

Linea 3.4

Contaminazione Chimica

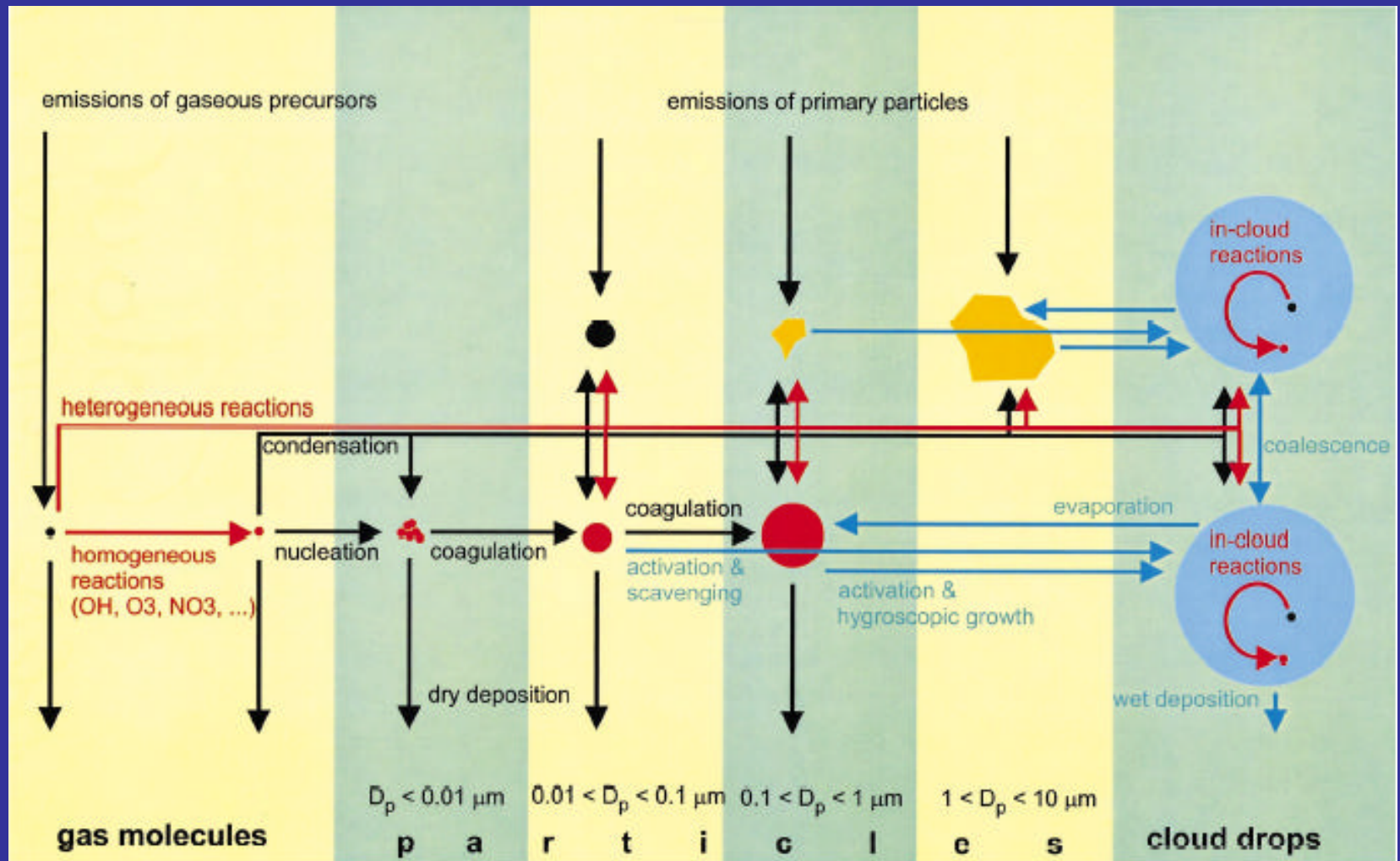
**Determinazione di inquinanti organici ed
elementi in tracce nell'aerosol
atmosferico della Laguna di Venezia**

**A. Gambaro^{1,2}, M. Berti¹, G. Cozzi¹, C. Turetta², G. Toscano¹,
R. Piazza¹, M. Lasfanti¹, L. Manodori², S. Ferrari¹, I. Moret^{1,2},
G. Capodaglio^{1,2}**

¹ Dipartimento di Scienze Ambientali, Università Ca' Foscari Venezia

² Istituto per la Dinamica dei Processi Ambientali – C.N.R., Venezia

Schema dei processi che influenzano la composizione dell'Aerosol Atmosferico

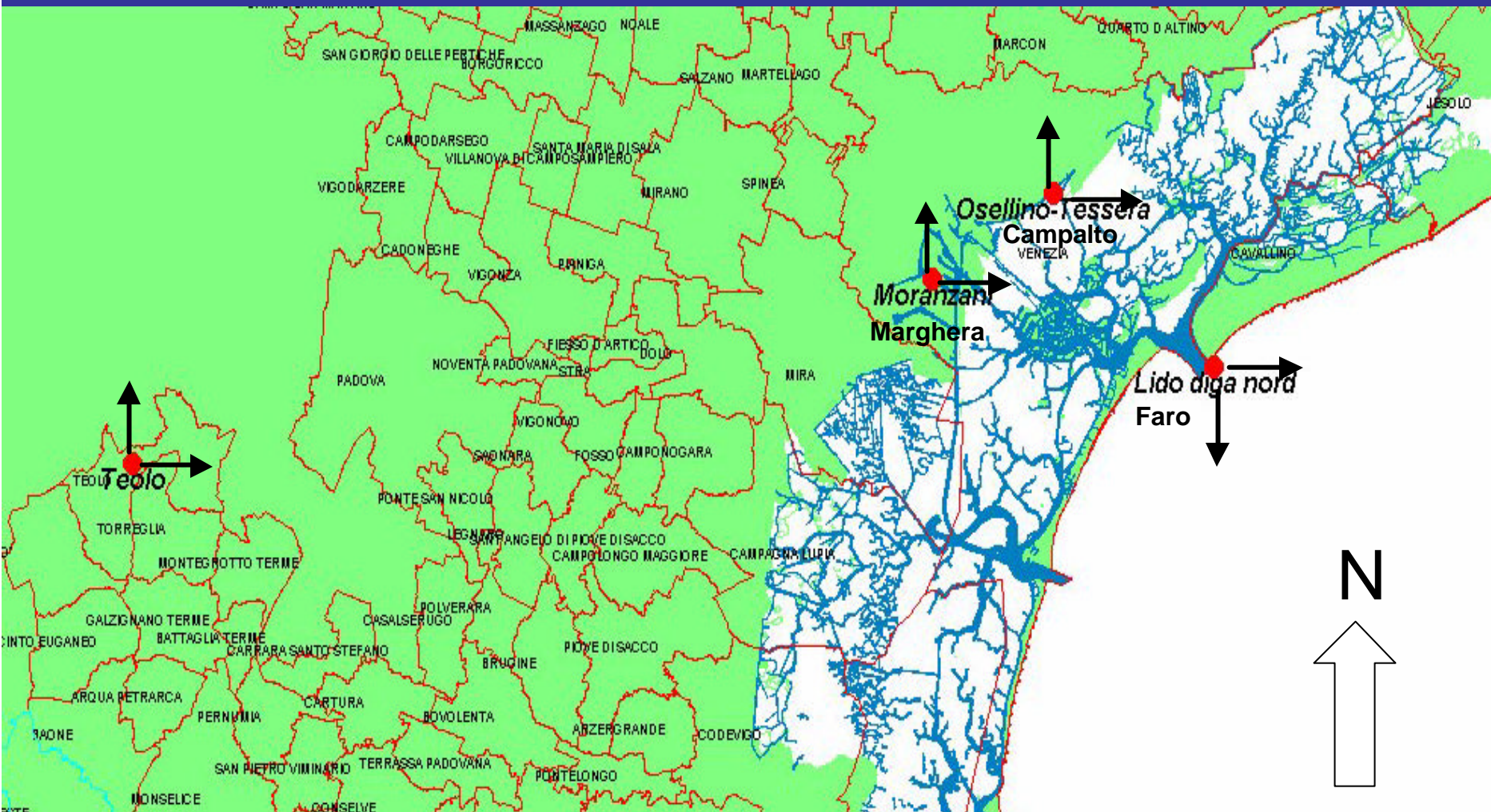


F. Raes et al., (2000) Formation and cycling of aerosols in the global troposphere *Atm Env.* 34

Nucleation mode particles
 $D_p < 0.01 \mu\text{m}$

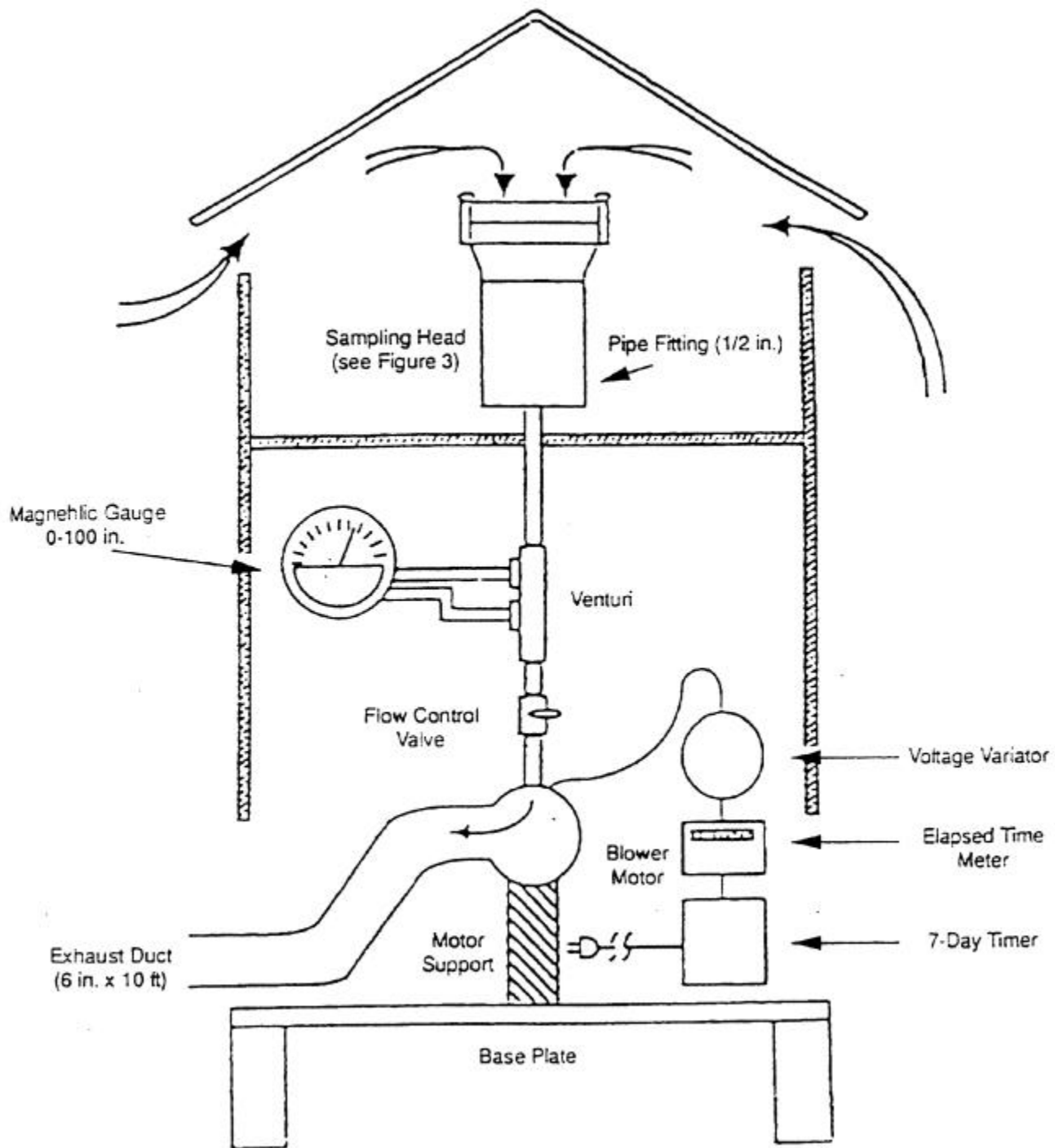
Aitken mode particles
 $0.01 < D_p < 0.1 \mu\text{m}$

Coarse mode particles
 $D_p > 1 \mu\text{m}$





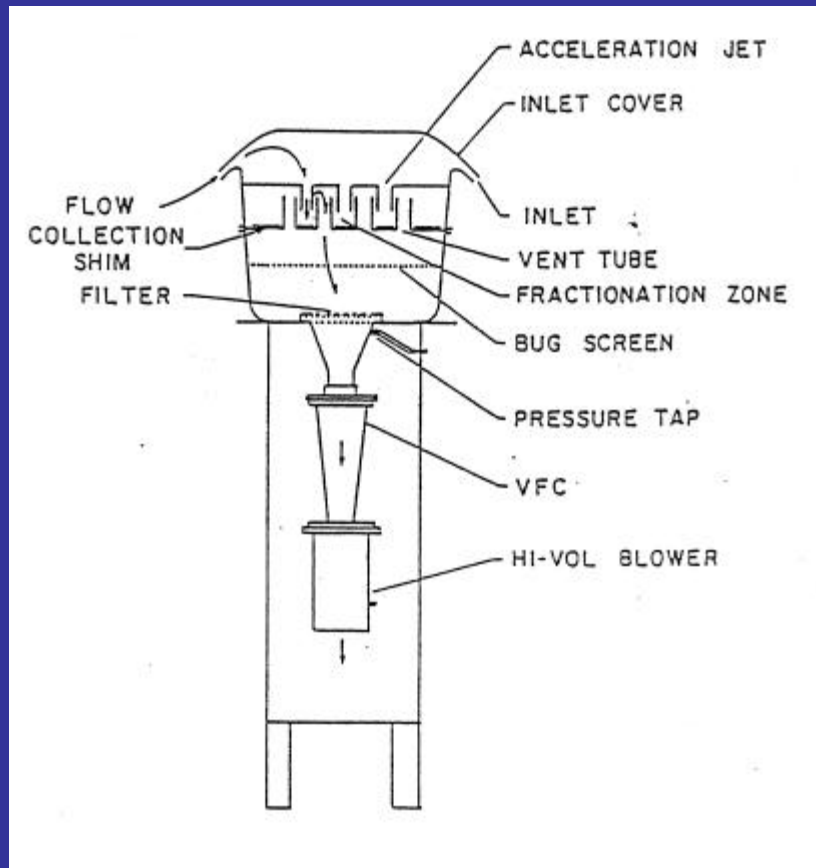




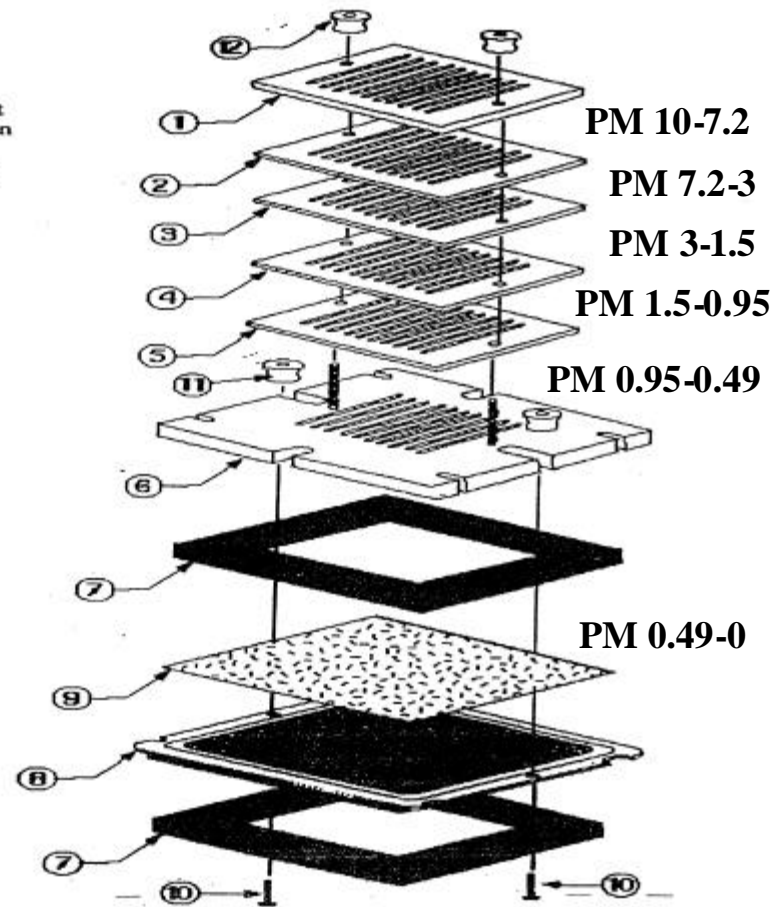




Campionatore di Aerosol



- 1 Stage 1
- 2 Stage 2
- 3 Stage 3
- 4 Stage 4
- 5 Stage 5
- 6 Base Plate
- 7 8" x 10" Gasket
- 8 Cartridge Screen
- 9 Filter Paper
- 10 Cartridge Bolt
- 11 Thumb-nut
- 12 Thumb-nut



Elementi Inorganici

V
Fe
Mn
Cu
Cd
Zn
Al
Pb
U
Co
Li

Microinquinanti Organici

PCB
IPA
IA
PCDD
PCDF

**Metodologia
analitica
Comp. organici**

Filtro, PUF

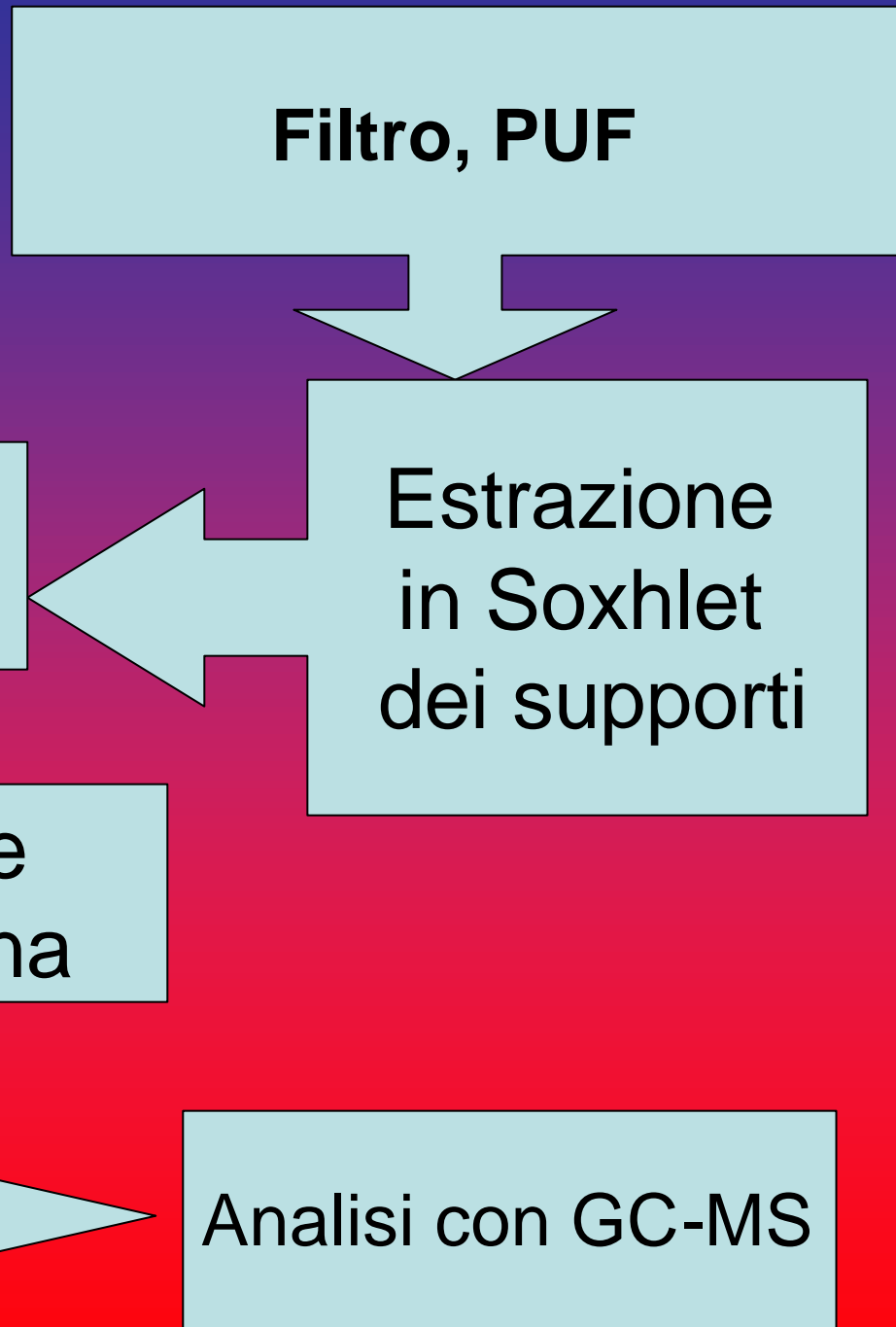
**Estrazione
in Soxhlet
dei supporti**

**Riduzione di volume
con azoto**

**Purificazione mediante
cromatografia su colonna**

**Riduzione di volume
a 100 μ l**

Analisi con GC-MS



Analisi chimica elementi inorganici

Peso del filtro

```
graph TD; A[Peso del filtro] --> B[Disgregazione con acidi Ultrapur mediante microonde]; B --> C[Analisi con ICP-MS (metalli di transizione)];
```

Disgregazione con
acidi Ultrapur
mediante microonde

Analisi con ICP-MS
(metalli di transizione)

PCB PUF

Accuratezza (n=6)

Ripetibilità (n=6, DSR%)

Congenere PCB	N° Cl	Media (pg)	Valore vero (pg)	Errore %
18	3	2,10E3	2,0E3	5,2
52	4	2,10E3	2,0E3	5,2
49	4	2,03E3	2,0E3	1,6
44	4	2,10E3	2,0E3	5,2
99	5	1,97E3	2,0E3	-1,3
110	5	2,06E3	2,0E3	3,0
118	5	1,91E3	2,0E3	-4,5
105	5	2,01E3	2,0E3	0,63
149	6	2,26E3	2,0E3	13
153	6	2,02E3	2,0E3	1,3
151	6	1,90E3	2,0E3	-4,9
183	7	1,95E3	2,0E3	-2,6
180	7	2,14E3	2,0E3	6,8
194	8	2,14E3	2,0E3	6,8
Totale		28,3E3	28,0E3	1,2

Congenere PCB	N° Cl	Ripetibilità
18	3	1,1
52	4	3,1
49	4	2,5
44	4	0,9
99	5	1,8
110	5	2,8
118	5	4,3
105	5	1,0
149	6	5,7
153	6	1,6
151	6	3,5
183	7	1,9
180	7	4,6
194	8	4,1
Totale		4,7

Materiale di riferimento certificato

NIST SRM 1649a

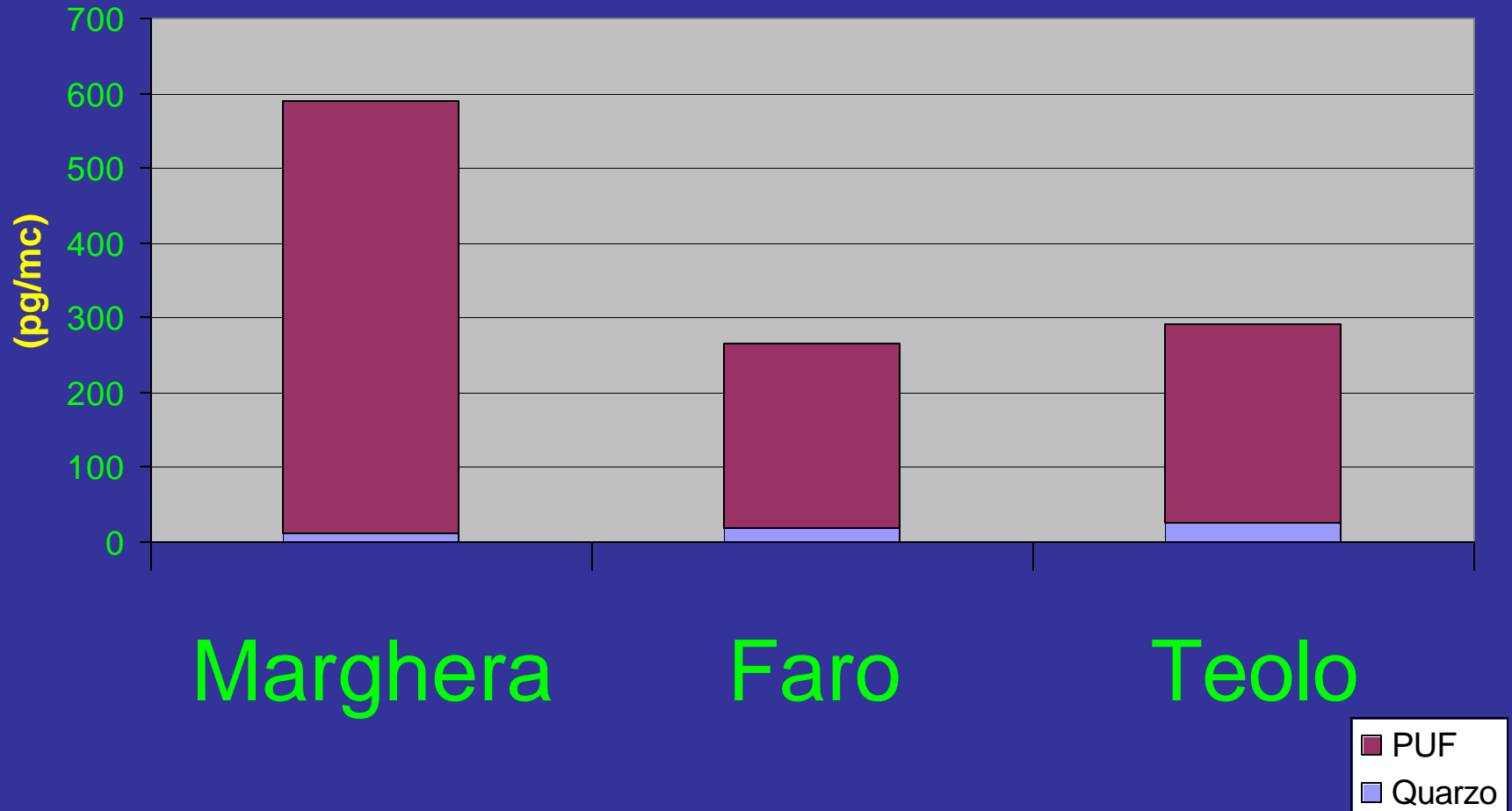
Accuratezza (n=5)

Ripetibilità (n=5, DSR %)

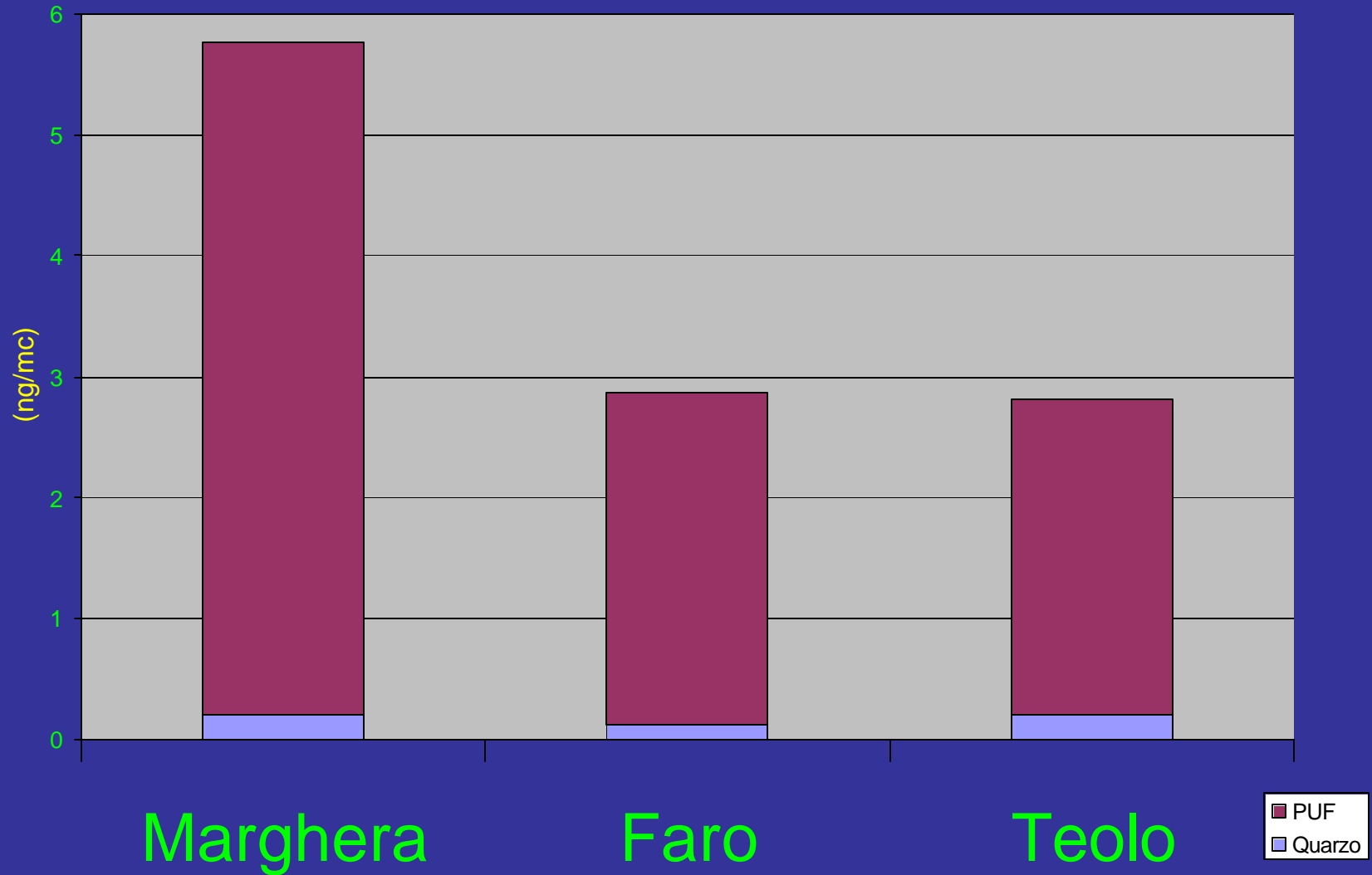
IPA	Media (DS)	Valore vero
	(ng/mg)	(ng/mg)
Fluorene	0,16(0,04)	0.21(±0,05)
Dibenzotiofene	0,16(0,09)	0.17(±0,01)
Fenantrene	3,22(0,04)	3,9(±0,4)
Antracene	0,46(0,1)	0,42(±0,08)
2-metilfenantrene	0,62(0,06)	0,70(±0,12)
4H-ciclopenta(def)fenantrene	0,26(0,07)	0,31(±0,06)
1-metilfenantrene	0,32(0,04)	0,36(±0,04)
Fluorantene	6,01(0,04)	6,20(±0,17)
Pirene	4,8(0,2)	5,0(±0,2)
Benzo(a)antracene	2,37(0,11)	2,12(±0,07)
Benzo(a)fluorantene	0,396(0,16)	0,393(±0,03)
Benzo(e)pirene	3,26(0,09)	2,97(±0,18)

IPA	Ripetibilità
Fluorene	28
Dibenzotiofene	11
Fenantrene	0,2
Antracene	22
2-metilfenantrene	9
4H-ciclopenta(def)fenantrene	20
1-metilfenantrene	13
Fluorantene	0,6
Pirene	1,3
Benzo(a)antracene	5
Benzo(a)fluorantene	30
Benzo(e)pirene	2,8
Totale	1,1

PCB totali pg/m^3

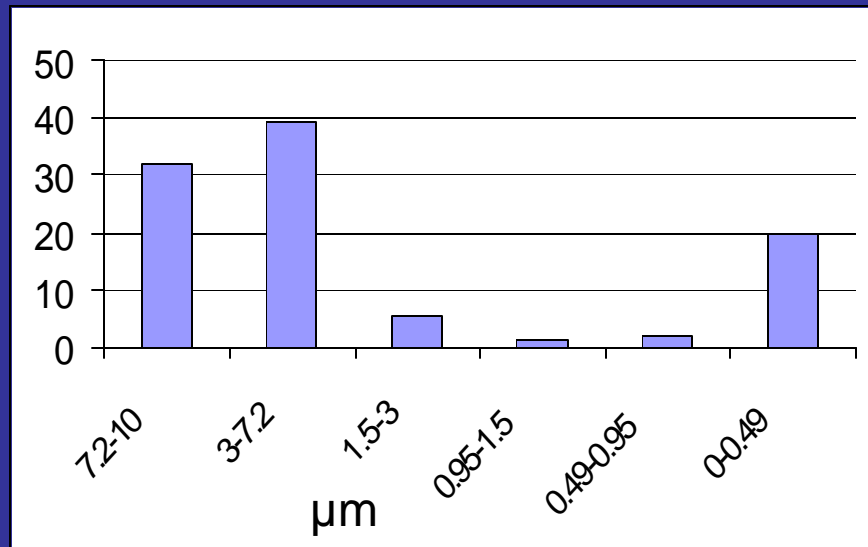


IPA totali ng/m³

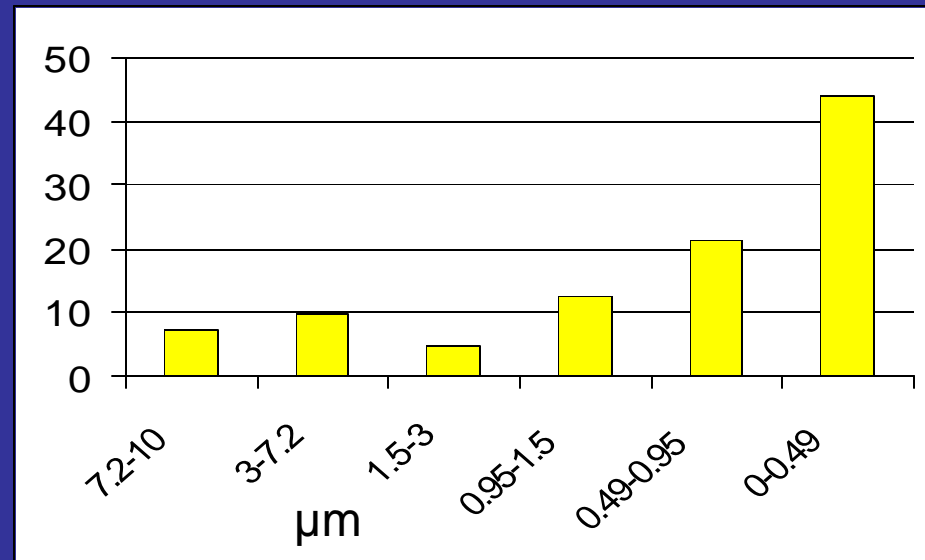


DISTRIBUZIONE GRANULOMETRICA %

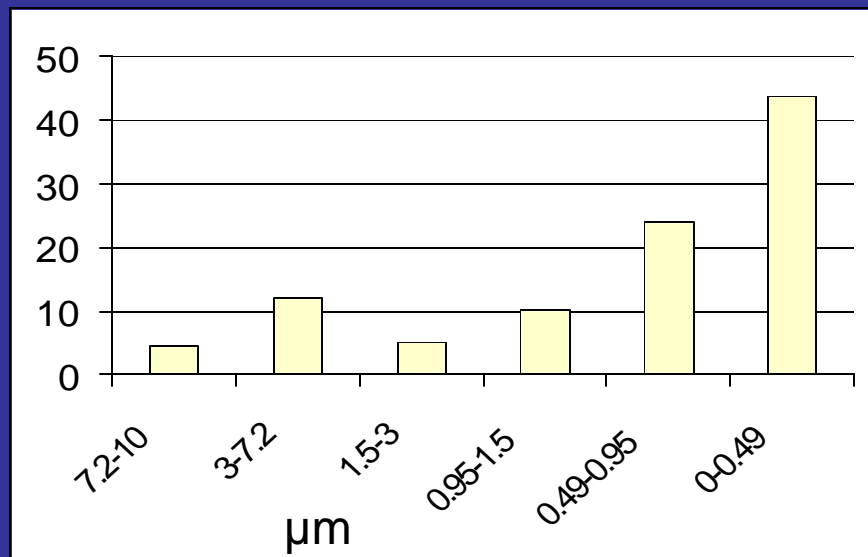
FARO



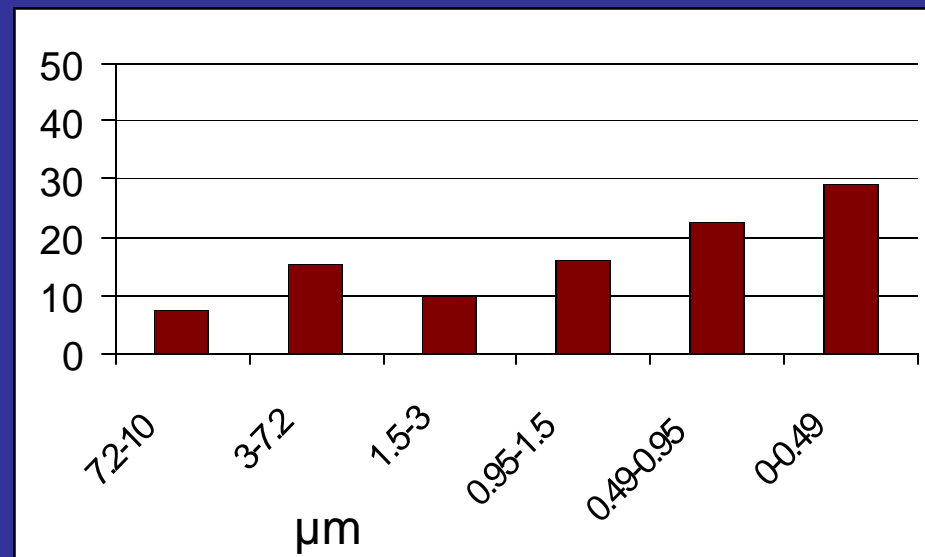
CAMPALTO



TEOLO



MARGHERA



16-20 / 7 / 2001

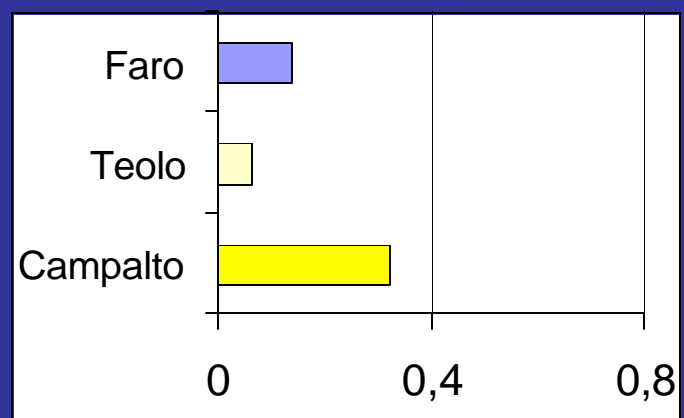
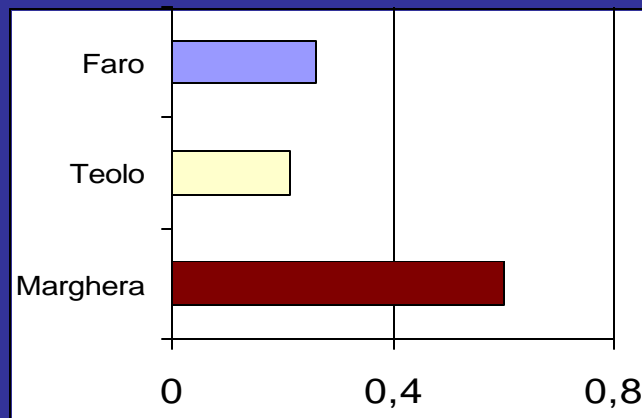
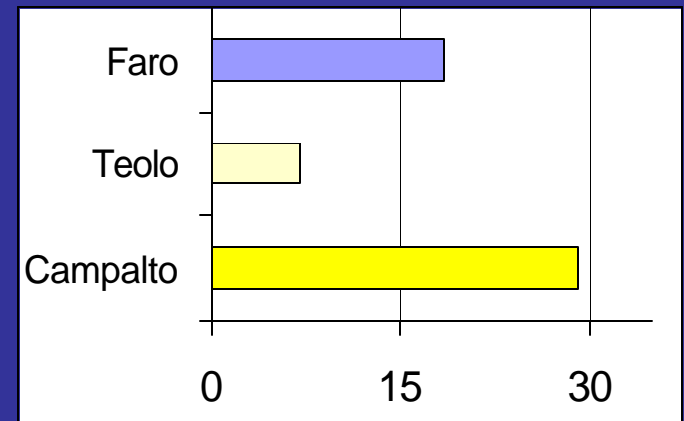
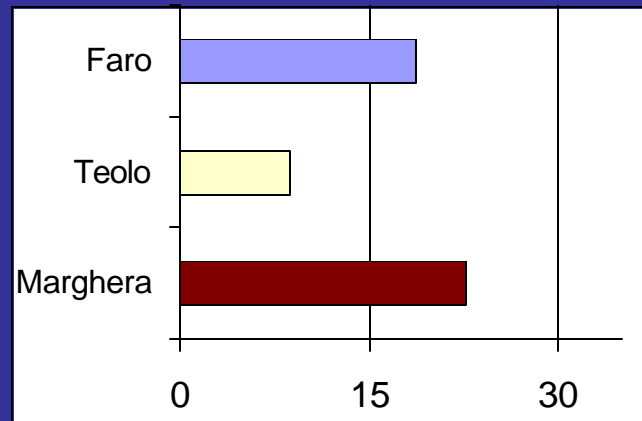
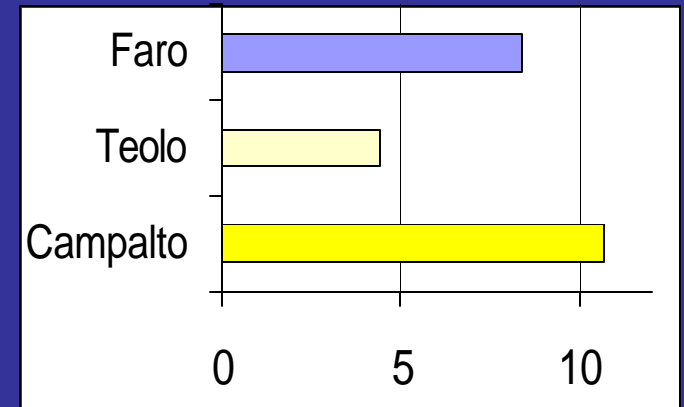
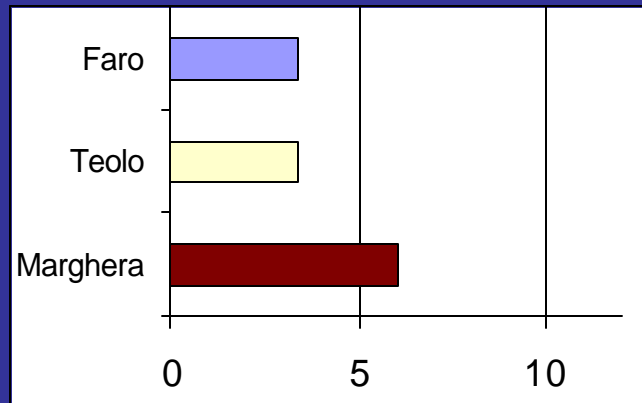
IPA

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**Concentrazione
ng/m³**

**Flusso
ng / (m² s)**

**Flusso
mg / (m² d)**



16-20 / 7 / 2001

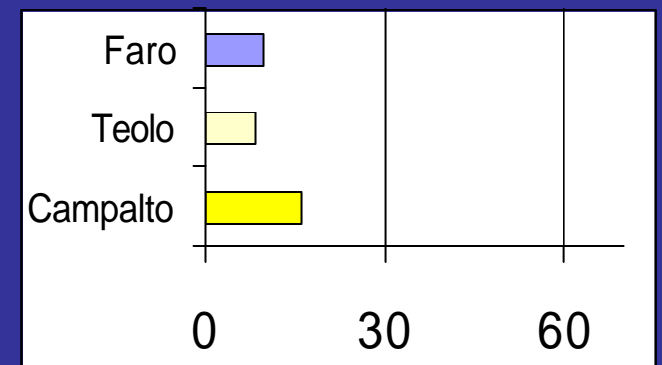
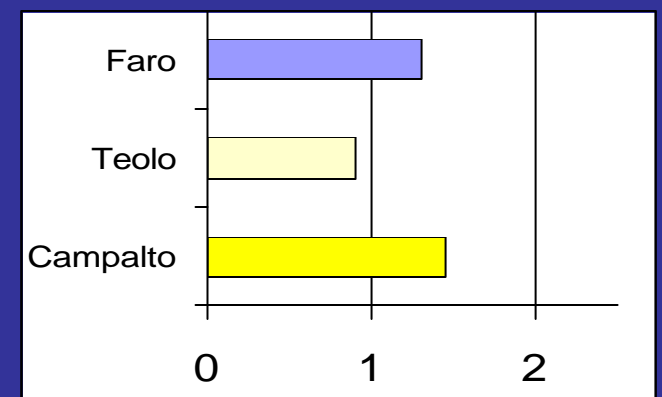
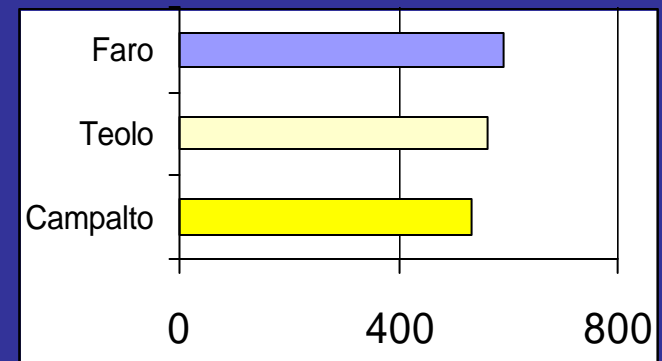
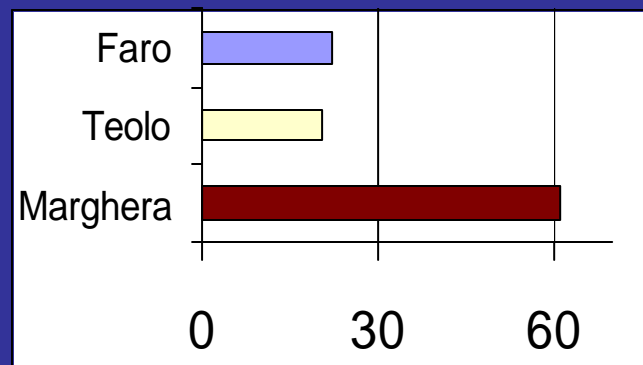
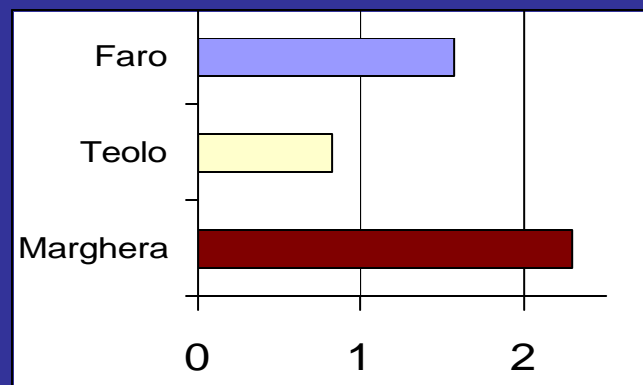
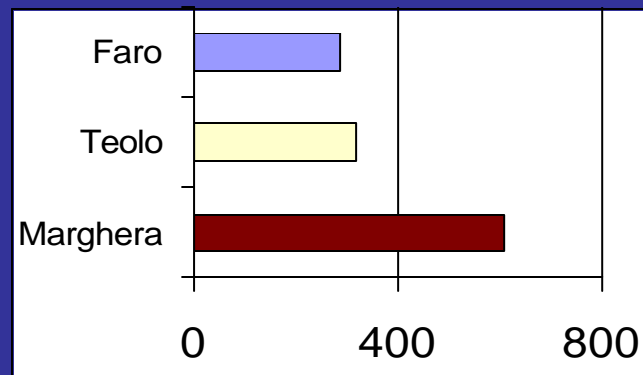
PCB

26-30 / 7 / 2001

Concentrazione
 $\mu\text{g} / \text{m}^3$

Flusso
 $\text{ng} / (\text{m}^2 \text{ s})$

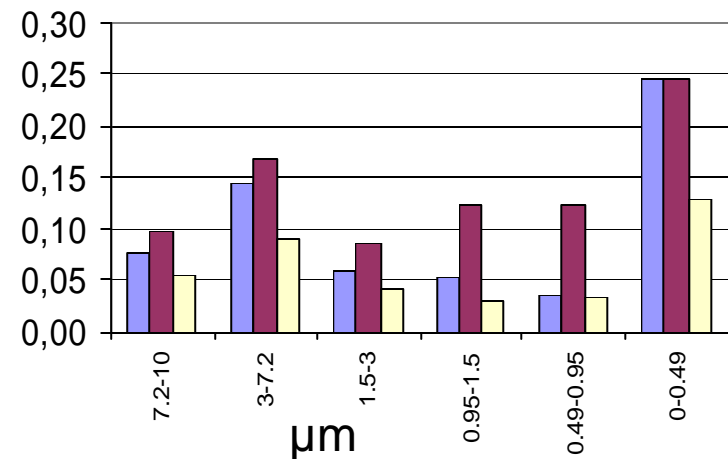
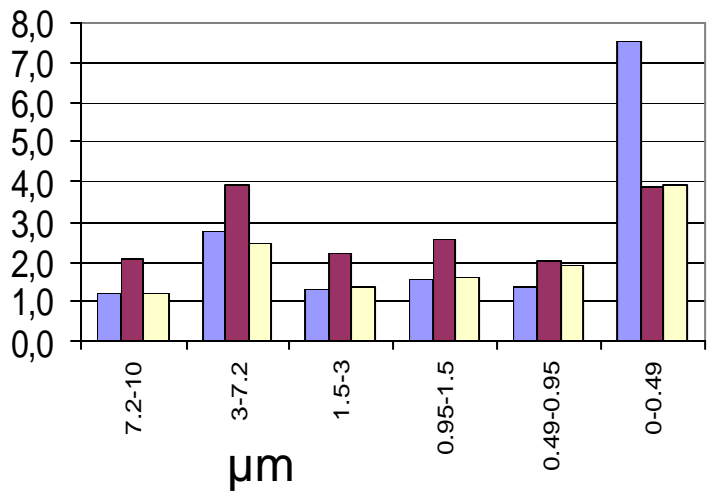
Flusso
 $\mu\text{g} / (\text{m}^2 \text{ d})$



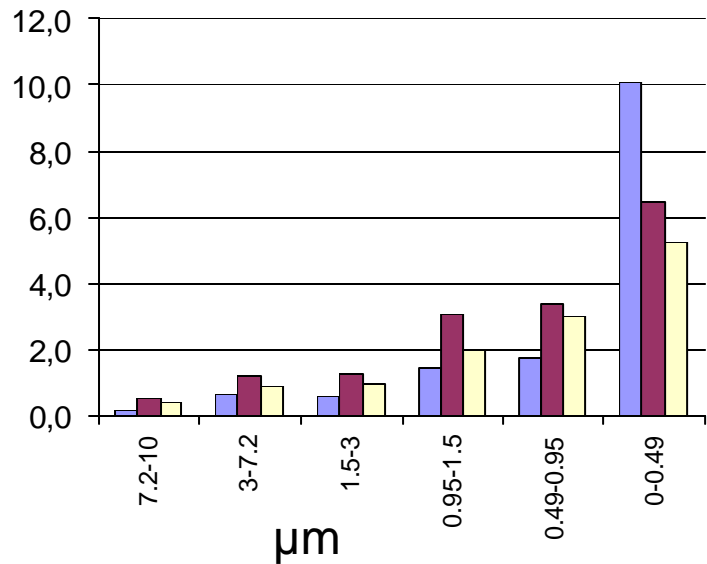
Mn (ng/m³)

16-20 / 7 / 2001

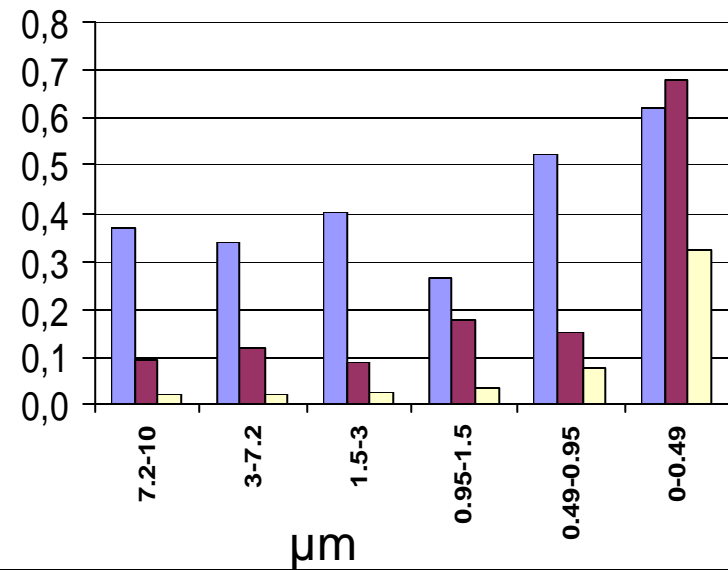
Li (ng/m³)



Pb (ng/m³)



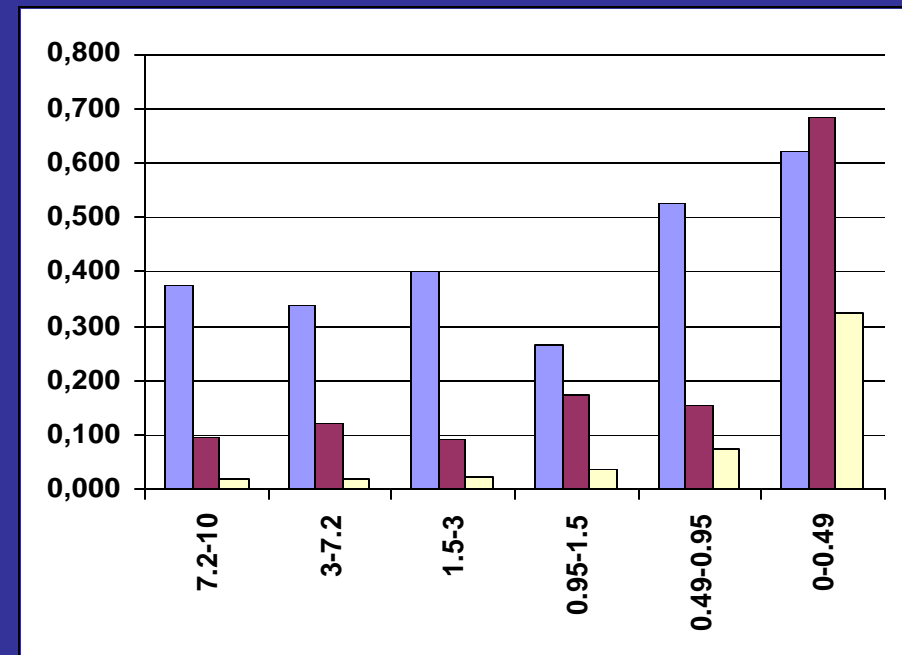
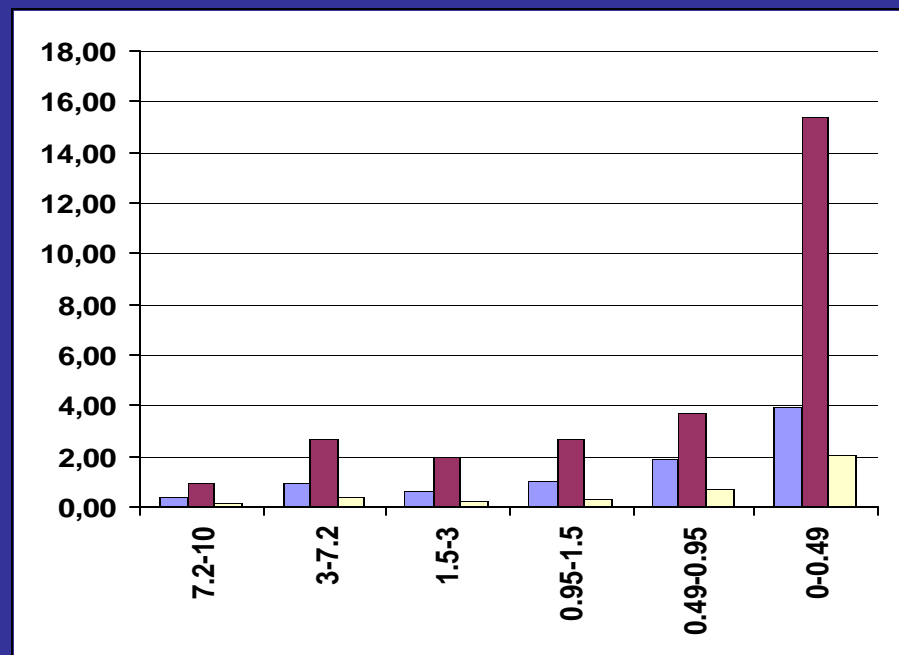
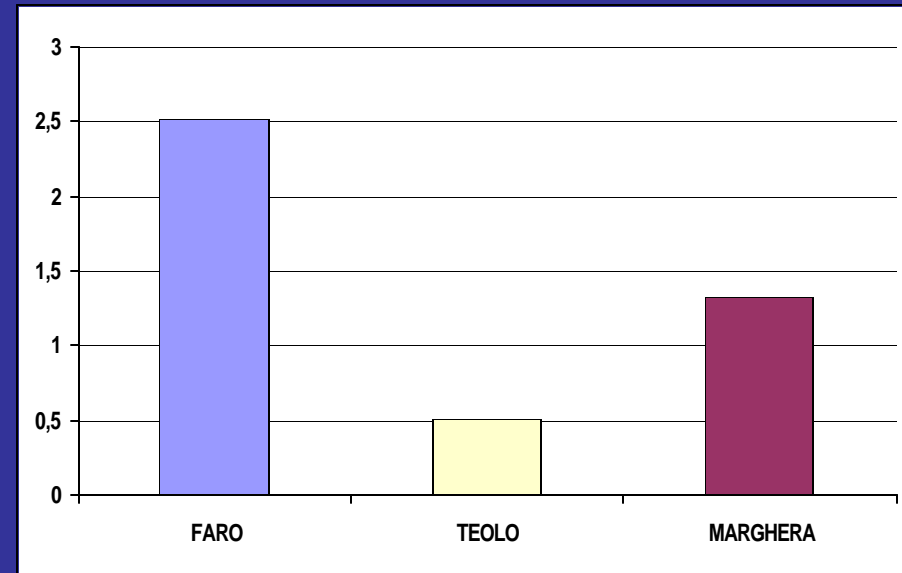
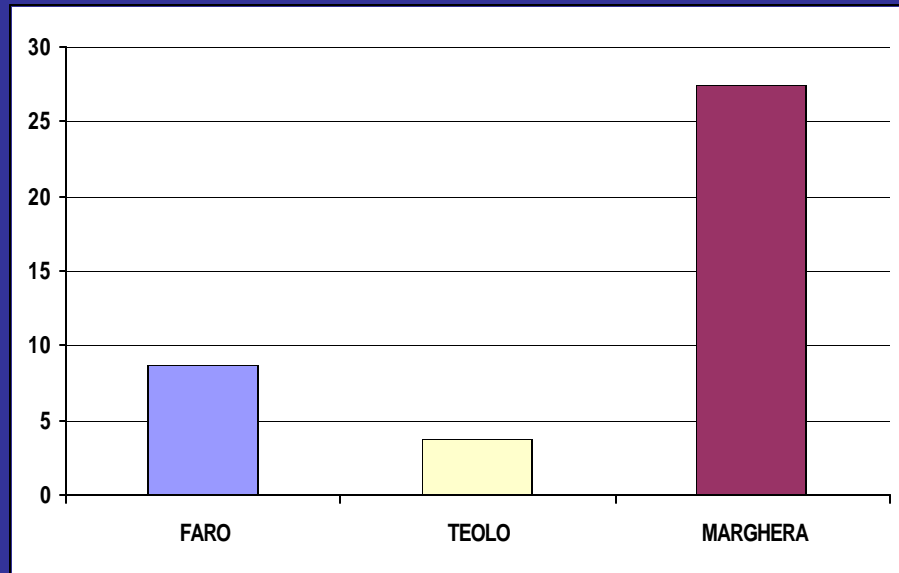
Cd (ng/m³)



V (ng/m³)

16-20 / 7 / 2001

Cd (ng/m³)



16-20 / 7 / 2001

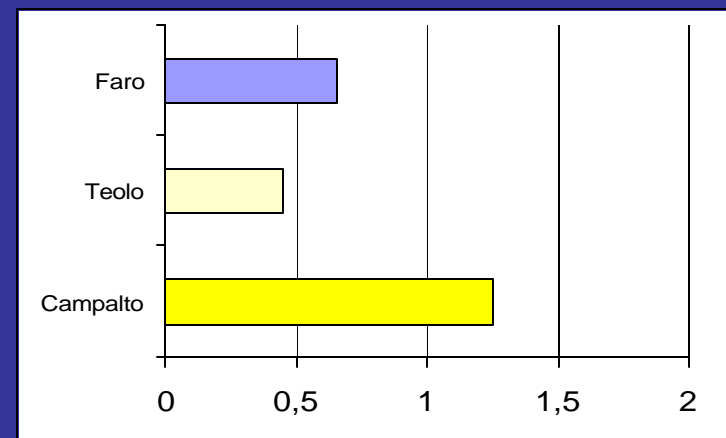
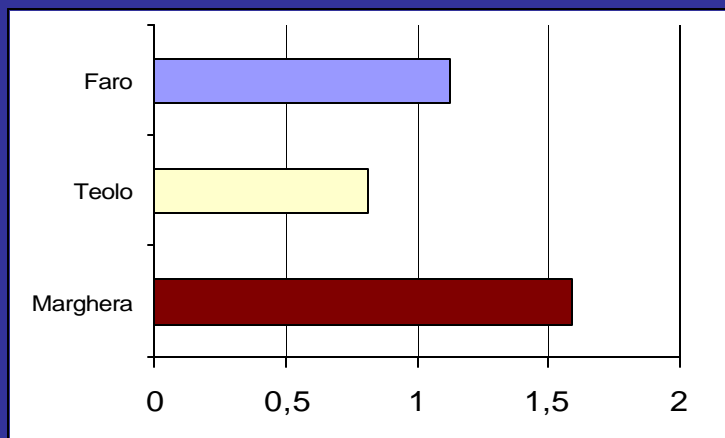
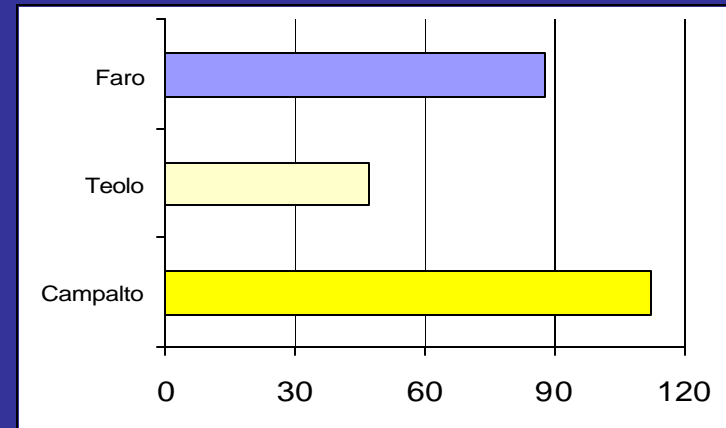
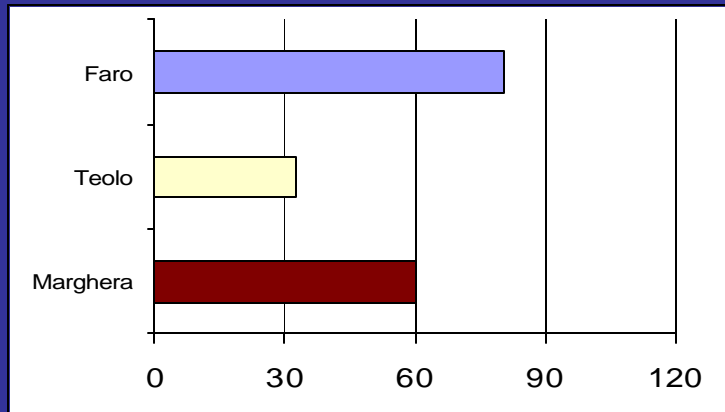
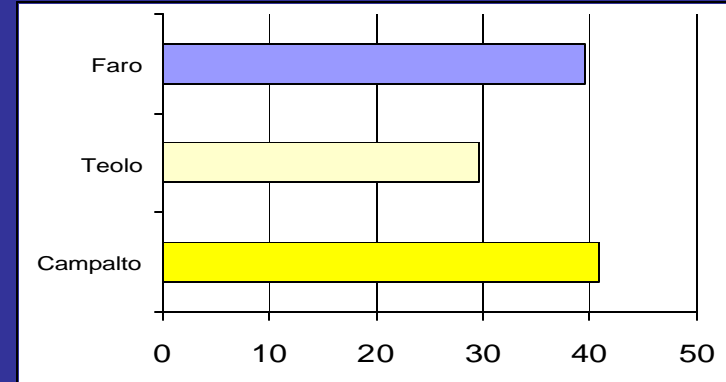
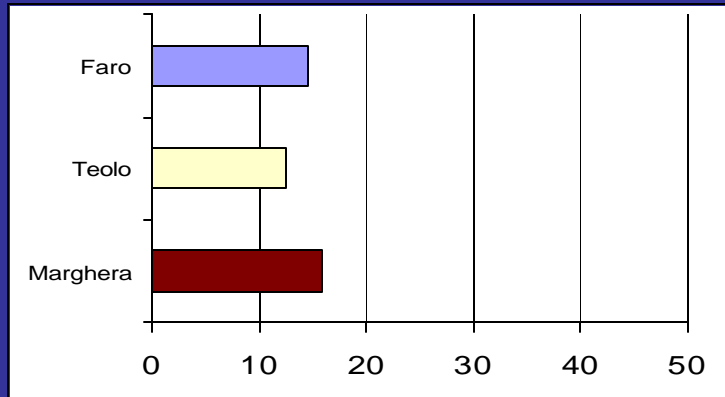
Pb

26-30 / 7 / 2001

Concentrazione
ng / m³

Flusso
ng / (m² s)

Flusso
mg / (m² d)

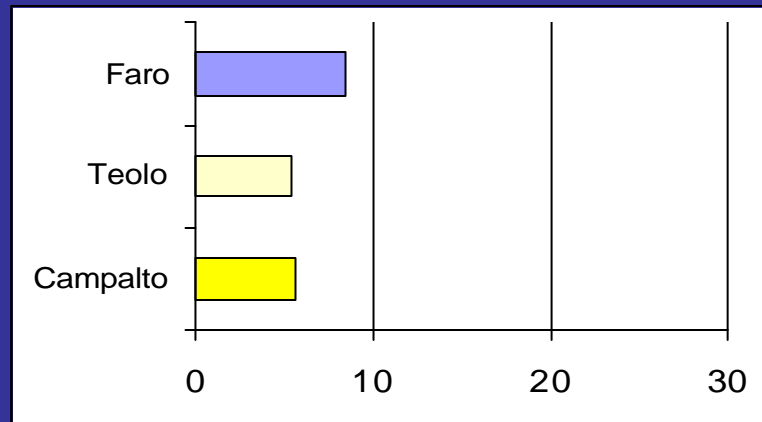
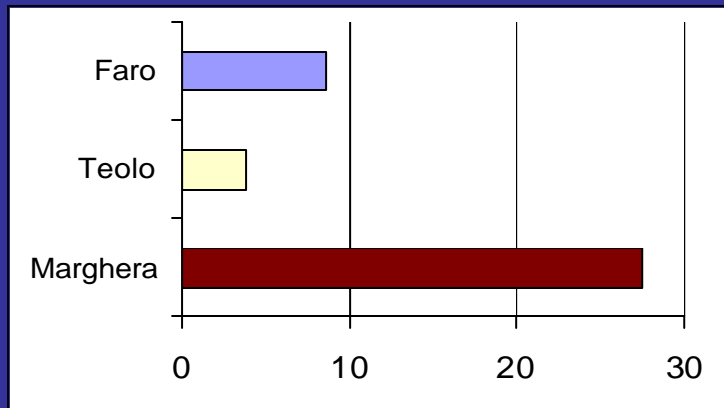


16-20 / 7 / 2001

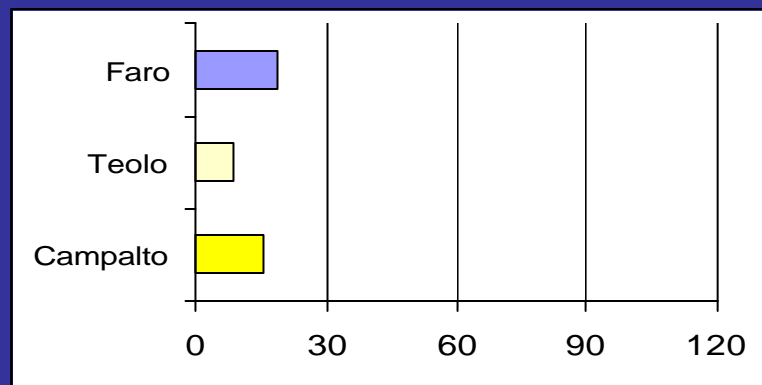
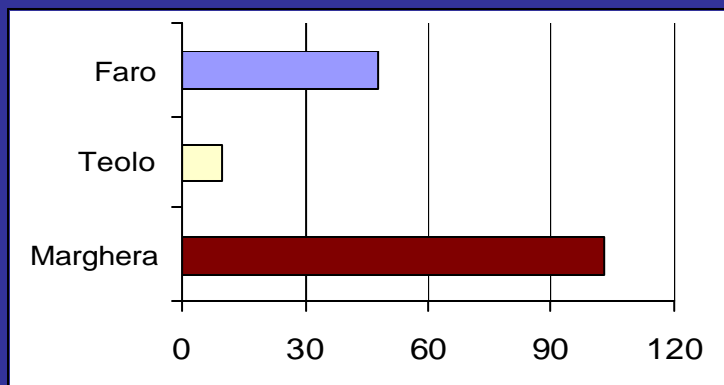
V

26-30 / 7 / 2001

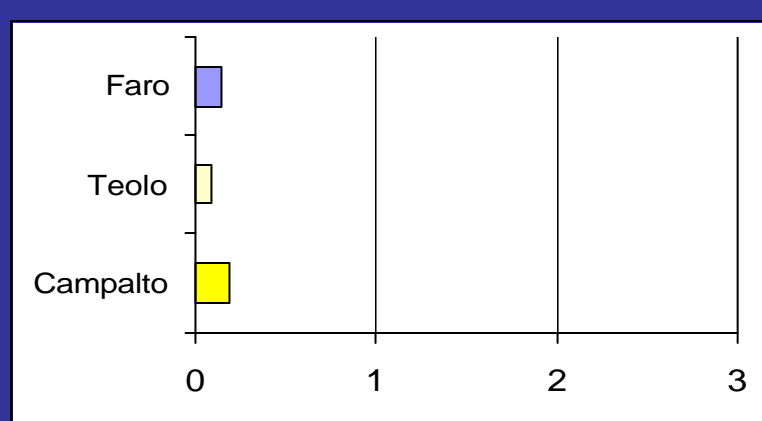
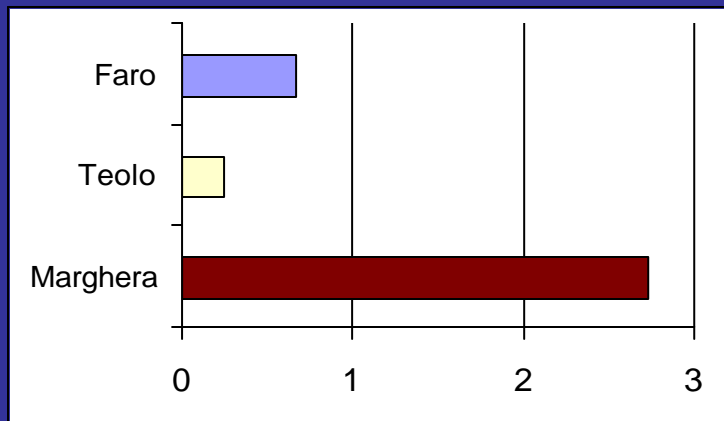
Concentrazione
ng / m³



Flusso
ng / (m² s)

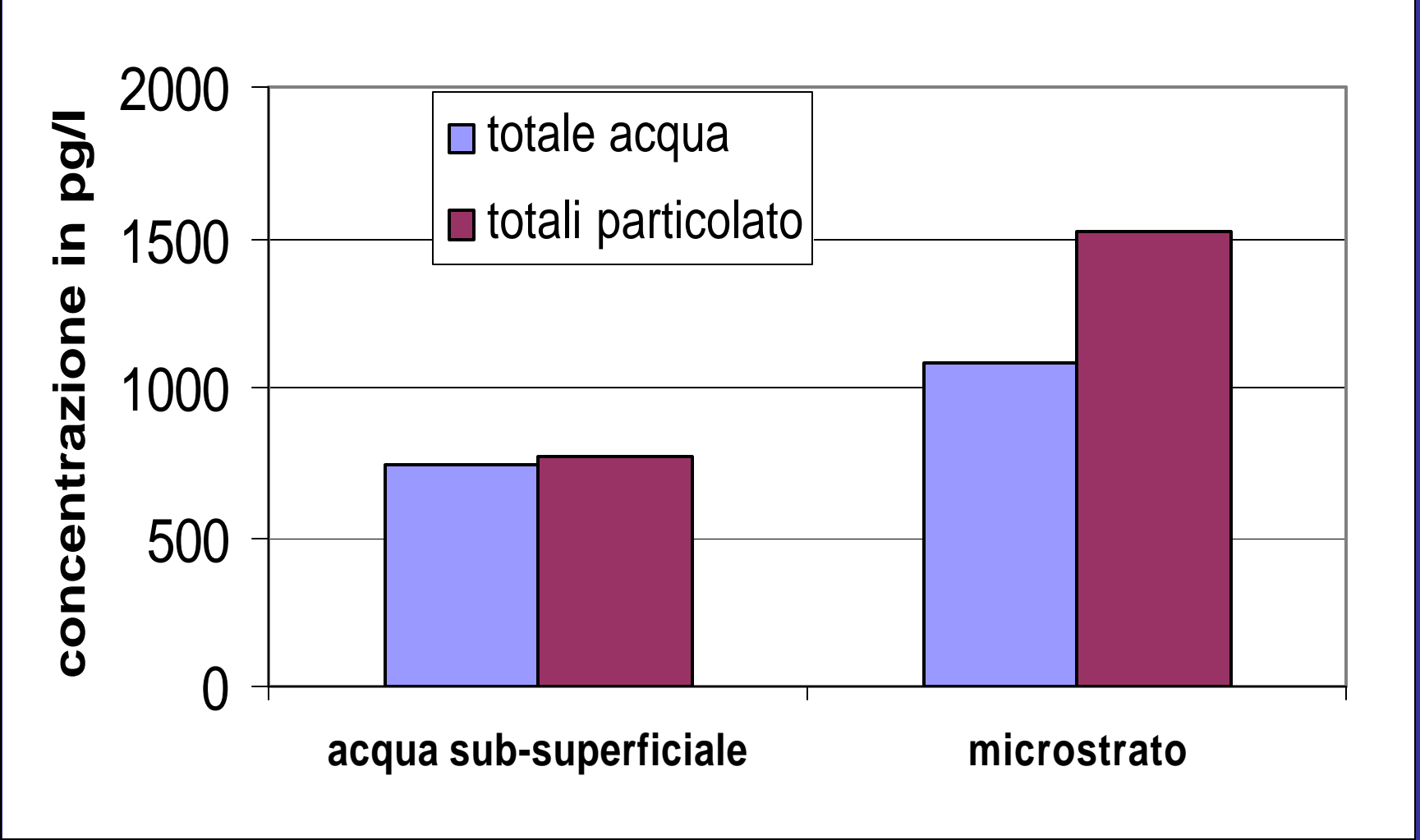


Flusso
mg / (m² d)



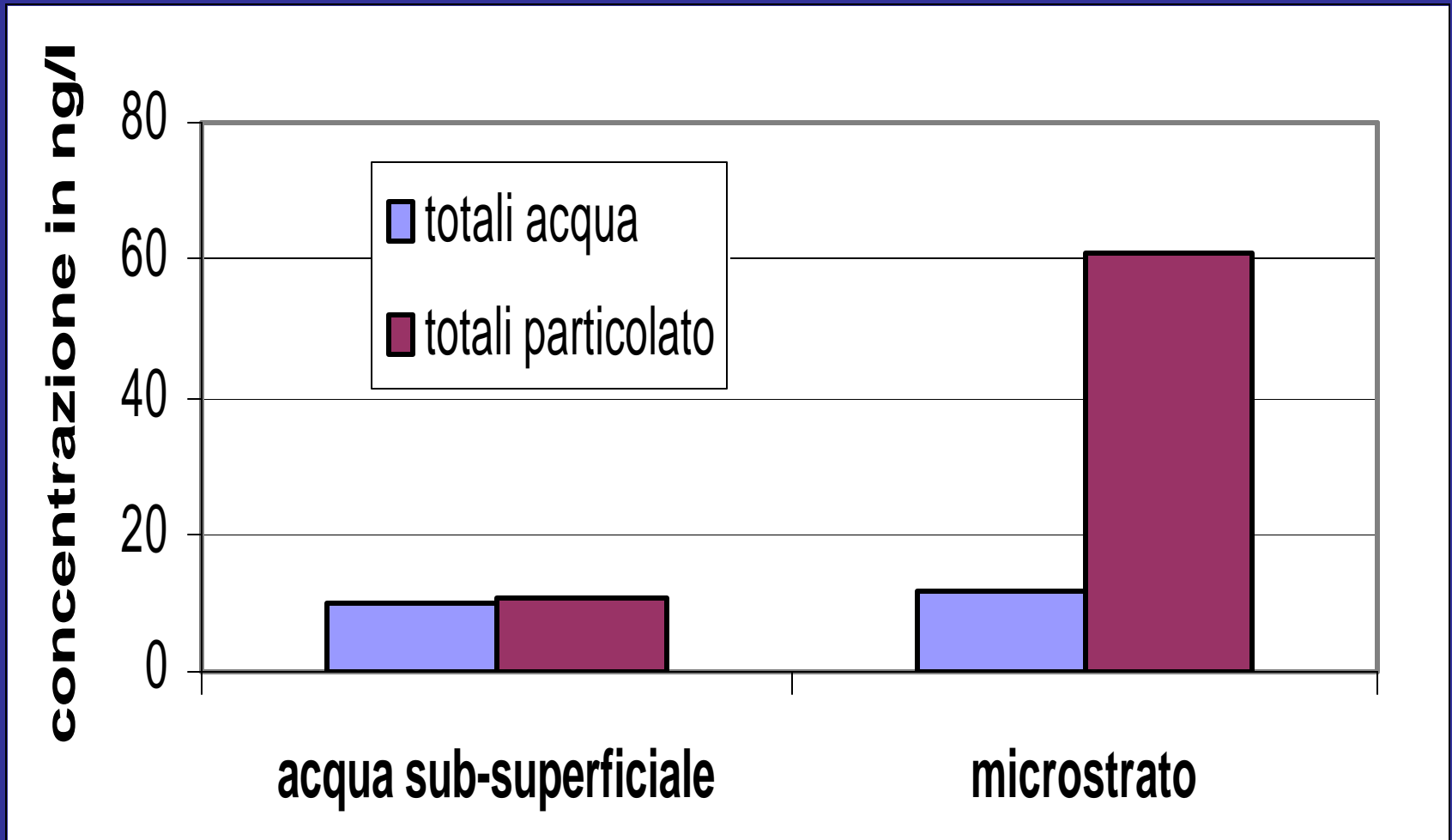
18/07/2001

PCB



18/07/2001

IPA



CONCLUSIONI

- **Il flusso di inquinanti organici (es PCB, IPA) e di elementi metallici di origine antropica (es. V) è maggiore nella stazione di Marghera rispetto alle altre stazioni**
- **Il flusso di inquinanti entrante in Laguna dal Mare Adriatico è significativo**
- **Le conclusioni ottenute sono limitate al periodo di campionamento** → **sono necessarie ulteriori campagne**
- **Chemiometria** → **Sorgenti**
- **Aerosol** → **Microlayer** → **Acqua**
- **Ruolo dell'aerosol sulla contaminazione della Laguna di Venezia**

Si ringrazia per la collaborazione:

A.R.P.A.V., Centro Meteorologico di Teolo

Consorzio di Bonifica Dese-Sile

Comando Zona Fari, Venezia

Ente della Zona Industriale di Marghera

CNR, ISDGM, Venezia

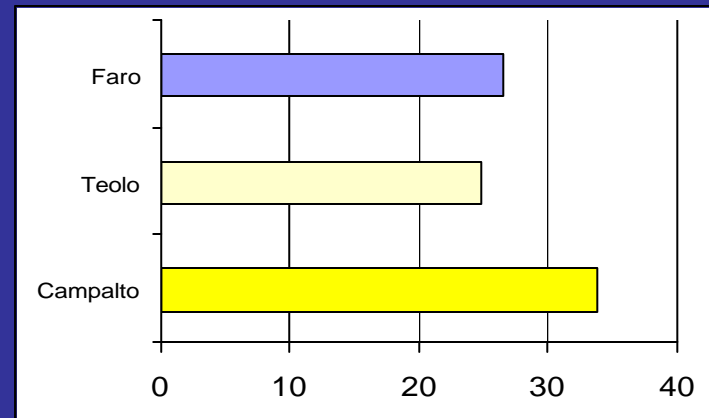
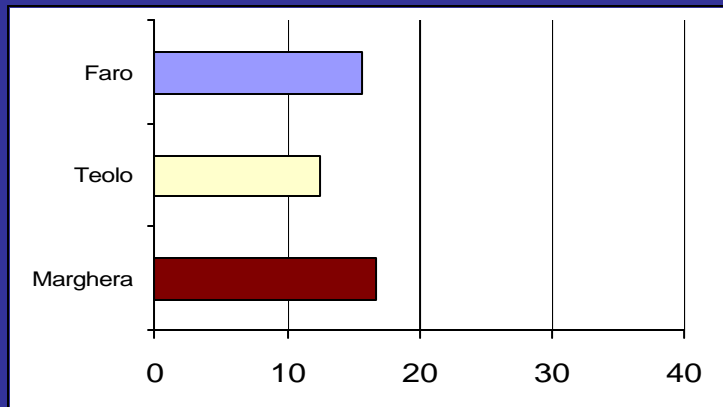
Magistrato alle acque di Venezia

16-20 / 7 / 2001

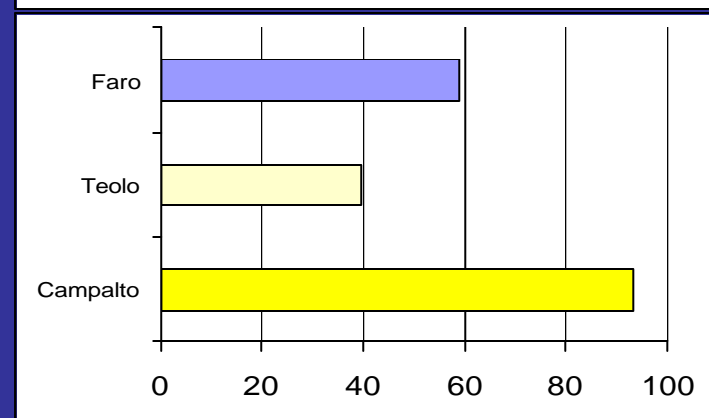
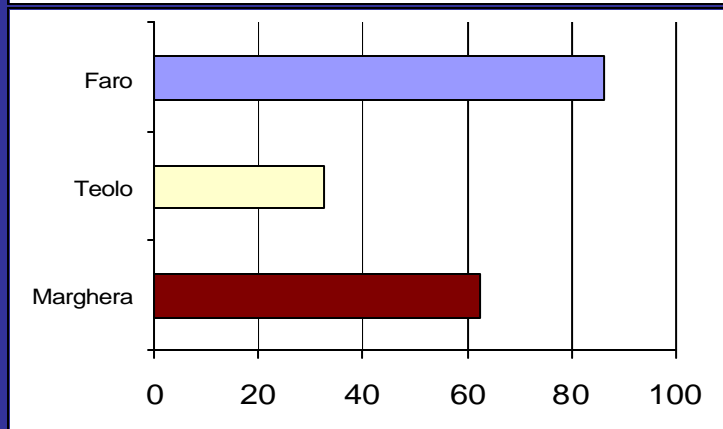
Mn

26-30 / 7 / 2001

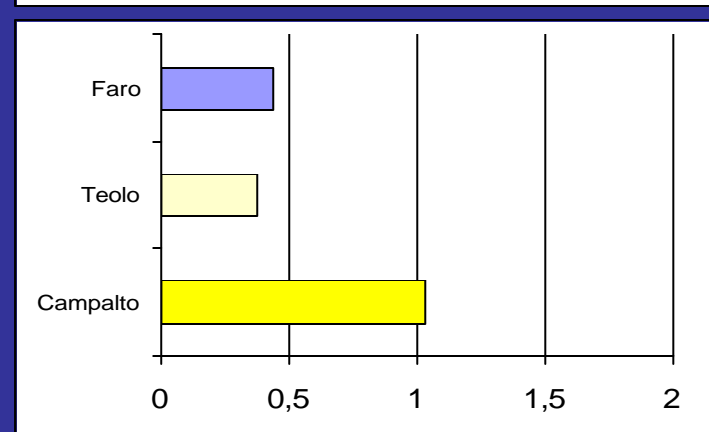
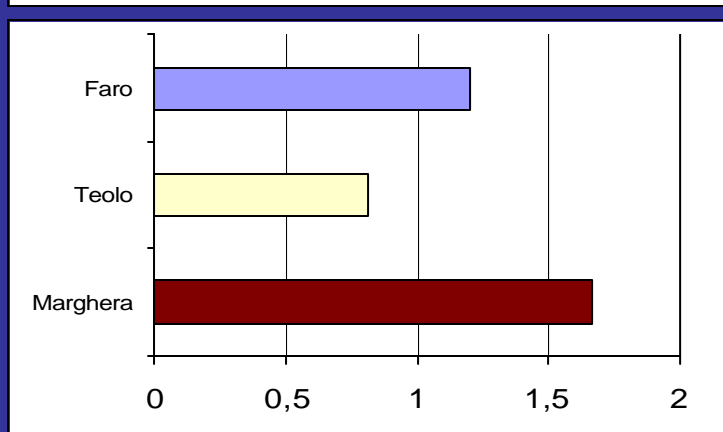
Concentrazione
 ng / m^3



Flusso
 $\text{ng} / (\text{m}^2 \text{ s})$



Flusso
 $\text{mg} / (\text{m}^2 \text{ d})$



IPA PUF

Accuratezza

IPA	Media (ng)	Valore vero (ng)	Errore %
Fluorene	5	6	-17
Dibenzotiofene	6	6	-5
Fenantrene	27	20	35
Antracene	5	6	-21
2-metilfenantrene	6	6	8
4H-ciclopenta(def)fenantrene	6	6	2
1-metilfenantrene	6	6	-5
Fluorantene	18	20	-10
Pirene	15	20	-24
Benzo(k)fluorantene	6	6	6
Benzo(a)fluorantene	6	6	-0.3
Benzo(e)pirene	6	6	6
Benzo(a)pirene	7	6	20
Perilene	7	6	24
Totale	199.3	182	10

Ripetibilità

(n=3, DSR %)

IPA	Ripetibilità
Fluorene	6
Dibenzotiofene	1
Fenantrene	8
Antracene	8
2-metilfenantrene	8
4H-ciclopenta(def)fenantrene	2
1-metilfenantrene	2
Fluorantene	0.33
Pirene	6
Benzo(k)fluorantene	0.69
Benzo(a)fluorantene	16
Benzo(e)pirene	3
Benzo(a)pirene	0.77
Perilene	9
Totale	23

Campionamento Inquinanti Organici

Campionatore ad alto volume con:

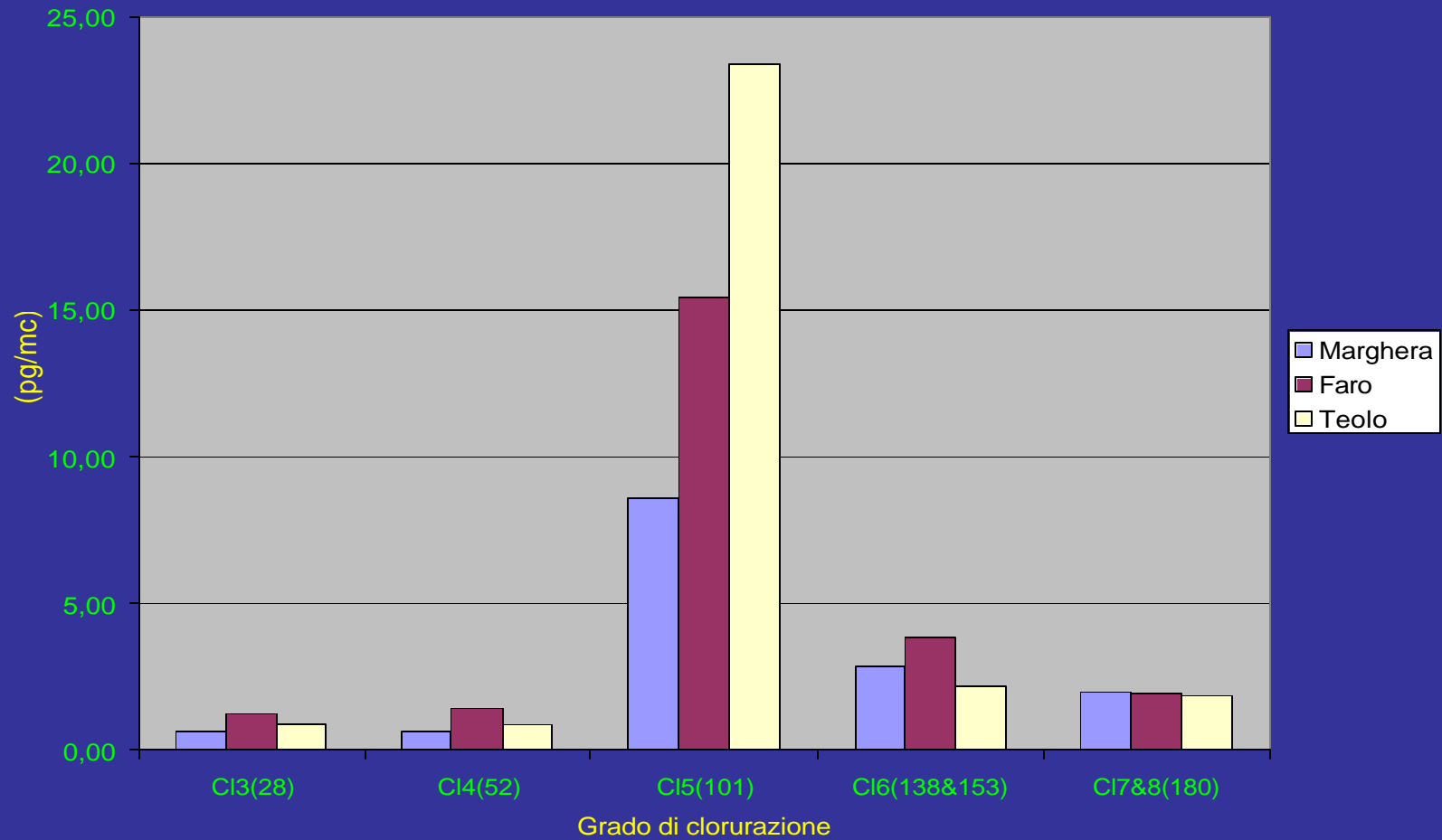
- Filtro di quarzo; Quartz filter To-13 (SKC Inc., USA)
- Polyurethane foam; PUF 75 MM (SKC Inc., USA)

Estrazione Campioni Organici

- Estrazione in Soxhlet per 24 ore dei supporti (>40 cicli)
- Miscela estraente: n-pentano/diclorometano (grado pesticidi) 2/1 (v/v)
- Aggiunta composti marcati direttamente sul campione prima di iniziare l' estrazione
- Standard completamente marcati ^{13}C per PCB e IPA
- Standard completamente deuterati per IA

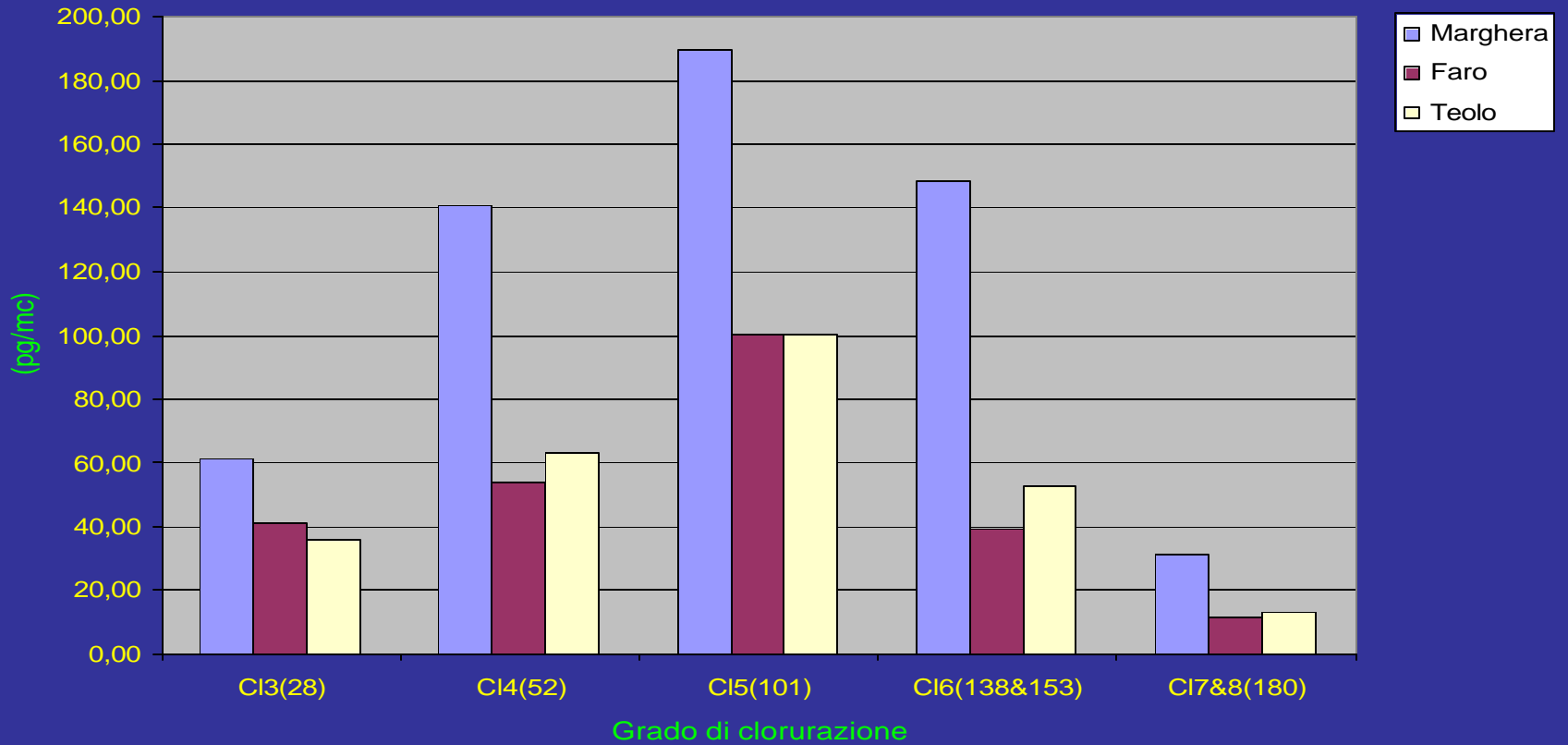
Congeneri PCB

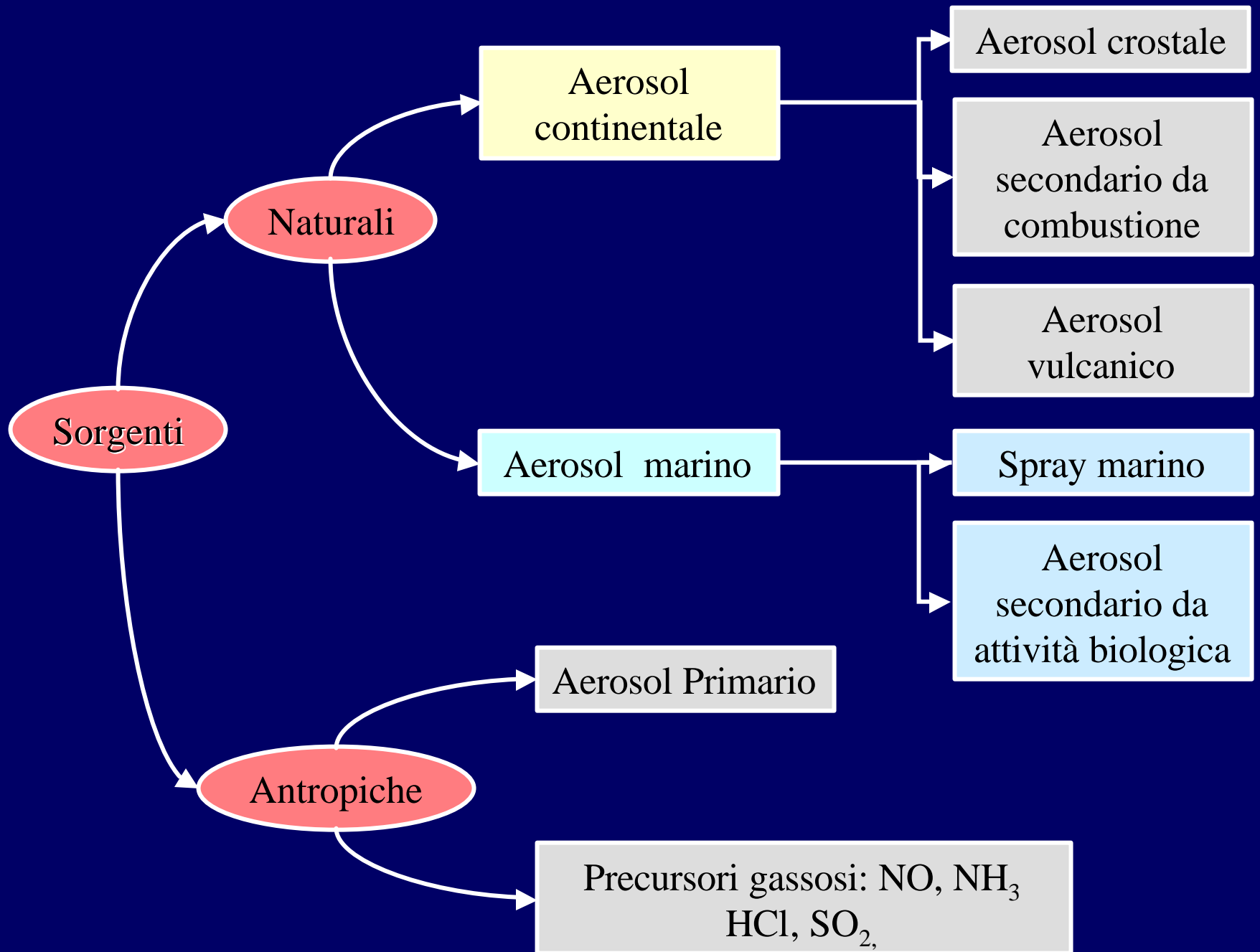
Congeneri PCB Filtro



Congeneri PCB

Congeneri PCB PUF



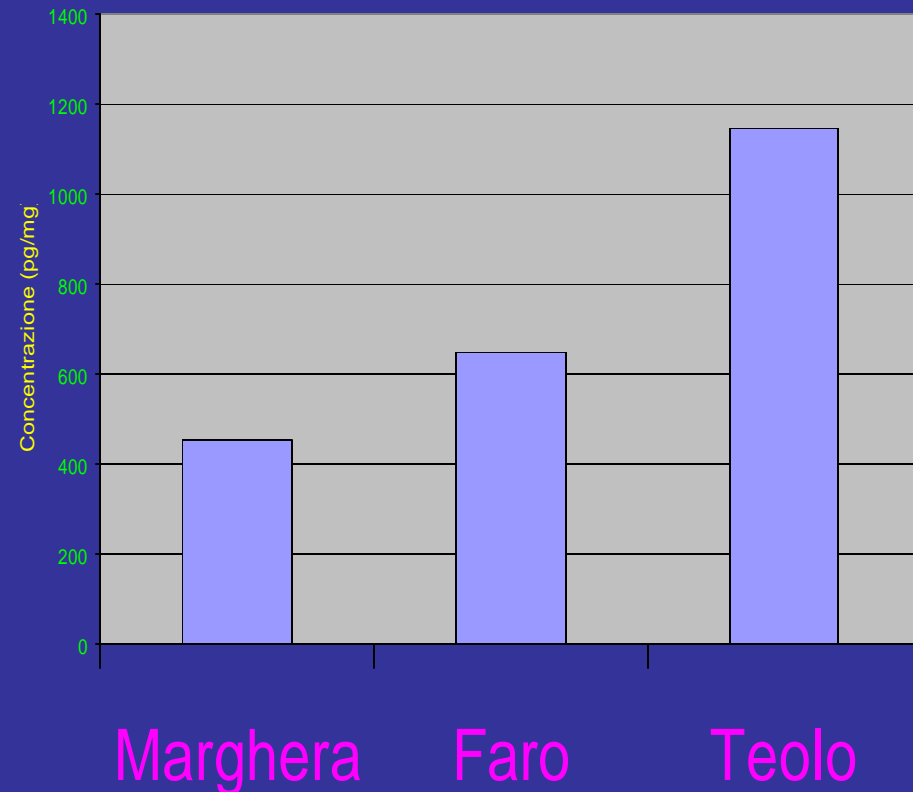
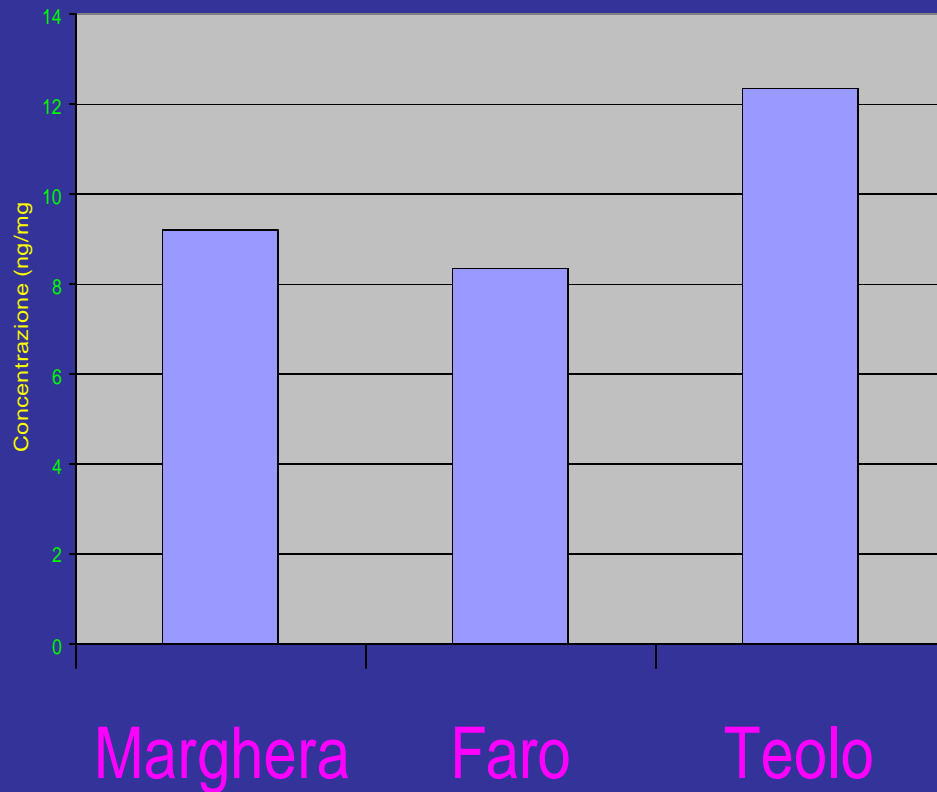




PARTICOLATO

IPA ng/mg

PCB pg/mg



Materiale di riferimento certificato

NIST SRM 1649a

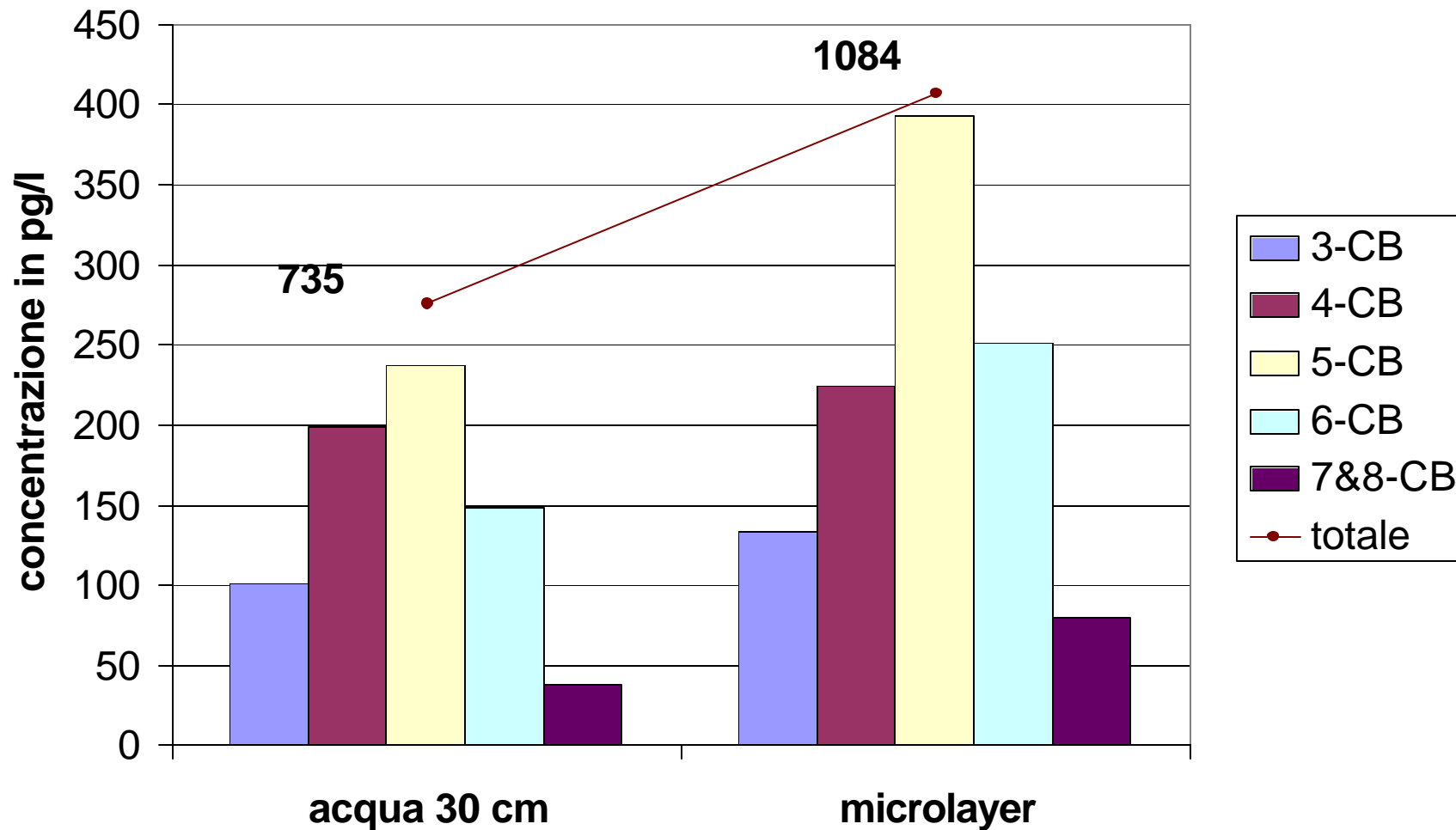
Accuratezza (n=5)

Ripetibilità (n=5, DSR %)

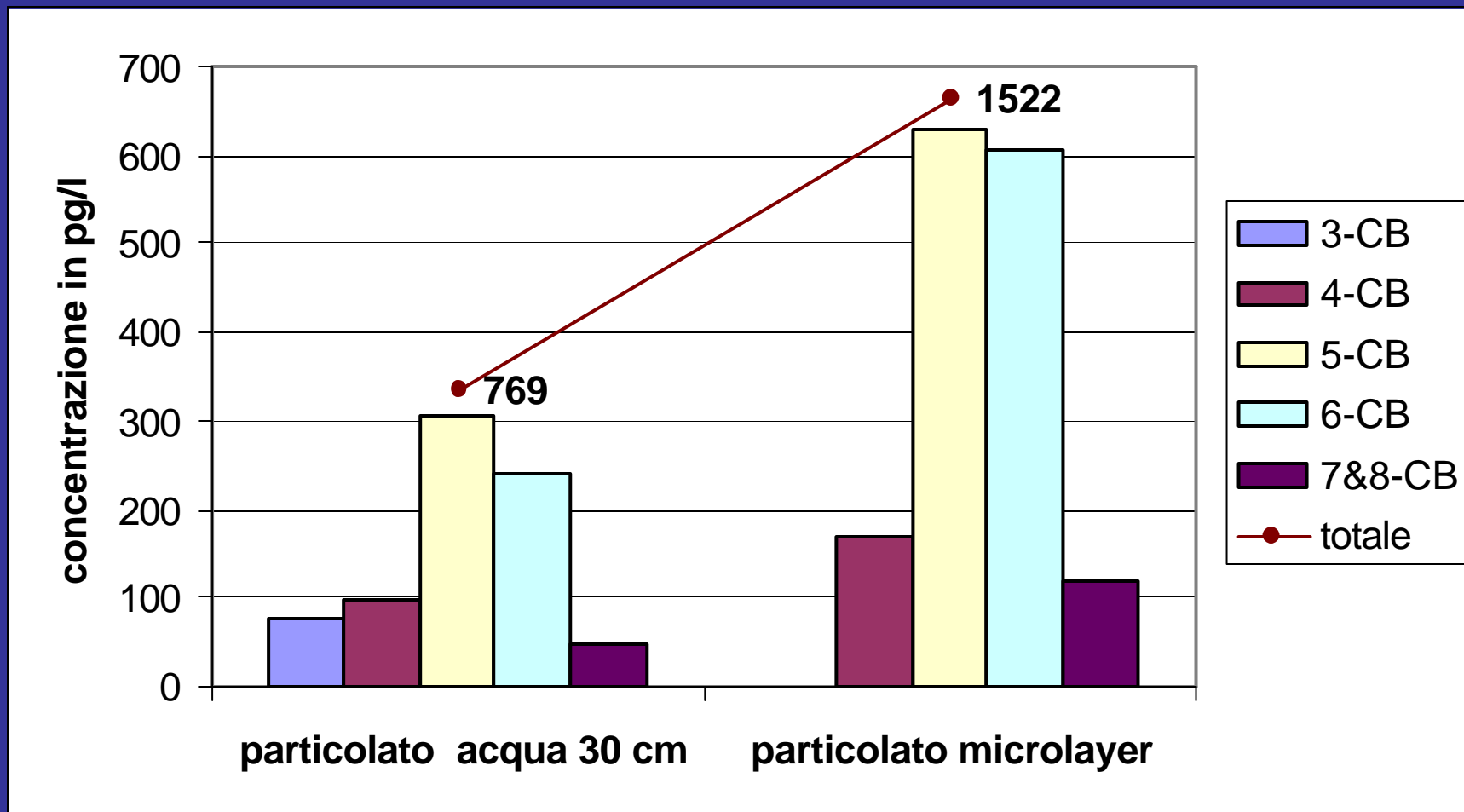
Congenere PCB	N° Cl	Media (DS)	Valore vero
		(pg/mg)	(pg/mg)
18	3	19,8(2,4)	19,6(±0,8)
52	4	23,0(2,0)	23,7(±0,9)
49	4	10,4(1,4)	11,7(±1,4)
44	4	13,4(0,3)	14,8(±1,5)
99	5	9,26(0,06)	9,21(±0,67)
110	5	26,5(1,0)	25,6(±1,5)
118	5	23,3(0,9)	24,7(±1,4)
105	5	9,0(0,9)	8,3(±0,8)
149	6	71,6(3,1)	72,8(±1,2)
153	6	77,9(6,2)	79,3(±7,7)
151	6	30,1(2,7)	32,9(±3,8)
183	7	19,8(2,4)	19,6(±0,9)
180	7	78,8(8,0)	75,7(±7,9)
194	8	30,7(4,0)	27,8(±3,5)

Congenere PCB	N° Cl	Ripetibilità
18	3	12
52	4	8
49	4	13
44	4	2
99	5	0,6
110	5	4
118	5	4
105	5	11
149	6	4
153	6	8
151	6	9
183	7	12
180	7	10
194	8	13
Totale		10

Sacca Sessola: andamento omologhi



Sacca Sessola: andamento omologhi





FARO



MARGHERA



TEOLO



CAMPALTO

FLUSSO $\text{ng}/(\text{m}^2 \text{ s}) =$

Conc. (ng/m^3) x vel. media del vento (m/s)

Confronto con dati di letteratura

	Nostro studio	Nostro studio	Galveston Bay	Galveston Bay
Omologhi PCB	Range concentrazione fase libera (pg/m ³)	Range concentrazione particolato (pg/m ³)	Range concentrazione fase libera (pg/m ³) (a)	Range concentrazione particolato (pg/m ³) (a)
Triclorurati	35.5 - 61.3	0.6 – 1.3	43.0 - 3428	ND – 26.0
Tetraclorurati	53.9 – 140.6	0.6 – 1.4	44.3 – 1172	ND – 14.6
Pentaclorurati	100.1 – 189.3	8.6 – 23.4	5.1 – 210	ND – 13.0
Esaclorurati	38.8 – 148.6	2.2 – 3.9	4.4 – 159	ND – 10.3
Epta- & ottaclorurati	11.8 – 31.0	1.9 - 2.0	ND - 305	ND – 53.0

(a): Park, J.-S, *et al.*, (2001), *Atm. Environ.*, **35**, 3315-3324