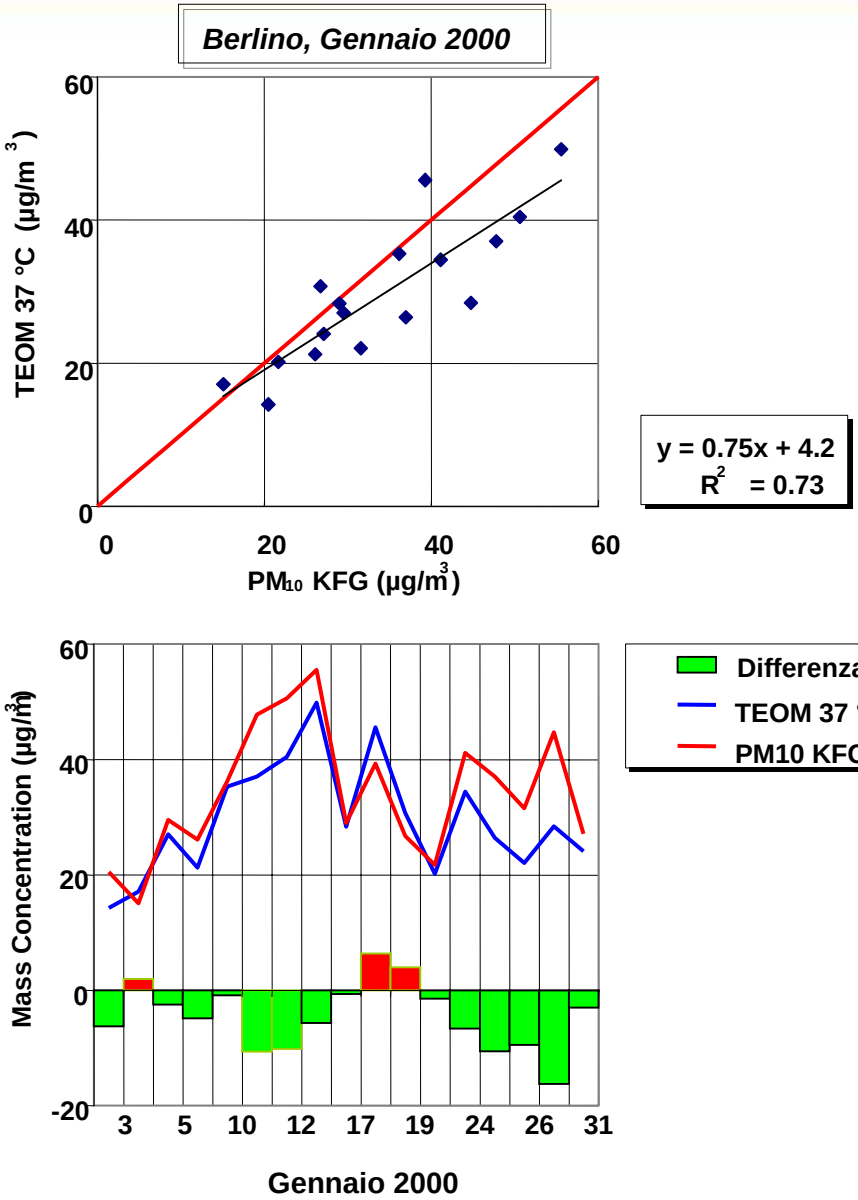
if $|Y_{Ref} - Y_{can}|$ fulfils EN1234.1

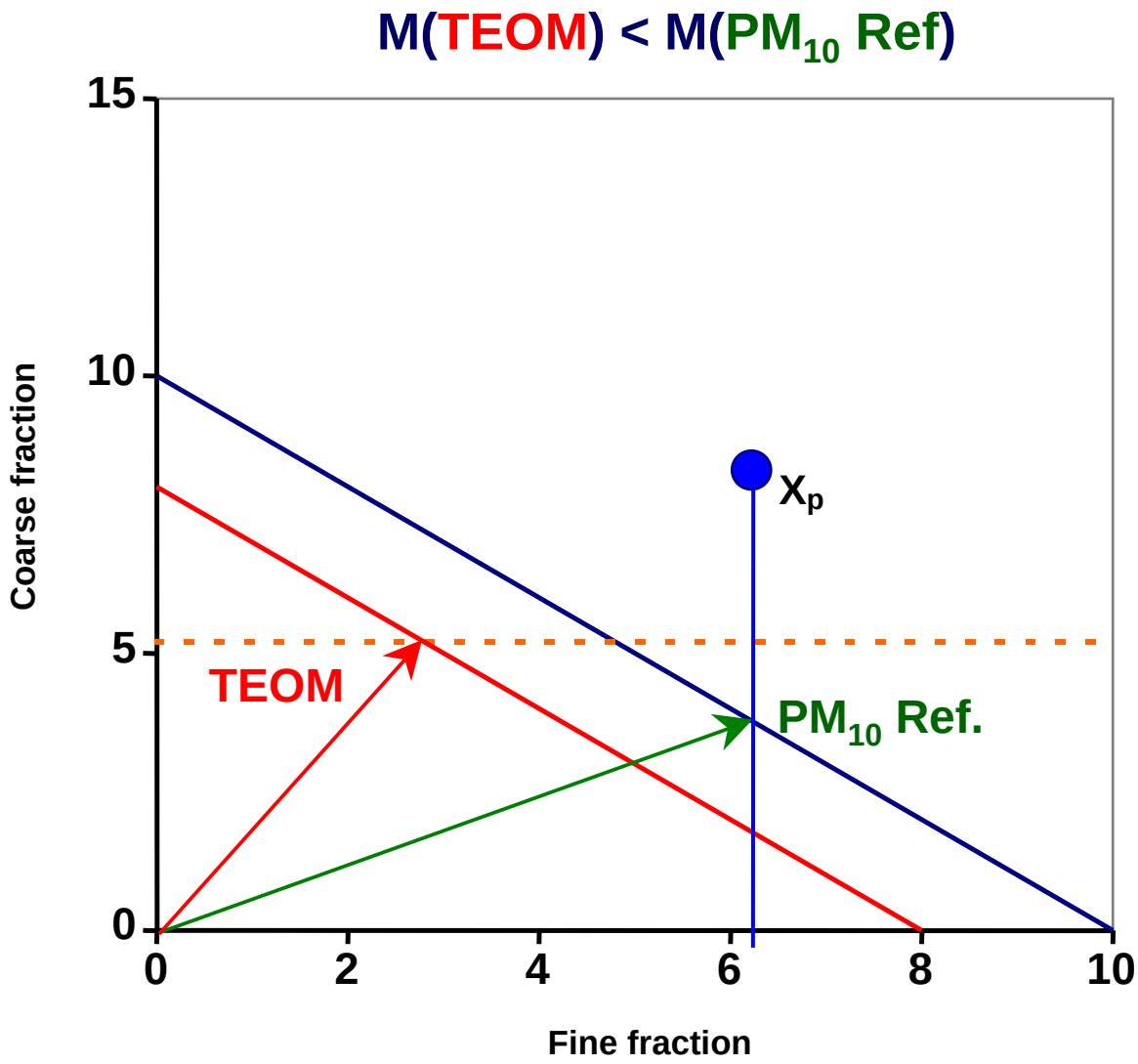
↓

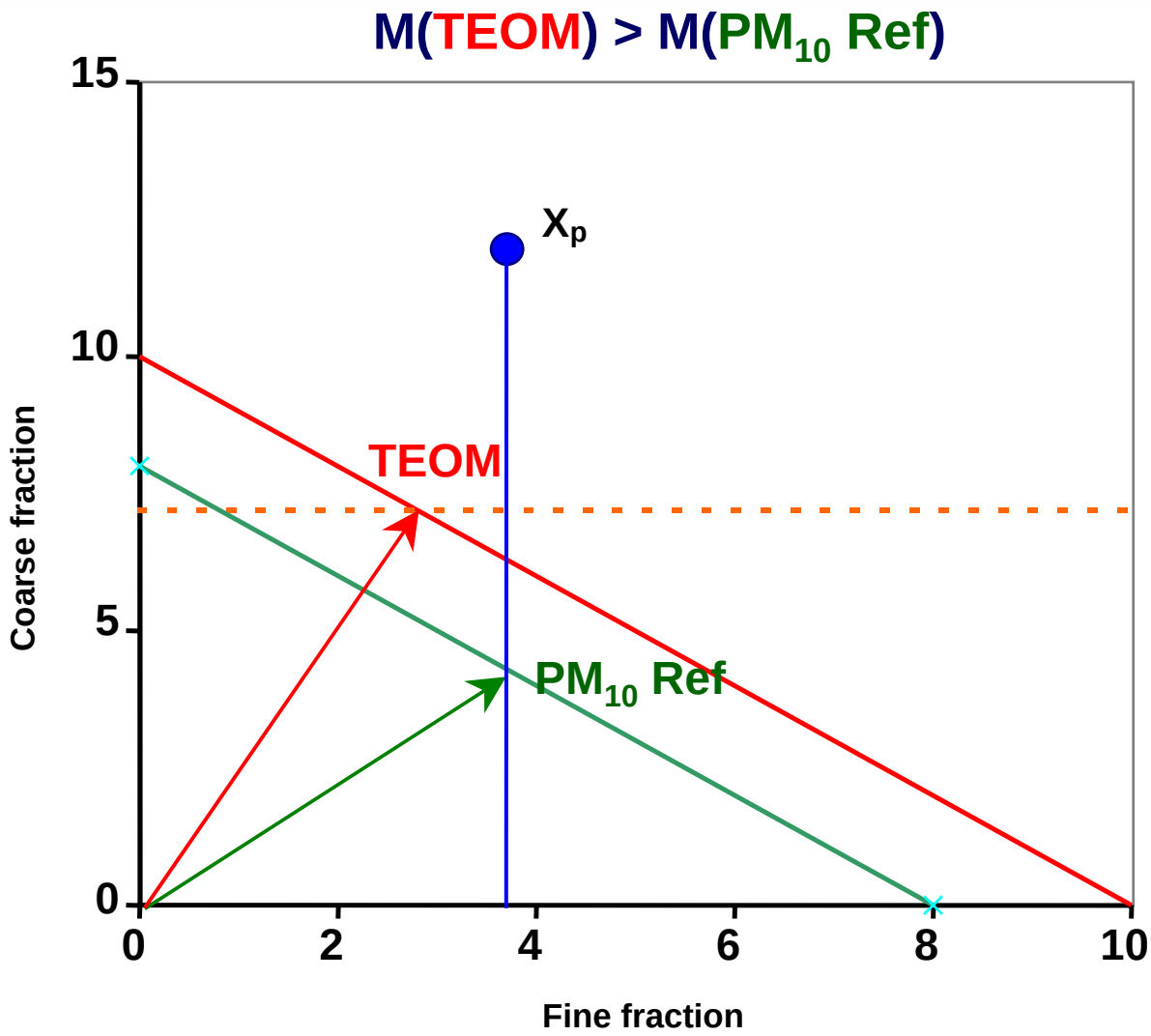
T_{Can} EQUIV T_{Ref}

M, L_c e L_a: invariant operators


Berlino
Dicembre 1999 - Gennaio 2000
Mass Concentration (µg/m3)
60
50
40
30
20
10
0
-10
-20
1
11
21
Order of runs
Diff. (PM10 Ref - TEOM)
PM10 Ref.
TEOM (37 °C)


Berlino, Gennaio 2000
TEOM 37 °C (µg/m3)
PM10 KFG (µg/m3)
y = 0.75x + 4.2
R2 = 0.73
Mass Concentration (µg/m3)
Differenza
TEOM 37 °C
PM10 KFG
Gennaio 2000


M(TEOM) < M(PM10 Ref)
15
10
5
0
Coarse fraction
Xp
TEOM
PM10 Ref.
0
2
4
6
8
10
Fine fraction


M(TEOM) > M(PM10 Ref)
15
10
5
0
Xp
TEOM
PM10 Ref
Coarse fraction
0
2
4
6
8
10
Fine fraction

EQUIVALENCE OF SAMPLING DEVICES

- *software routines:*

leak test

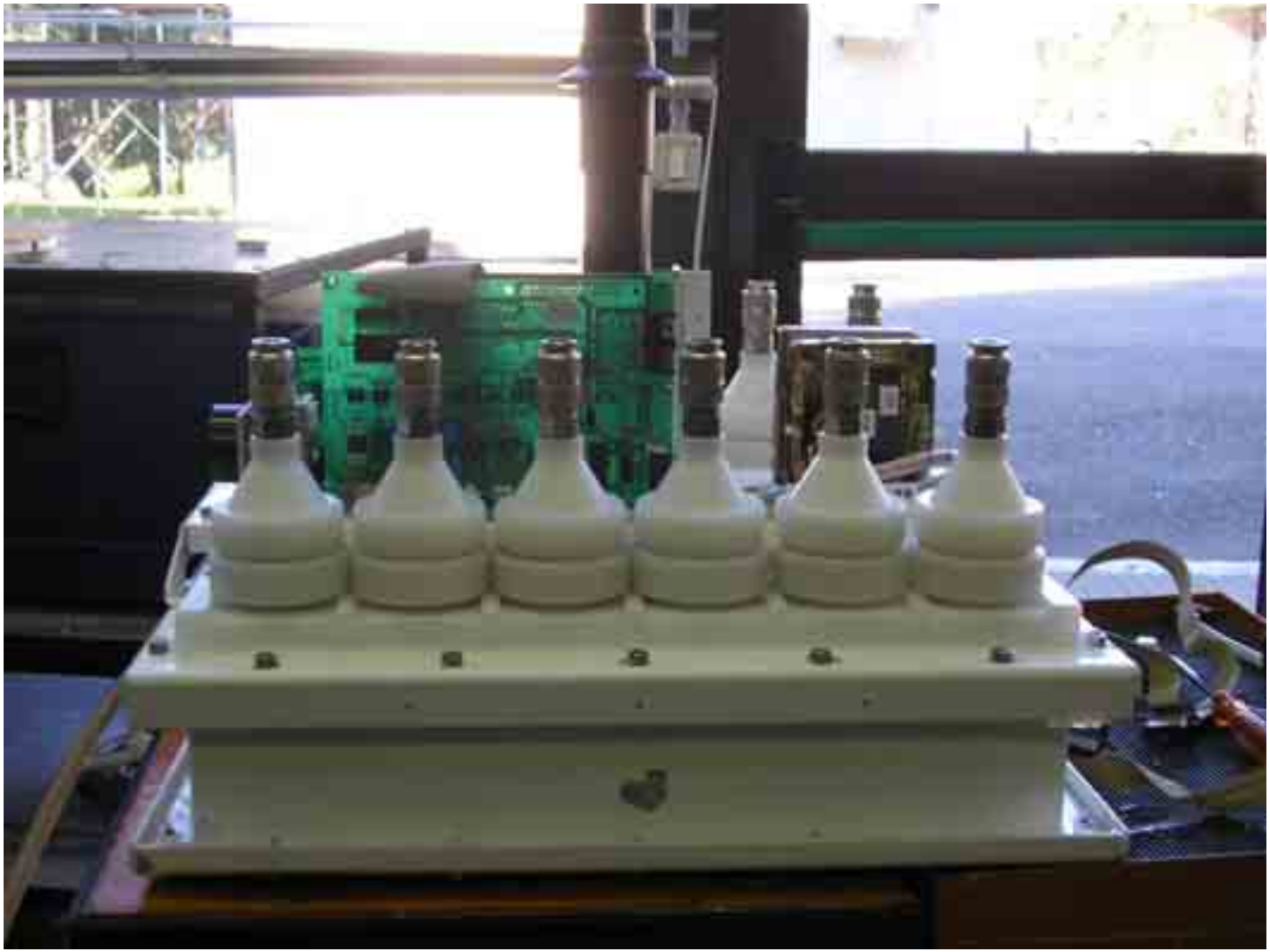
span test

- *laboratory test*

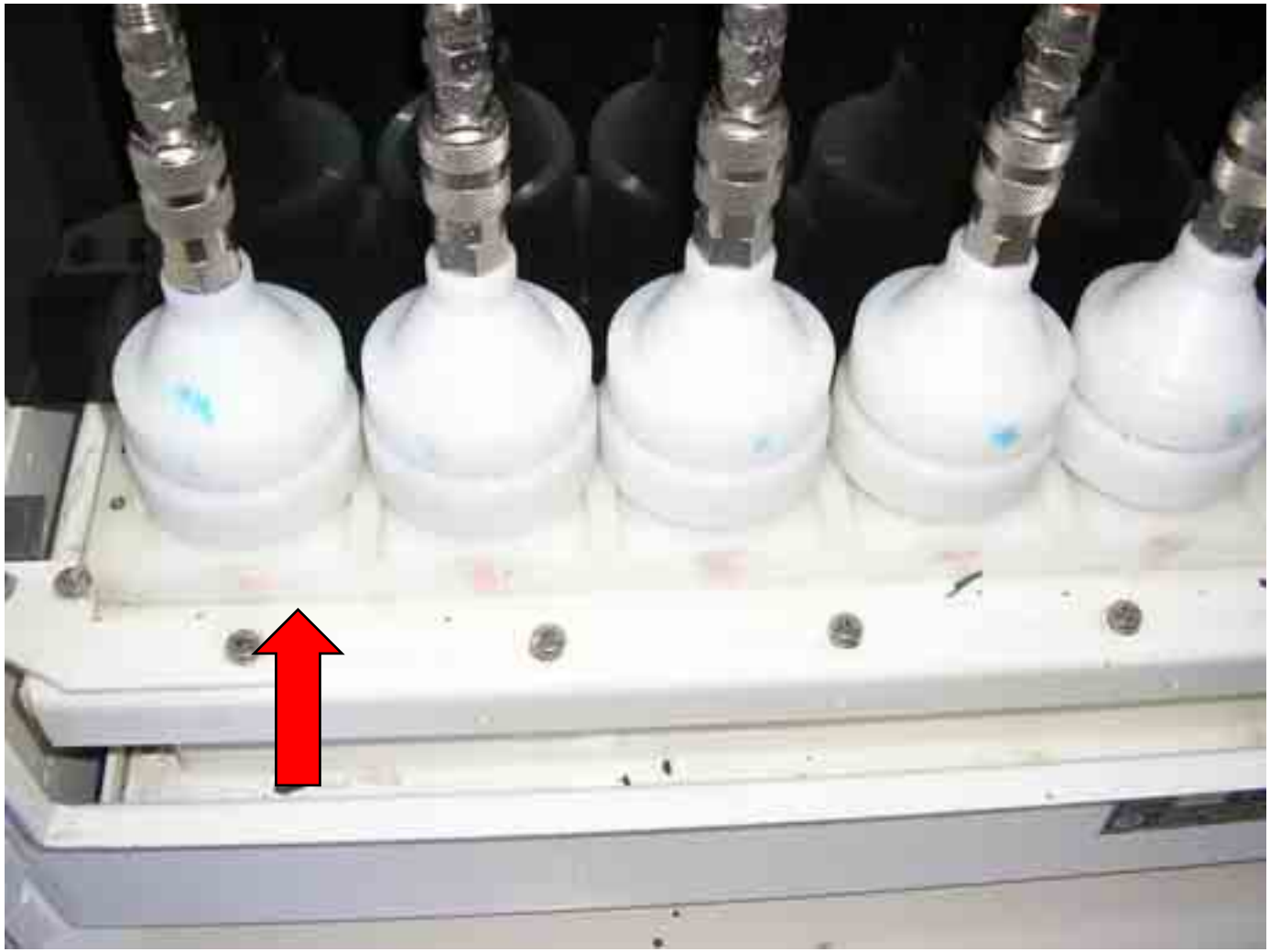
Equivalence of sampling devices: laboratory test

Equivalence of sampling devices: laboratory test

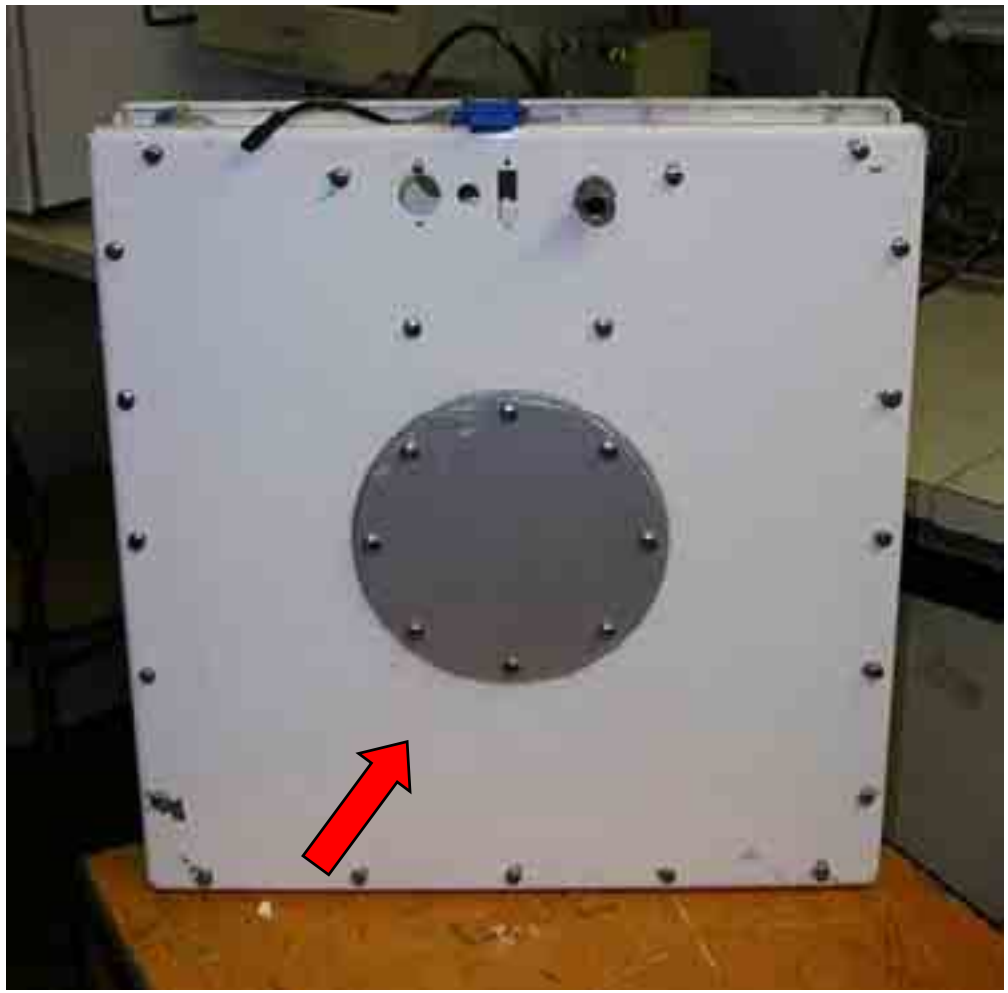
Equivalence of sampling devices



Equivalence of sampling devices



Equivalence of sampling devices



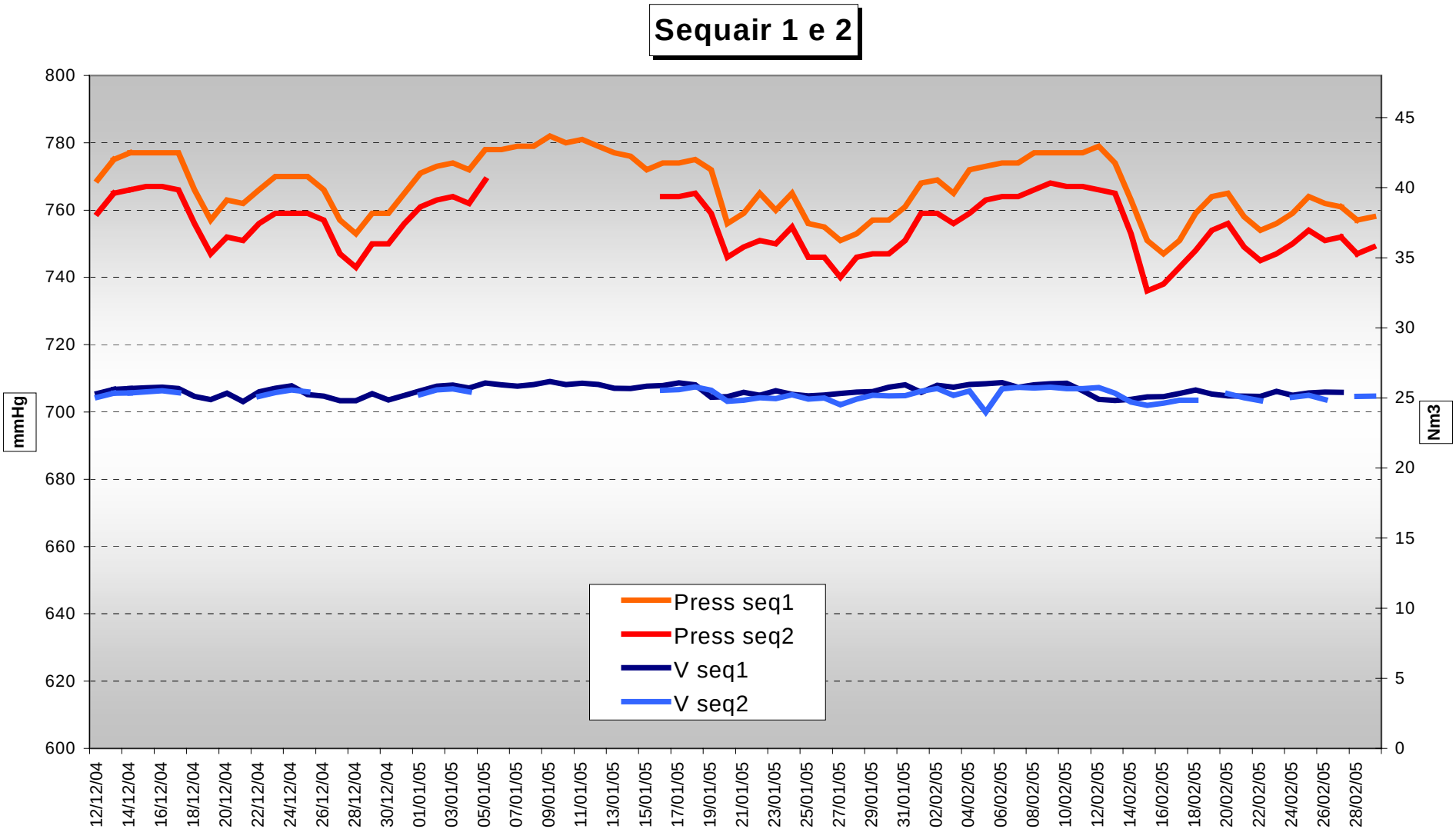
Gas Leak Detector, LD-228

Specifications:

- **Detection method:** Relative measurement of heat conductivity with atmospheric air
- **Suction pump:** Diaphragm pump
- **Type of gas measured:** **He** and **H_2**
- **Sensitivity:** Minimum leakage volume detected 0.01 ml/min (helium gas)
- **Ambient temperature:** 10-35 °C (no dewing)
- **Power Source:** Built in battery, adaptor enclosed, charging time 4 hours. Maximum continuous operating time: 9 hours
- **Probe:** Ca. 80 cm from the main unit
- **Dimensions:** 7.5 x 4.0 x 16.2 cm (WxDxH)

Equivalence of sampling devices

Equivalence of sampling devices



QC for gravimetric method

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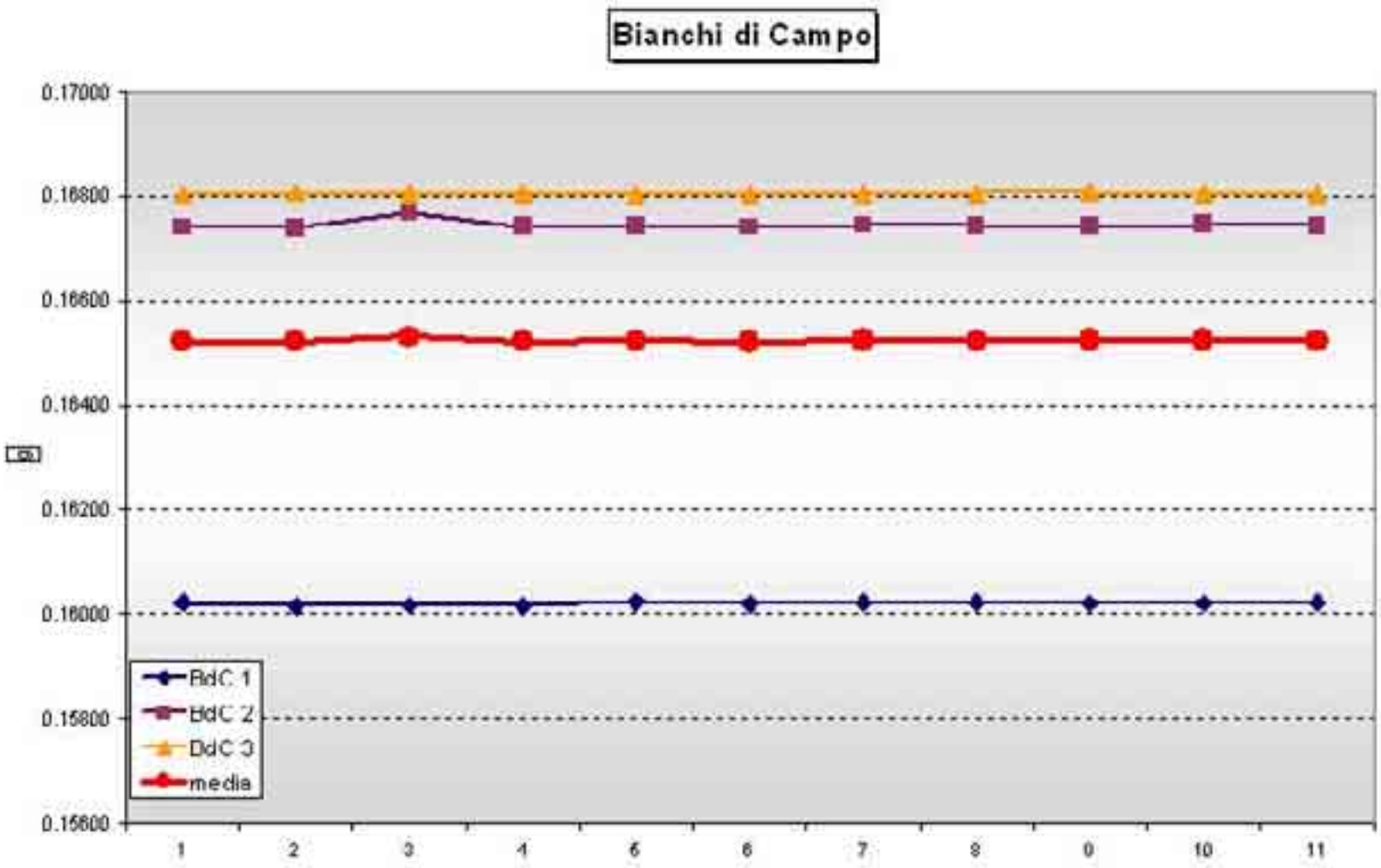
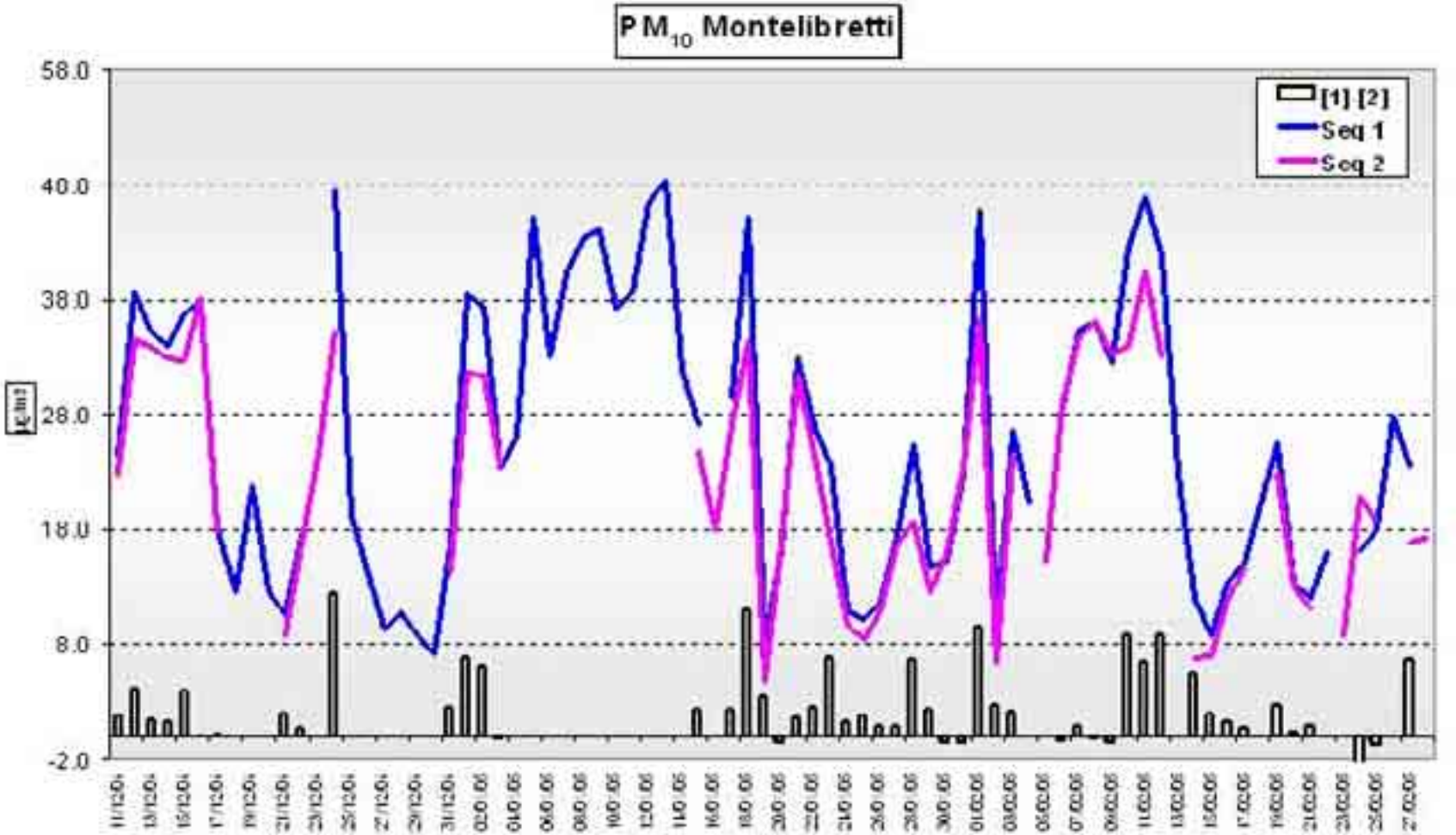
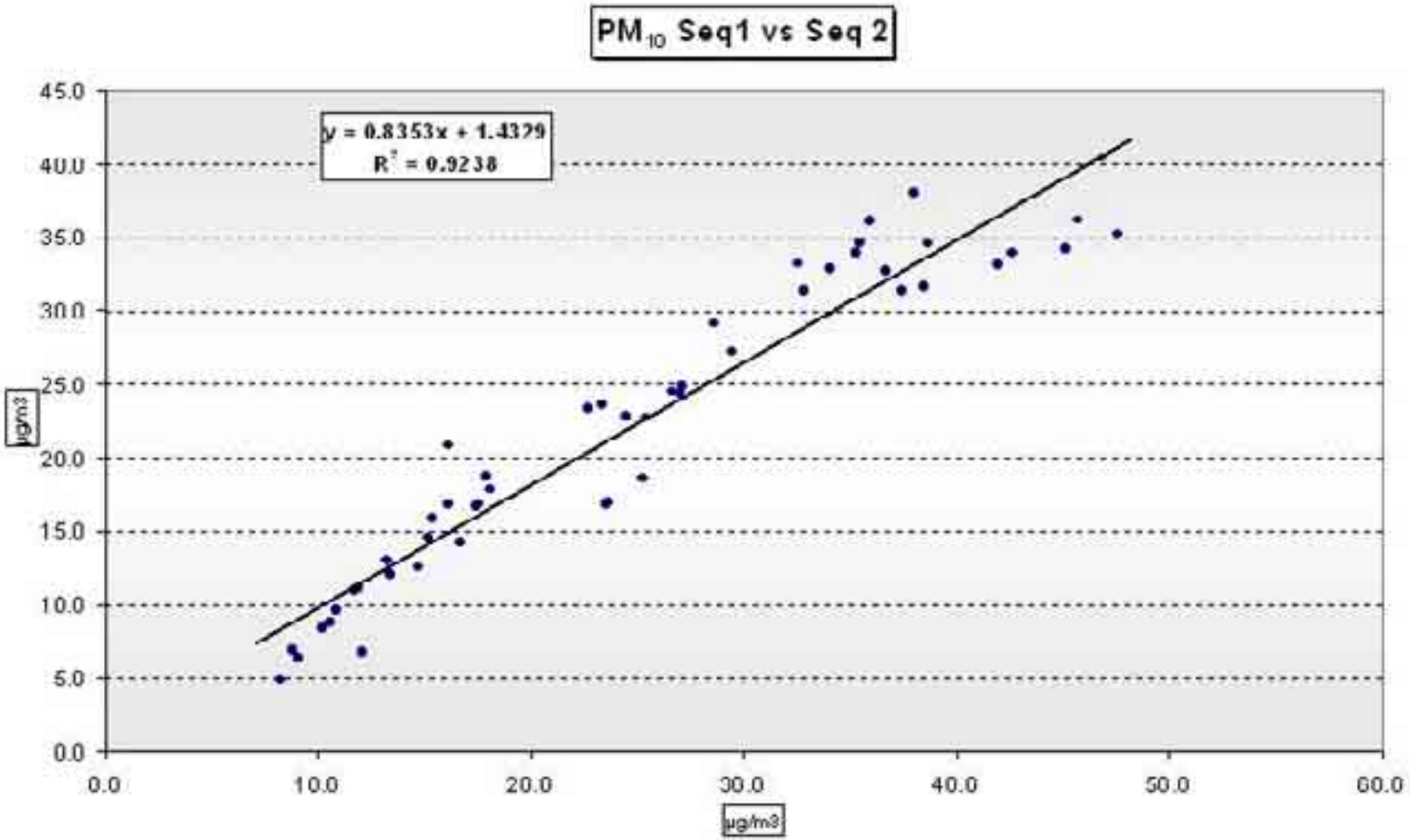


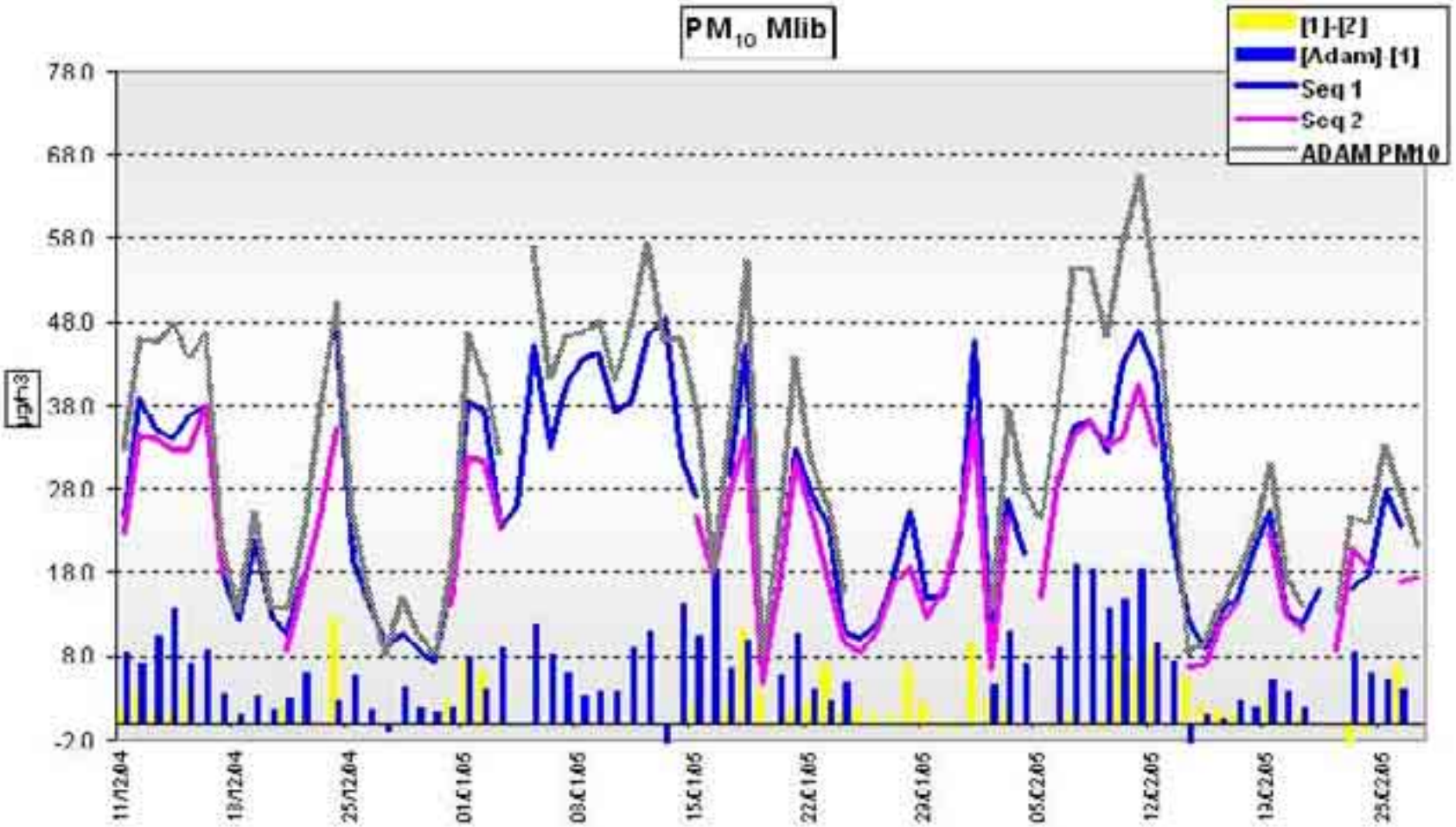
QC for gravimetric method



QC for gravimetric method

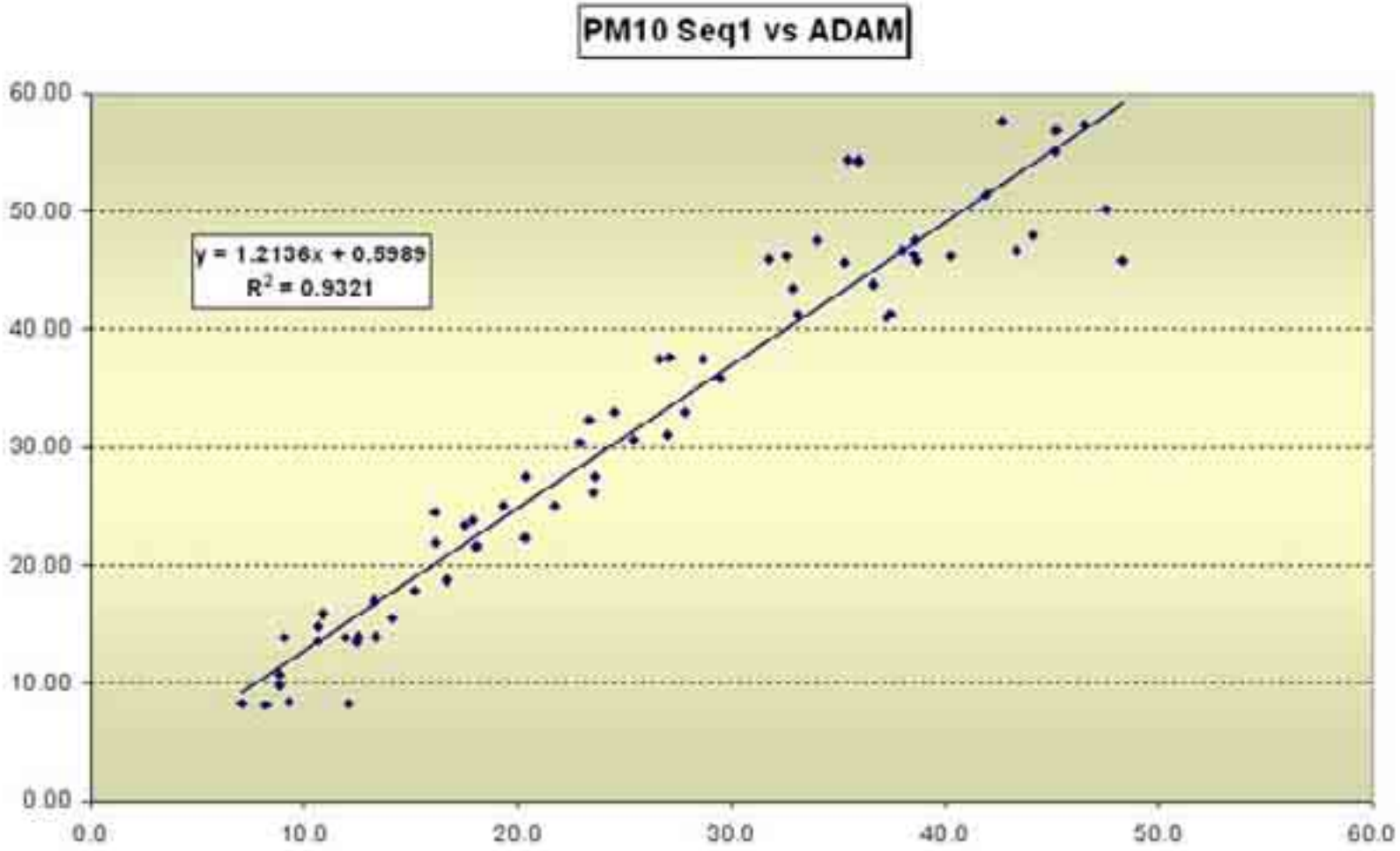


QC for gravimetric method



intercomparison with β system

QC for gravimetric method



intercomparison with β system