## "Capacity Building and Strengthening Institutional Arrangement"

## Analysis and sampling of air and air pollution

# $So_2$, $No_x$, Co etc. monitoring equipment

## Mr. Alessandro Di Menno Di Bucchianico

APAT

Agency for Environmental Protection and Technical Service

# CO ANALYZER



**Non-Dispersive Infrared (NDIR) photometer**

# SO$_2$ ANALYZER
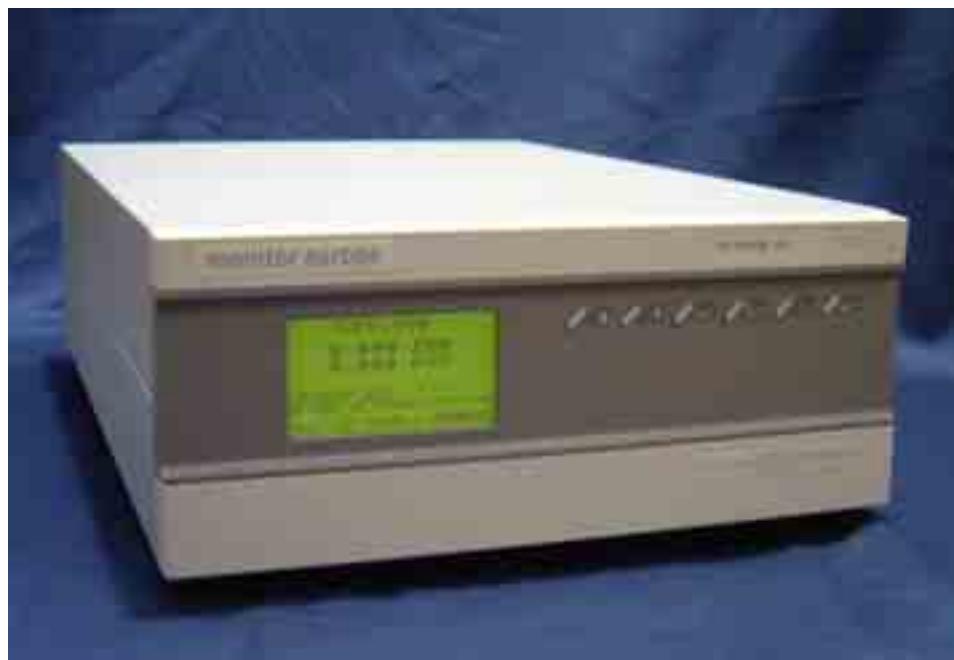


## Ultra Violet (UV) fluorescence

# NO$_x$ ANALYZER

**NO$_x$:**

NO + NO$_2$ + HONO + other nitrogenous compounds

**Chemiluminescence-based**
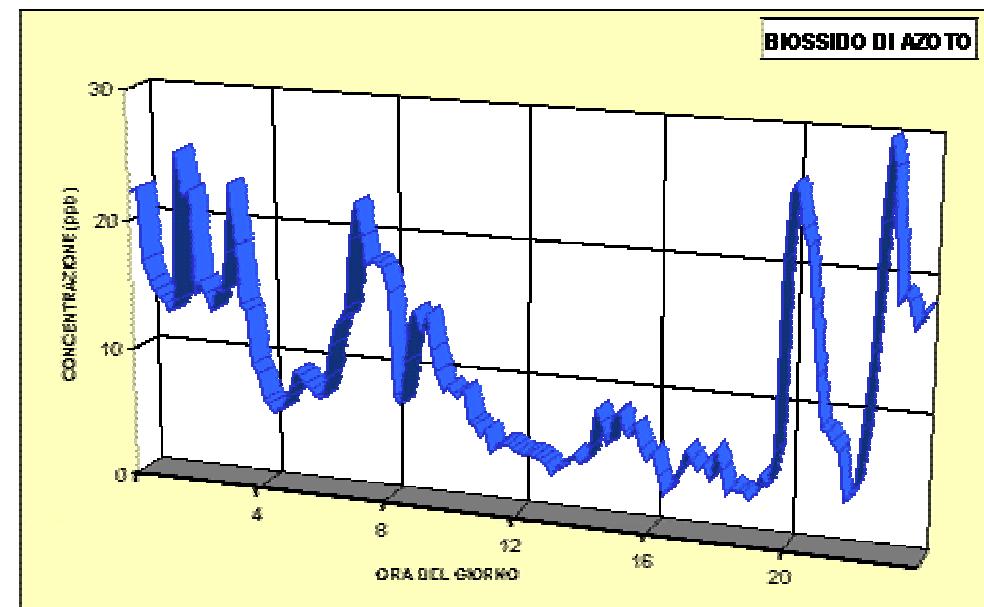
# OZONE ANALYZER

**Ultra Violet (UV) absorption**

**(254 nm)**
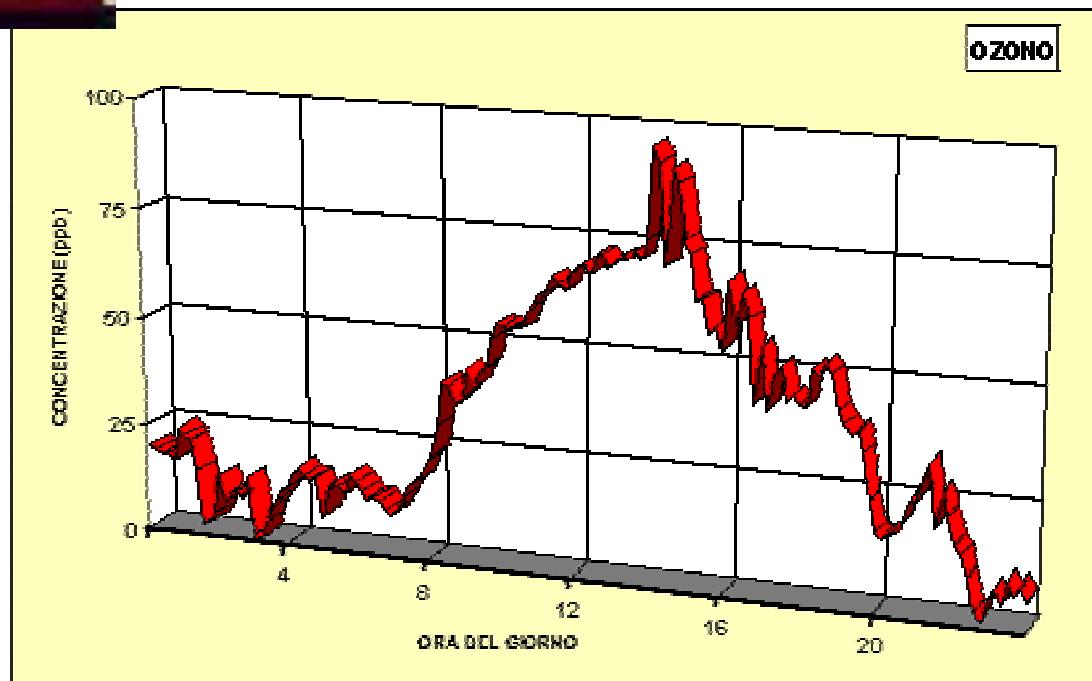
# PAN ANALYZER

**GC-ECD analysis**
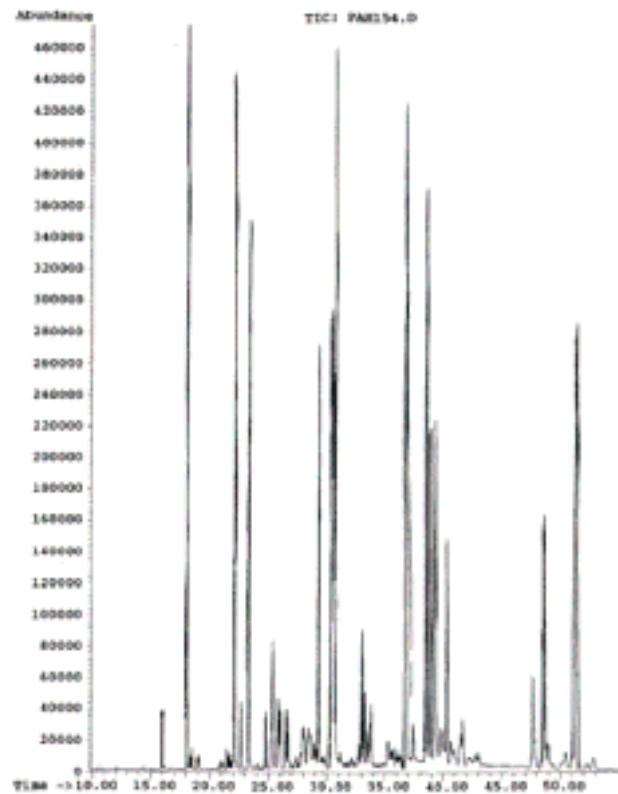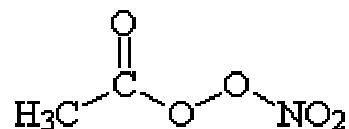
# BTX ANALYZER

Benzene
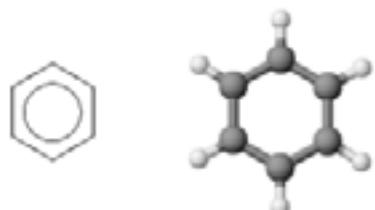
Toluene
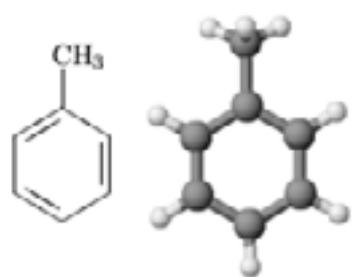
Xylene
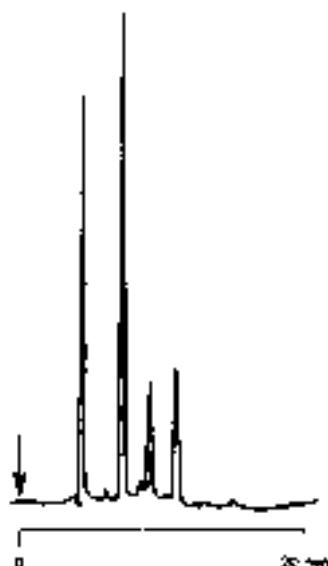
1,2-dimethylbenzene    1,3-dimethylbenzene    1,4-dimethylbenzene
(ortho-xylene)              (meta-xylene)             (para-xylene)

**GC-FID analysis**

# FORMALDEHYDE ANALYZER

### DNPH (DiNitro Phenyl Hydrazine) cartridges
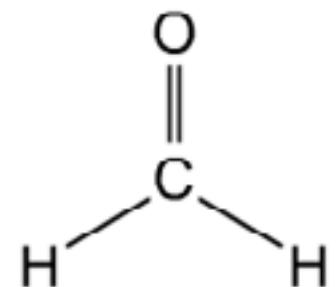


**HPLC analysis**

# PAH AND N-PAH ANALYZER



**HV sampler**



**LV sampler**

**GC-MS analysis**



**Benzo(a)pirene**
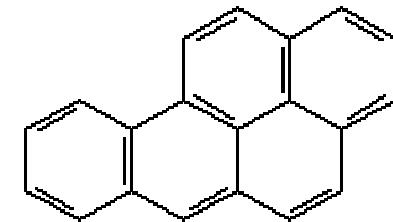


**Nitrofluoranthene**

# STABILITY MONITOR



Stability monitor measures natural radon radioactivity and consists of a particulate matter sampler equipped with a Geiger-counter for determining the total beta activity of the short-lived radon progeny (2h time resolution)

# DOAS

## Differenrential Optical Absorption Spectroscopy

Ultra Violet (UV)

absorption

# DIFFUSION DENUDERS

| | species | concentration range (ppb) |
|---|---|---|
| **GAS** | $SO_2$ | 0.2-30 |
| | $NO_2$ | 0.2-50 |
| | $HNO_3$ | 0.1-20 |
| | $HNO_2$ | 0.2-10 |
| | HCl | 0.05-10 |
| | $NH_3$ | 0.1-20 |
| | | |
| **PARTICLES** | Sulphates | 0.2-40 |
| | Nitrates | 0.1-10 |

# Filters

Air in

Pump

Gas

Particulate matter
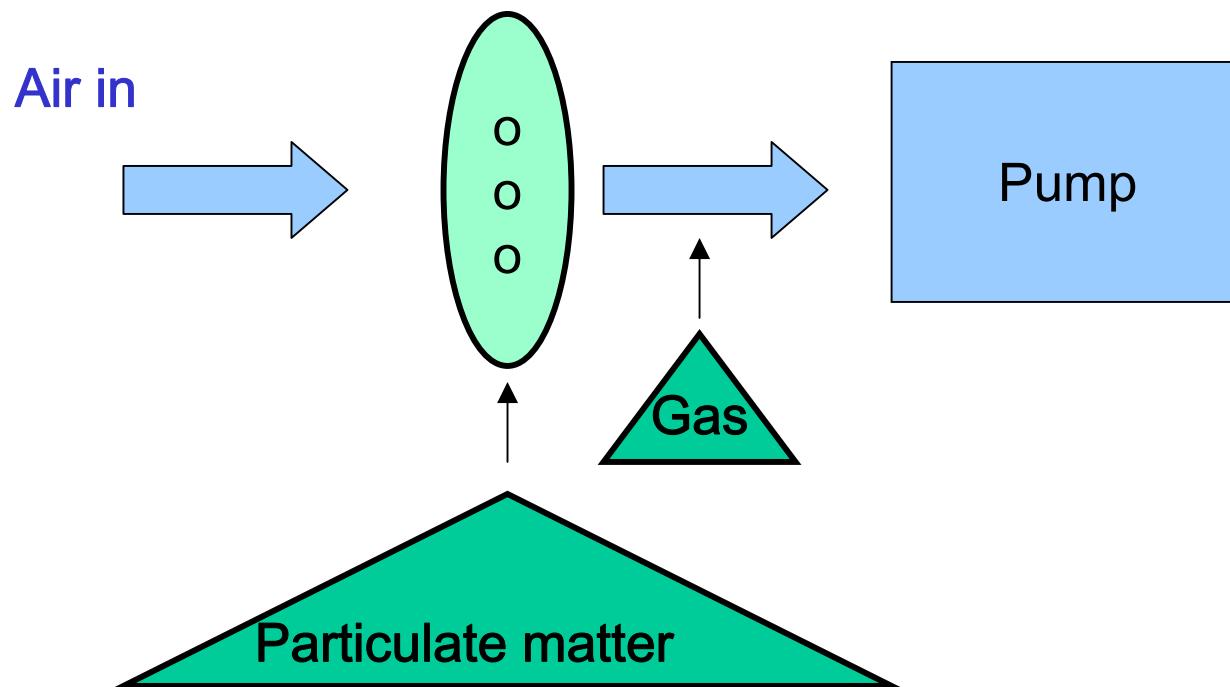
Flow-rate (20 l/min)
Only for particles
Gas-particle interaction effects
Loss of volatile salts

Filters

acid and basic gases

Air in

TEFLON

IMPREG

IMPREG

Pump

Particulate matter
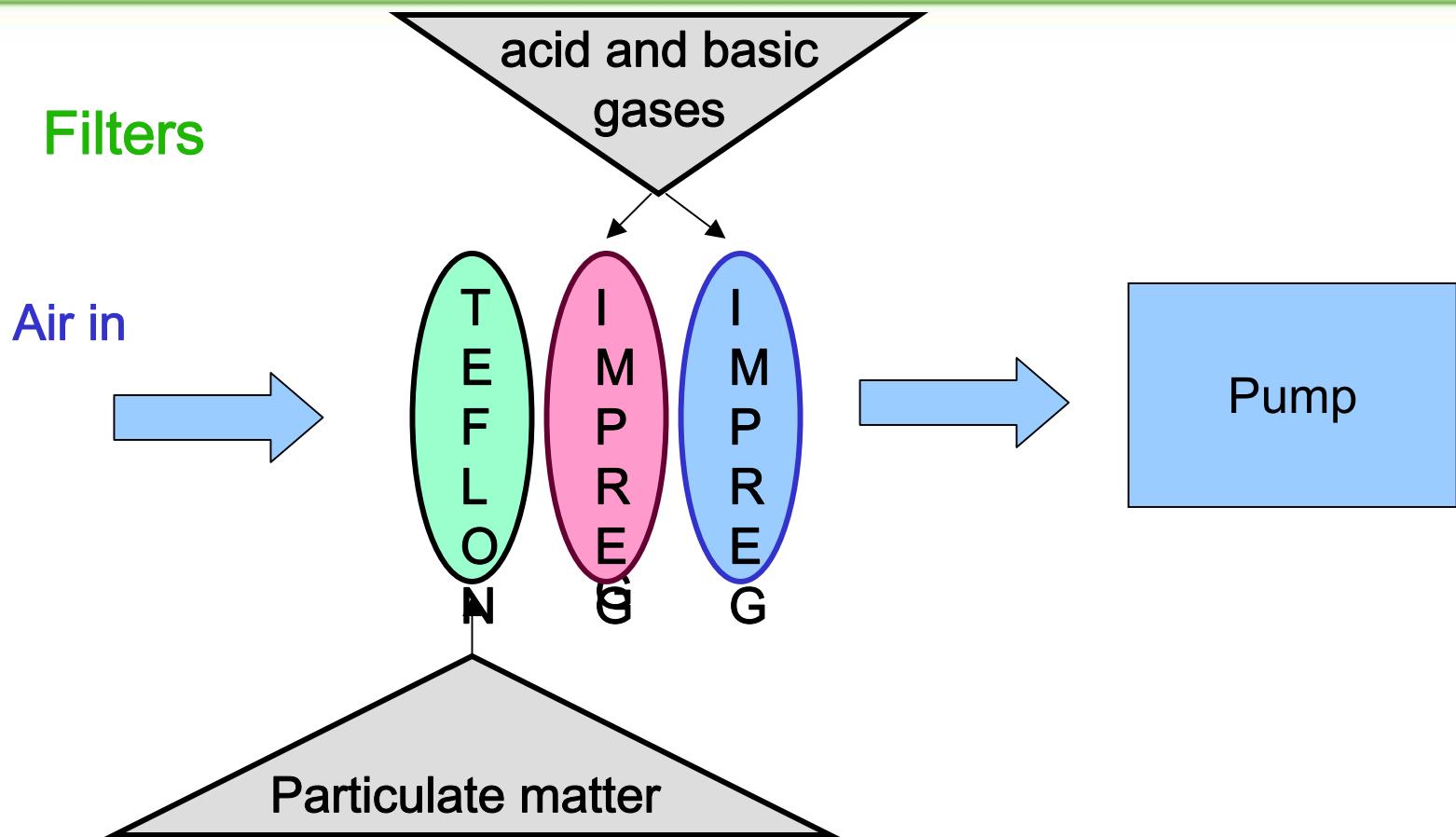
Flow-rate (20 l/min)
For gas and particles
Wrong distinction between gas and particles

## Wrong distinction between gas and particles

Air in:

$HNO_3$, $NH_3$ (gas)

$NH_4NO_3$ (part.)

$NH_4NO_3$    $HNO_3$    $NH_3$

$NH_4NO_3$    $HNO_3$ gas + $HNO_3$ ev.    $NH_3$ gas + $NH_3$ ev.

Under-estimate    Over-estimate

# Cylindrical denuder



Reactive coat
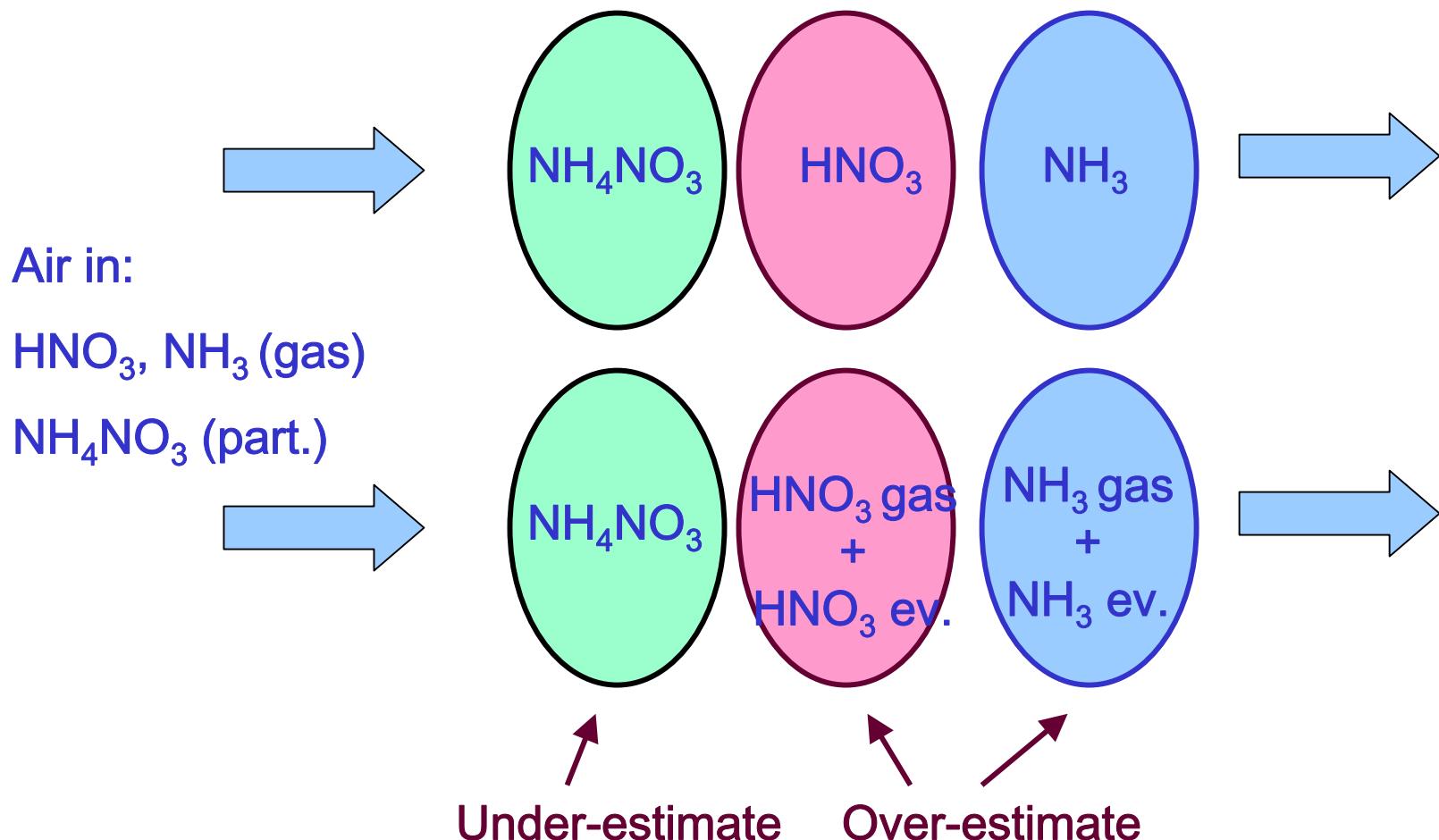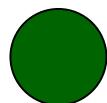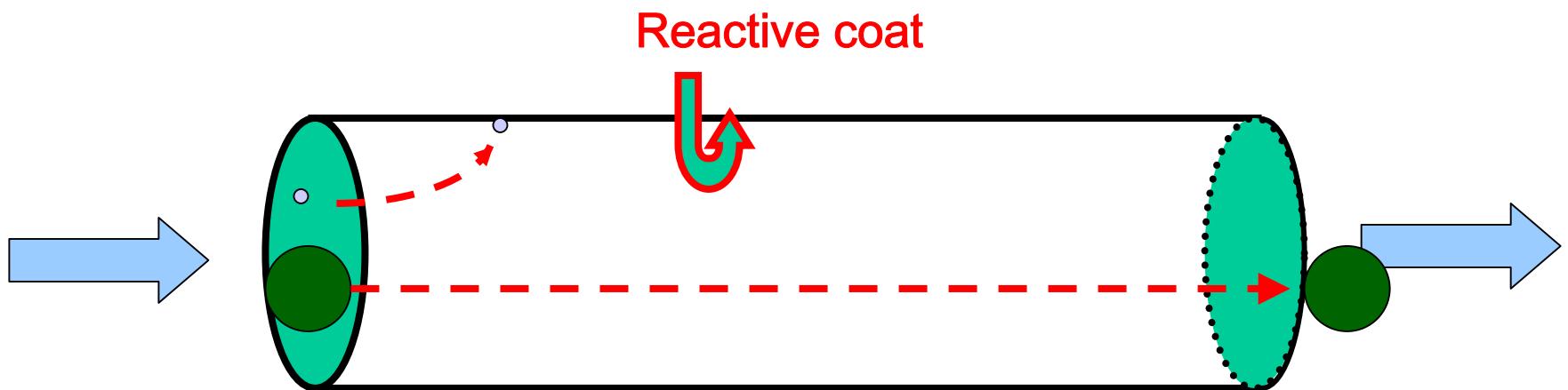
**Particles (low diffusion coefficient)**

**Gas molecule (high diffusion coefficient)**

Flow-rate (2 l/min)
Only for gas

# Annular denuder and filter-pack
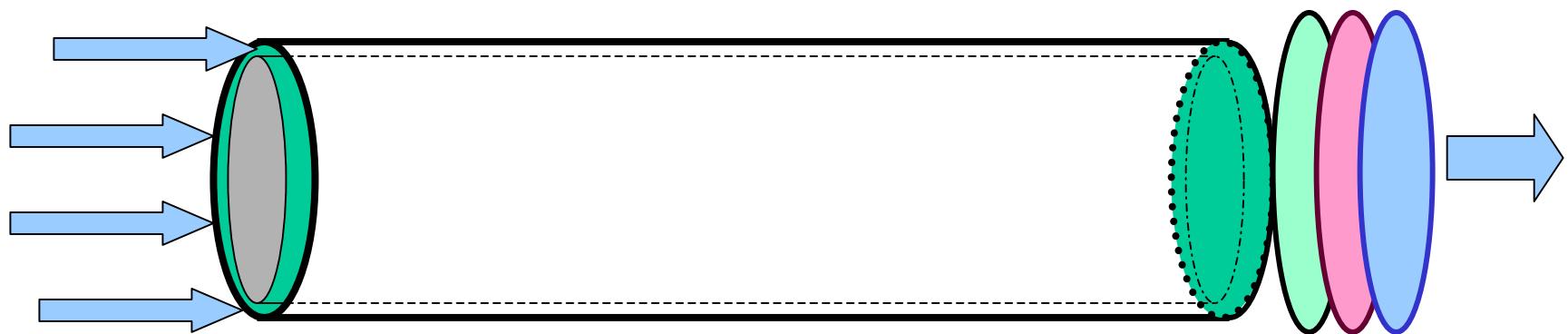


Flow-rate (15 l/min)
Distinction between gas and particles

Nitric acid ($HNO_3$)/Particulate nitrate ($NO_3^-$)
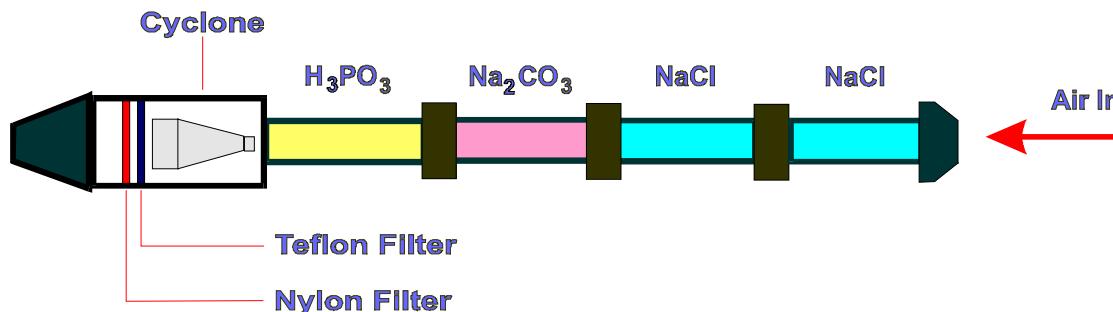


# Cylindrical denuder

Hydrochloric acid (HCl)/Particulate chloride ($Cl^-$)
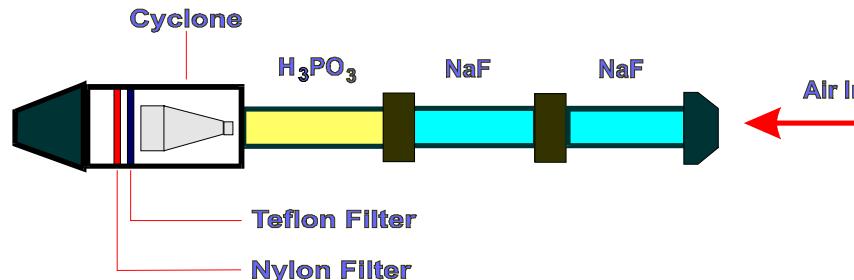
## Nitrous acid (HONO)/Particulate nitrite ($NO_2^-$)



Cyclone · $H_3PO_3$ · $Na_2CO_3$ · $Na_2CO_3$ · TCM · Air In

Nylon Filter
$Na_2CO_3$ Impregnated Filter 1
$Na_2CO_3$ Impregnated Filter 2
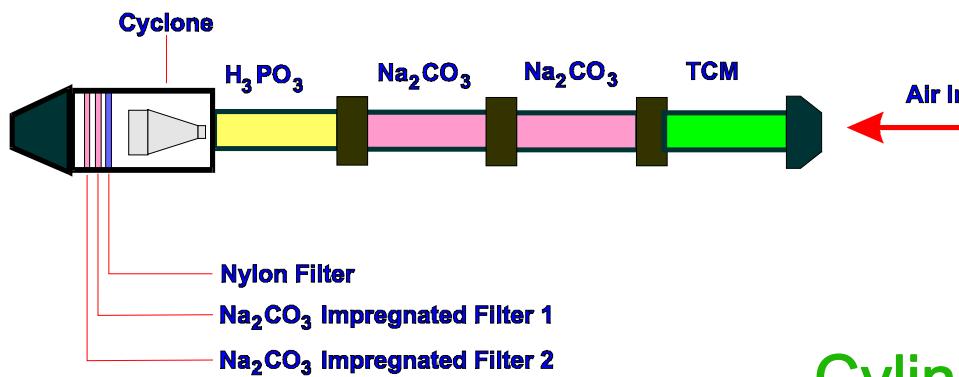
## Cylindrical denuder

## Ammonia ($NH_3$)/Particulate ammonium ($NH_4^+$)



Cyclone · $H_3PO_3$ · $H_3PO_3$ · $Na_2CO_3$ · Air In

Teflon Filter
Nylon Filter
$Na_2CO_3$ Impregnated Filter 1
$Na_2CO_3$ Impregnated Filter 2
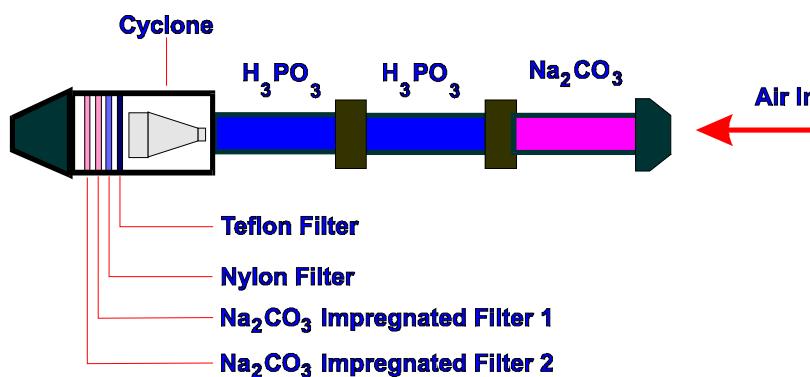
# PASSIVE SAMPLERS

Good for: $SO_2$, $NO_2$, $O_3$, $NH_3$
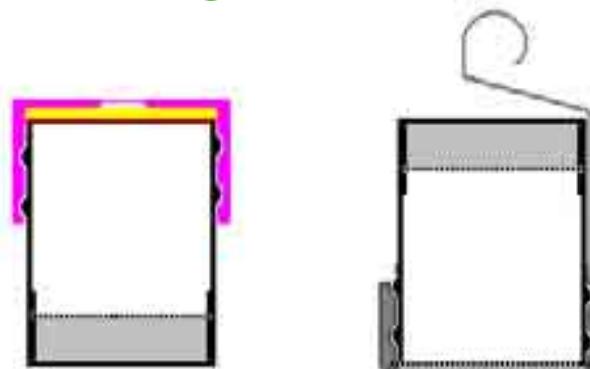
### FICK'S FIRST LAW OF DIFFUSION

A relationship wherein the flux of a diffusing species is proportional to the concentration gradient:

$$J_x = -D\frac{dC}{dx}$$

where

$J_x$ = the flux of the diffusing species;
$dC/dx$ = the incremental change in concentration with distance;
$D$ = diffusivity or diffusion coefficient (the proportionality constant).

# PASSIVE SAMPLERS
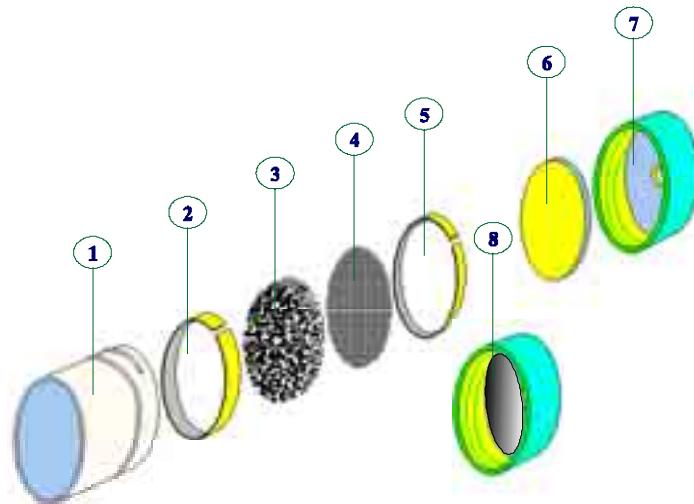


1 -  glass cylinder (*20 mm I.D. x 20 mm diffusive path lenght*)
2 -  viewing stainless steel ring
3 -  adsorbent bed
4 -  stainless steel net
5 -  retaining stainless steel ring
6 -  rubber/Teflon septum
7 -  perforated plastic screw
8 -  removable aluminium and stainless steel disposal (*air barrier*)

# PASSIVE SAMPLERS

## ADVANTAGES OF PASSIVE SAMPLERS

Passive samplers offer some advantages over active sampling devices:

•Simple to use.

•Can be worn in flammable or similar environments.

•Unobtrusive - offer high level of wearer acceptability.

•Not limited by power, as no batteries are required.

•Calibration not required.

•Easy to transport (for analysis).

# PASSIVE SAMPLERS

## DISADVANTAGES OF PASSIVE SAMPLERS

Disadvantages include:

Few badges have been validated for use in compliance work.

Air current, temperature & humidity may affect accuracy.

Susceptible to cross contamination.

# PM$_{10}$ LEVELS

## Air Concentration trend in Florence



Chart: PM$_{10}$ air concentration trend in Florence (µg/m$^3$), quinquennial means

Legend: traffic (dark blue), background (light blue)

| quinquennial means | traffic | background |
|---|---|---|
| 1985-1989 | — | 59 |
| 1990-1994 | 66 | 47 |
| 1995-1999 | 49 | 38 |
| 2000-2004 | 47 | 41 |

# SO$_2$ LEVELS

## *Air Concentration trend in Florence*



μg/m$^3$

Chart showing SO$_2$ air concentration (quinquennial means):
- 1985-89: 45
- 1990-94: 21
- 1995-99: 8
- 2000-04: 3

quinquennial means

# NO$_2$ LEVELS

## Air Concentration trend in Florence



μg/m$^3$

Chart:
- Legend: traffic (dark blue), background (light blue)
- Y-axis: 0 to 100

| quinquennial means | traffic | background |
| --- | --- | --- |
| 1985 -89 | | |
| 1990 -94 | 89 | 54 |
| 1995 -99 | 87 | 47 |
| 2000 -04 | 78 | 41 |

quinquennial means

# CO LEVELS

## *Air Concentration trend in Florence*
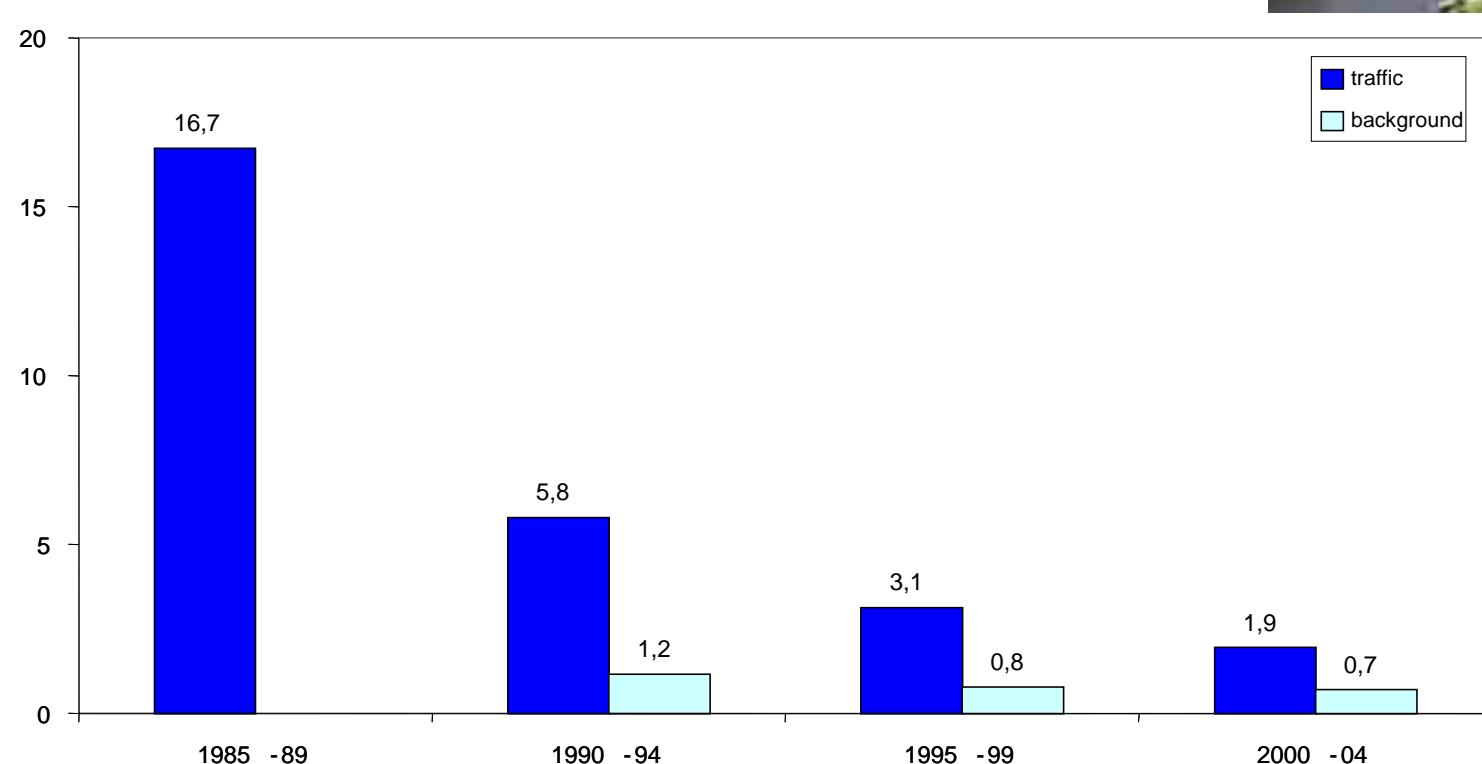


quinquennial means

# BENZENE LEVELS

## *Air Concentration trend in Florence*
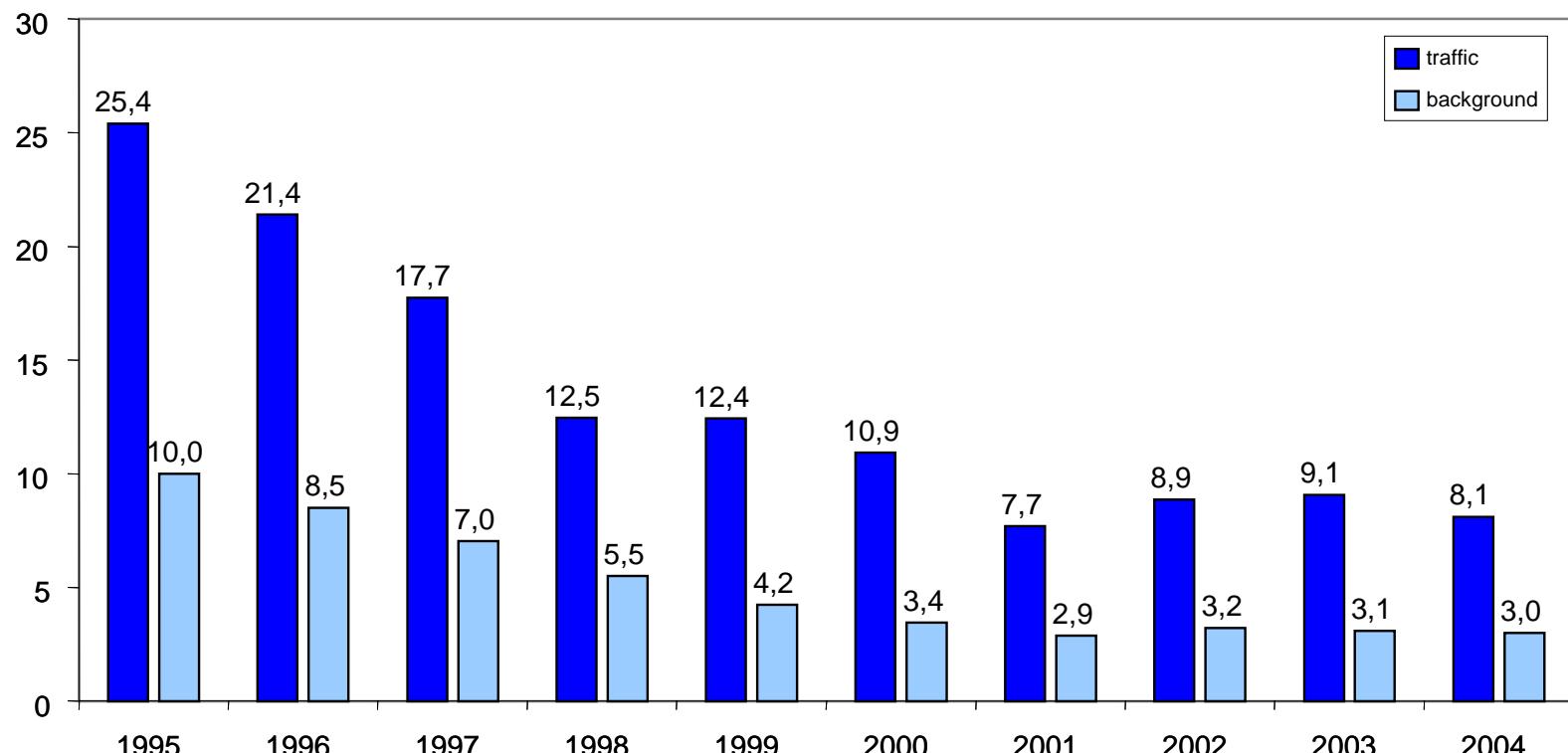


annual means

# PTS LEVELS

## *Air Concentration trend in Milan*



**Media annua MILANO Polveri Totali Sospese
Juvara e V.le Liguria**
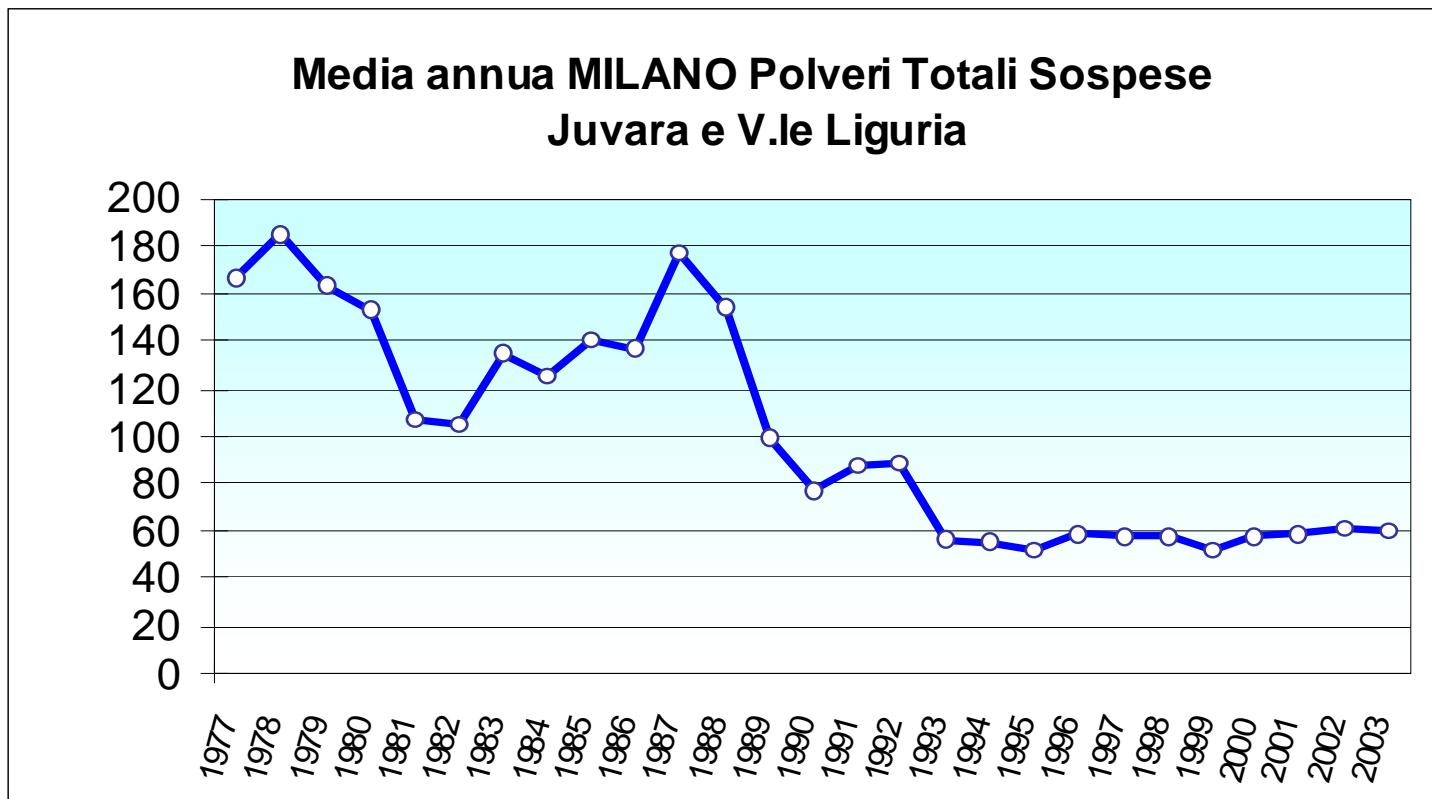
annual means

# SO$_2$ LEVELS
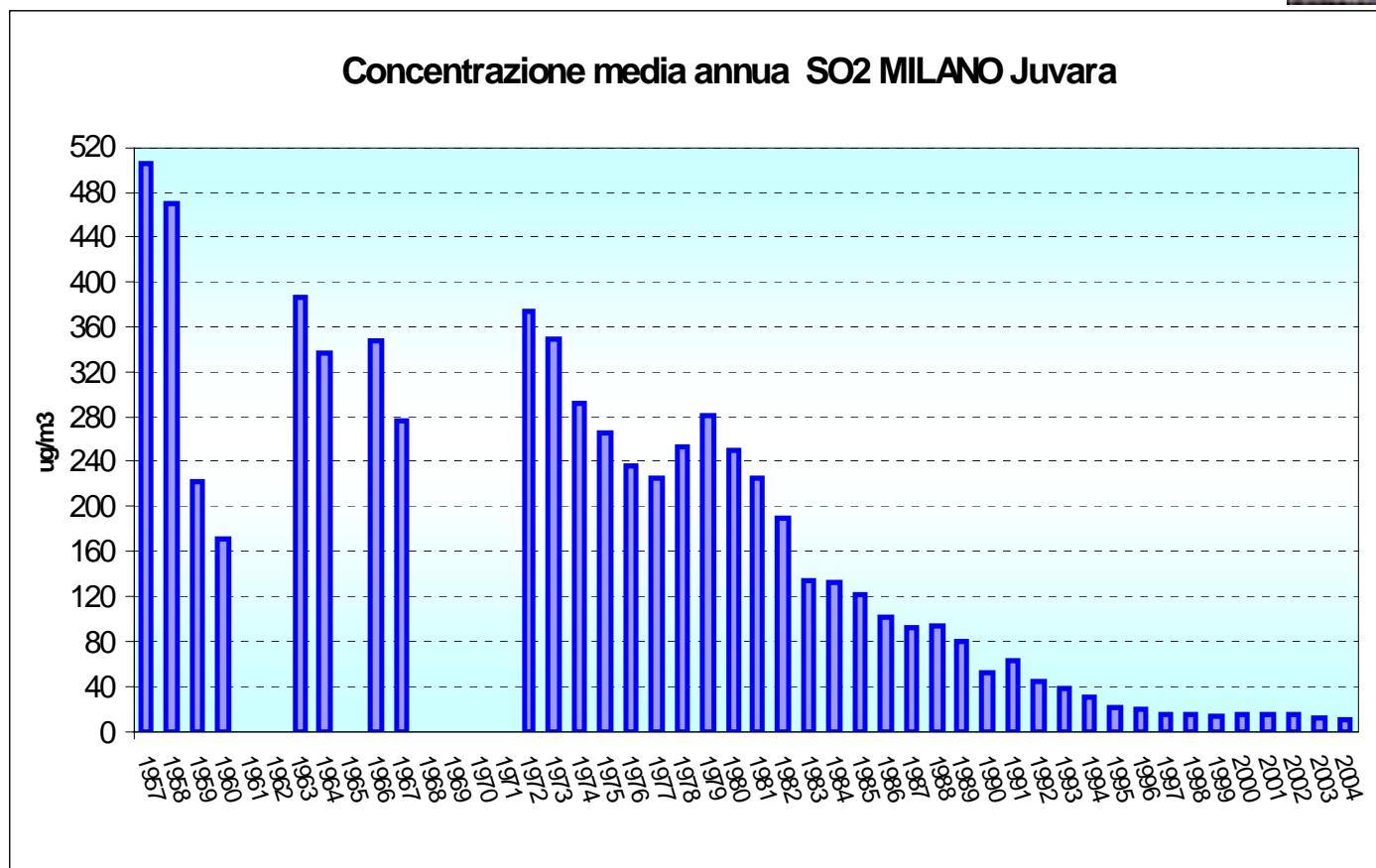
## *Air Concentration trend in Milan*



annual means

# NO$_2$ LEVELS

## *Air Concentration trend in Milan*



**MEDIA ANNUA BIOSSIDO DI AZOTO NO2**
**MILANO - Juvara**

annual means

# CO LEVELS

## *Air Concentration trend in Milan*

**MEDIA ANNUA MONOSSIDO DI CARBONIO CO
MILANO - Marche**
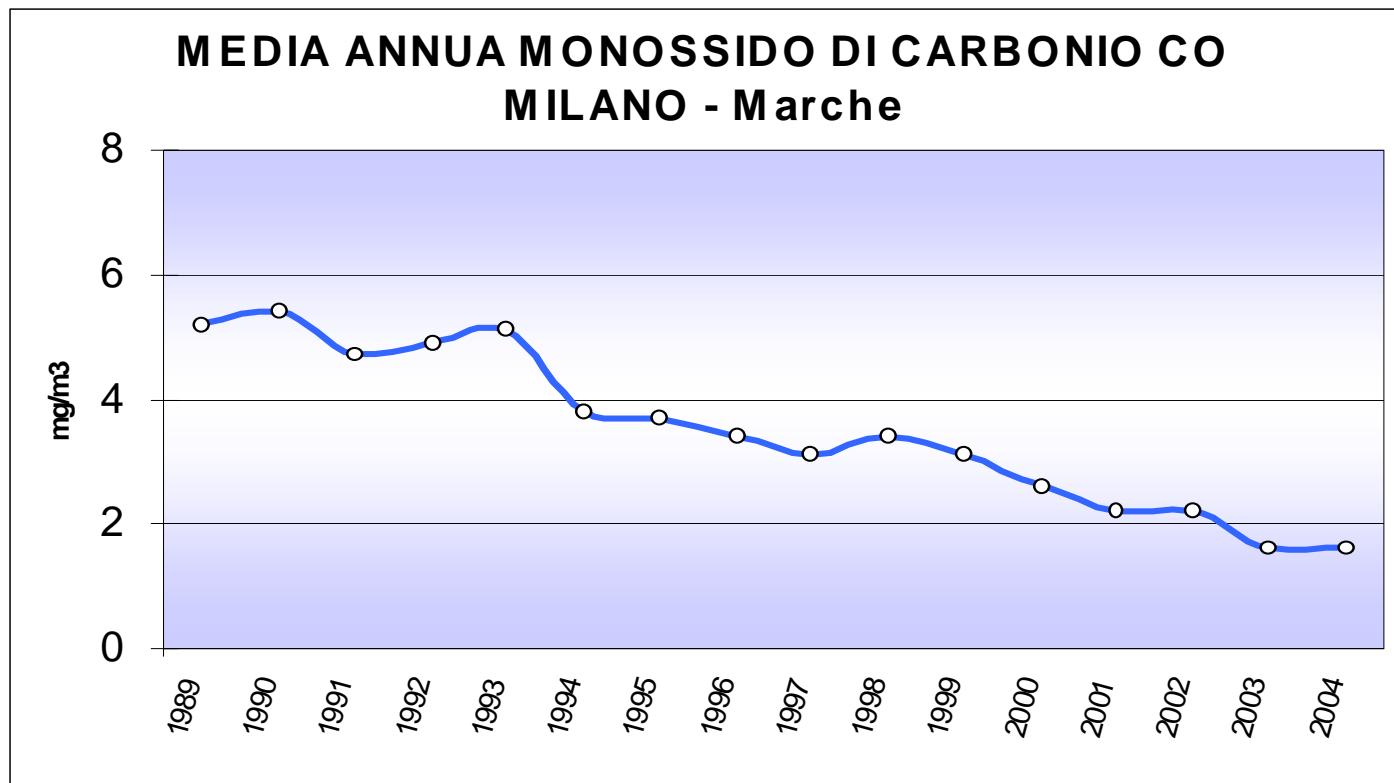
annual means

# BENZENE LEVELS

## *Air Concentration trend in Milan*



Città di Milano - Benzene

annual means