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Air Sampling for Particulate Matter

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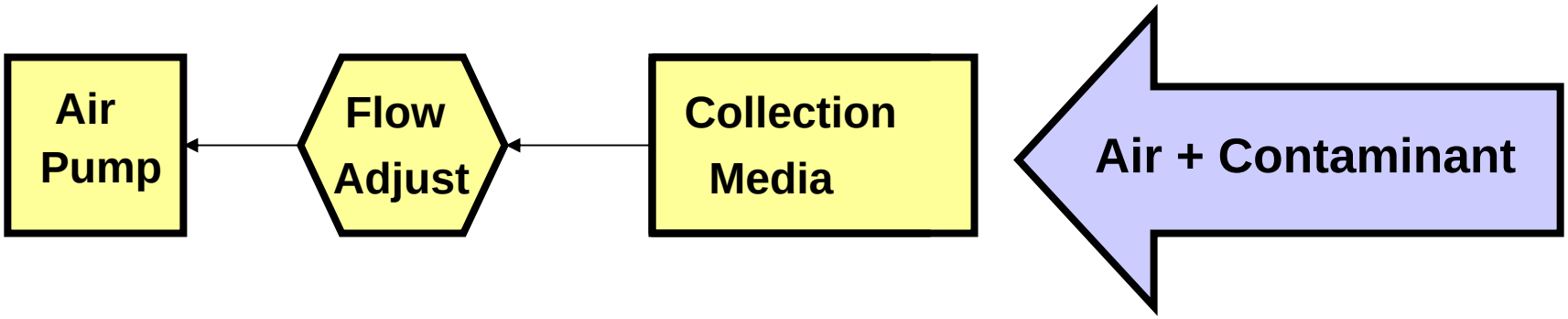
Section A

Introduction

Exposure Assessment Methods

- General air-sampling methodology



General Sampling Methodology

- Personal sampling
  - Battery powered pump worn by worker
- Sample from “breathing zone”
- Area sampling
  - Sample from fixed location

Concentration

$$\text{Concentration} = \frac{\text{Mass}_{\text{contaminant}}}{\text{Volume}_{\text{air}}}$$

- Contaminant mass from laboratory analysis
- Air volume from product of calibrated air flow rate and sampling time

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Section B

Sample Pumps and Volume Determination

Personal Sampling Pumps

Source: Patrick Breysse

Sample Volume

$$V = Q\ T$$

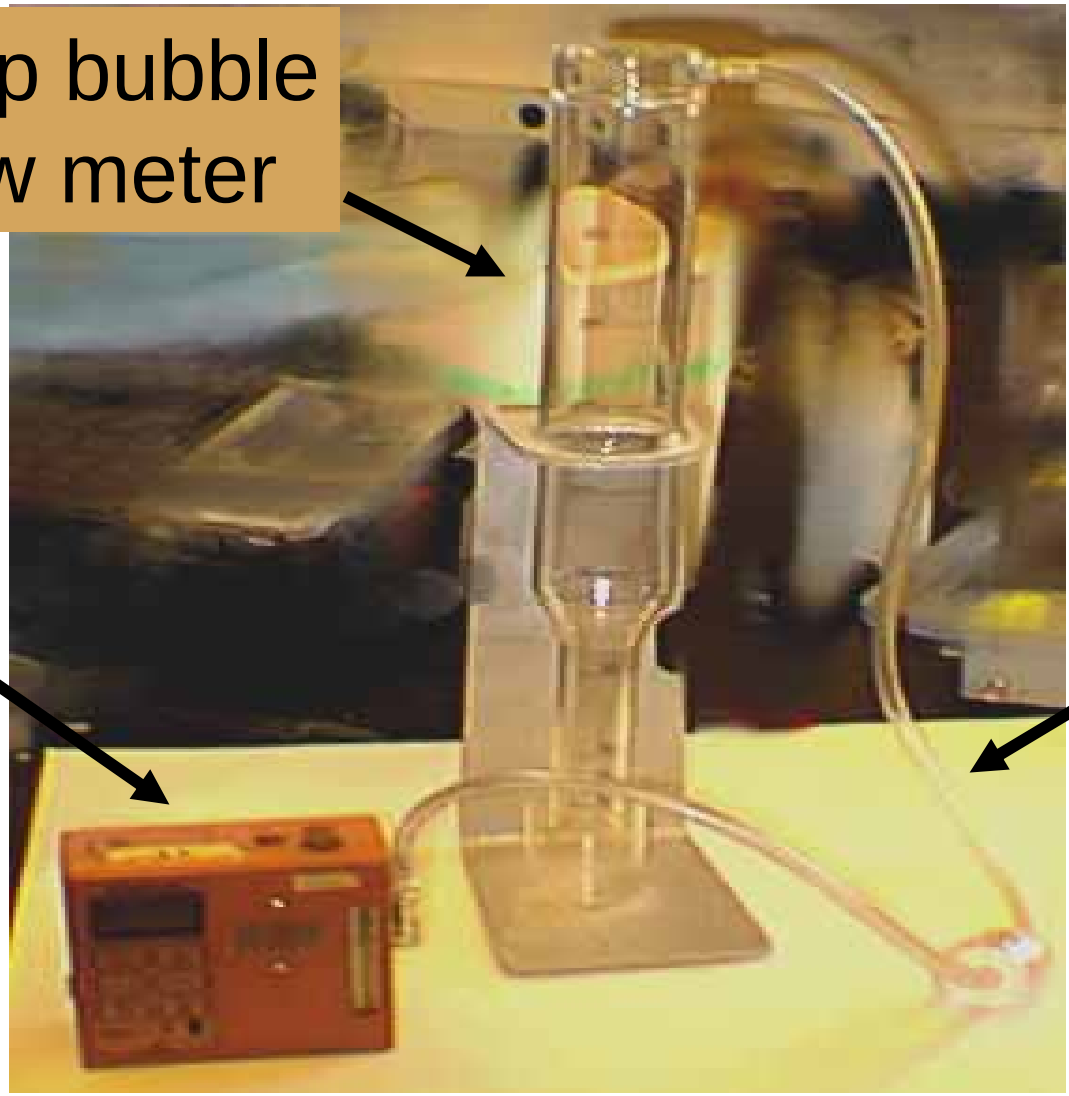
- Where V is volume, L
- Q is flow rate, L/min
- T is sample time, min

$$(2.5\,\mathrm{L/min})(480\,\mathrm{min}) = 1{,}200\,\mathrm{L}$$

$$(1{,}200\,\mathrm{L})(1\,\mathrm{m^3}/1000\,\mathrm{L}) = 1.2\,\mathrm{m^3}$$

Source: U. S. Government

Pump Calibration



Source: Patrick Breysse

Frictionless Piston Flow Meter

Source: Patrick Breysse

Soap Bubble Flow Meter

- Measure time required for bubble to move through specified volume in burette

$$\left(\frac{1.0\,\mathbf{L}}{30\ \mathbf{sec}}\right)\left(\frac{60\ \mathbf{sec}}{\mathbf{min}}\right)=2.0\,\mathbf{L}\,\mathbf{/}\,\mathbf{min}$$

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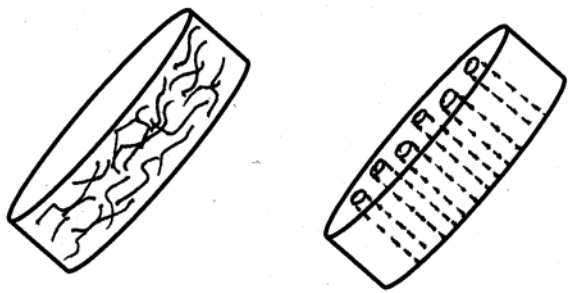
Section C

Sample Collection

Sampling for Aerosols

- Filtration is method of choice
- Filter defined by composition, diameter, and pore size
- General classes of filters used:
  - Membrane filter
  - Nuclepore filter



Source: Peter Lees

Filter Selection

- Membrane filter types
  - Mixed cellulose ester (MCE)
  - Teflon
  - Polyvinyl chloride
- Filter type selected primarily for compatibility with analytical method

Continued

Filter Selection

- MCE filters
  - Clears for microscopy
  - Particle counting and sizing
  - Fiber counting (asbestos)
- PVC filters
  - Do not absorb water vapor
  - Stable for gravimetric analysis

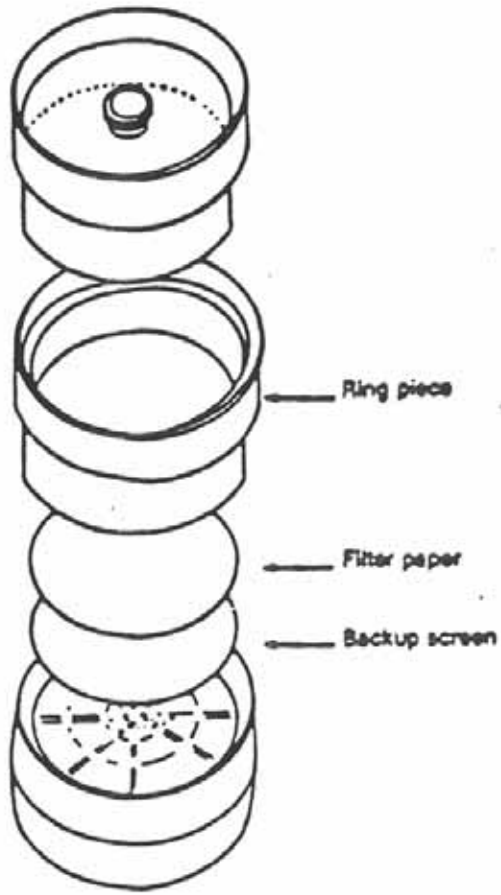
Continued

Filter Selection

- Teflon filters
  - Low tare weight
  - Low mass gravimetric analysis

37 mm Filter Cassette

- Plastic cassette holds filter paper
- Filter collects "total" dust
- Filter diameter is 37 mm



Retaining Ring

Filter paper

Support Pad

Source: Peter Lees

Continued

37 mm Filter Cassette

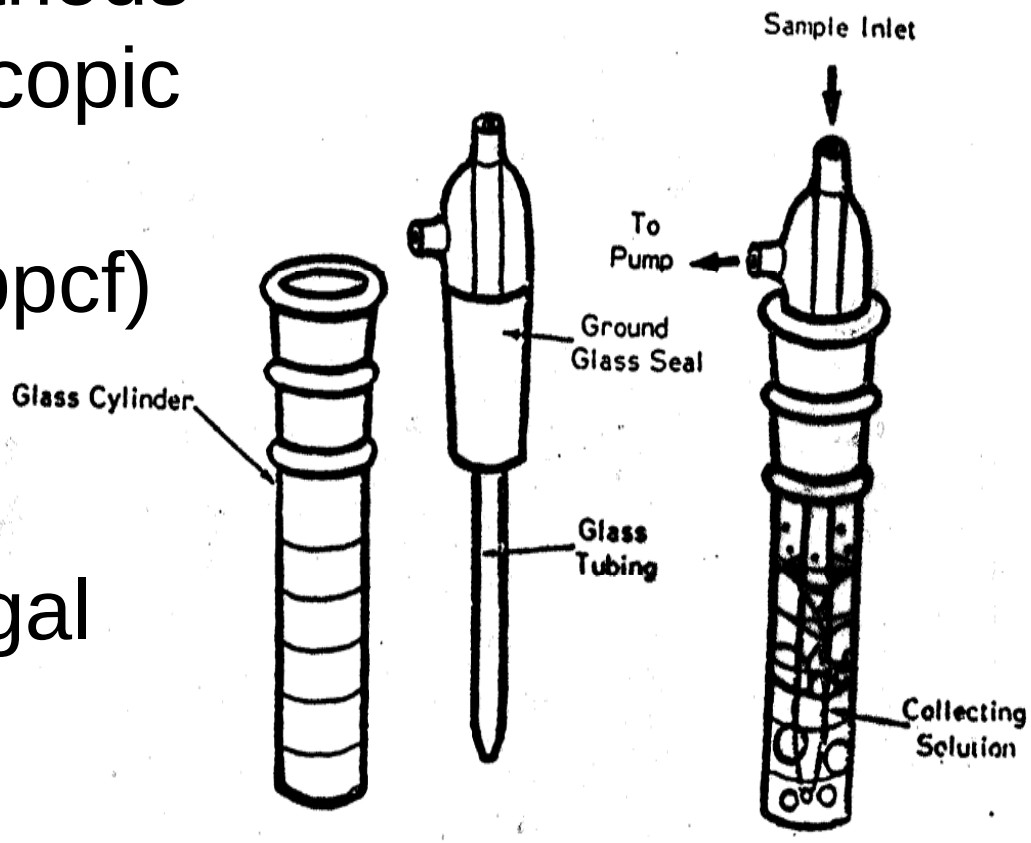
Source: Patrick Breysse

Filter Analysis

- Gravimetric (pre-weight minus post-weight)
- Specific contaminant analysis
  - Metals
  - Silica
  - Fibers
  - Polyaromatic hydrocarbons

Impingers

- Old dust methods used microscopic counting of particles (mppcf)
- Current bioaerosol method (fungal spores and bacteria)



Source: U. S. Government

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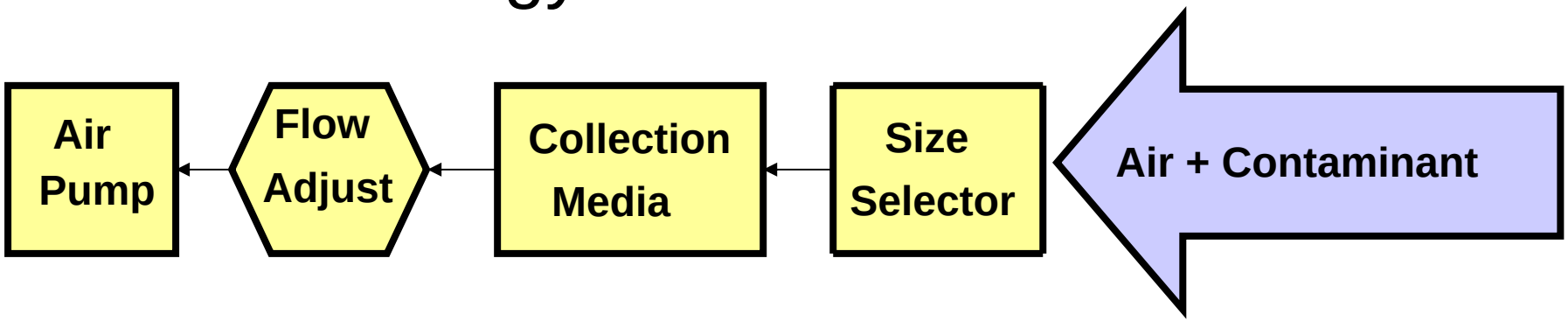
Section D

Size-Selective Samplers

Exposure Assessment Methods

- Size-selective air-sampling methodology



- Size selector permits collection of more biologically-relevant aerosol fraction
  - Respirable fraction, thoracic fraction, inhalable fraction, PM10, PM 2.5

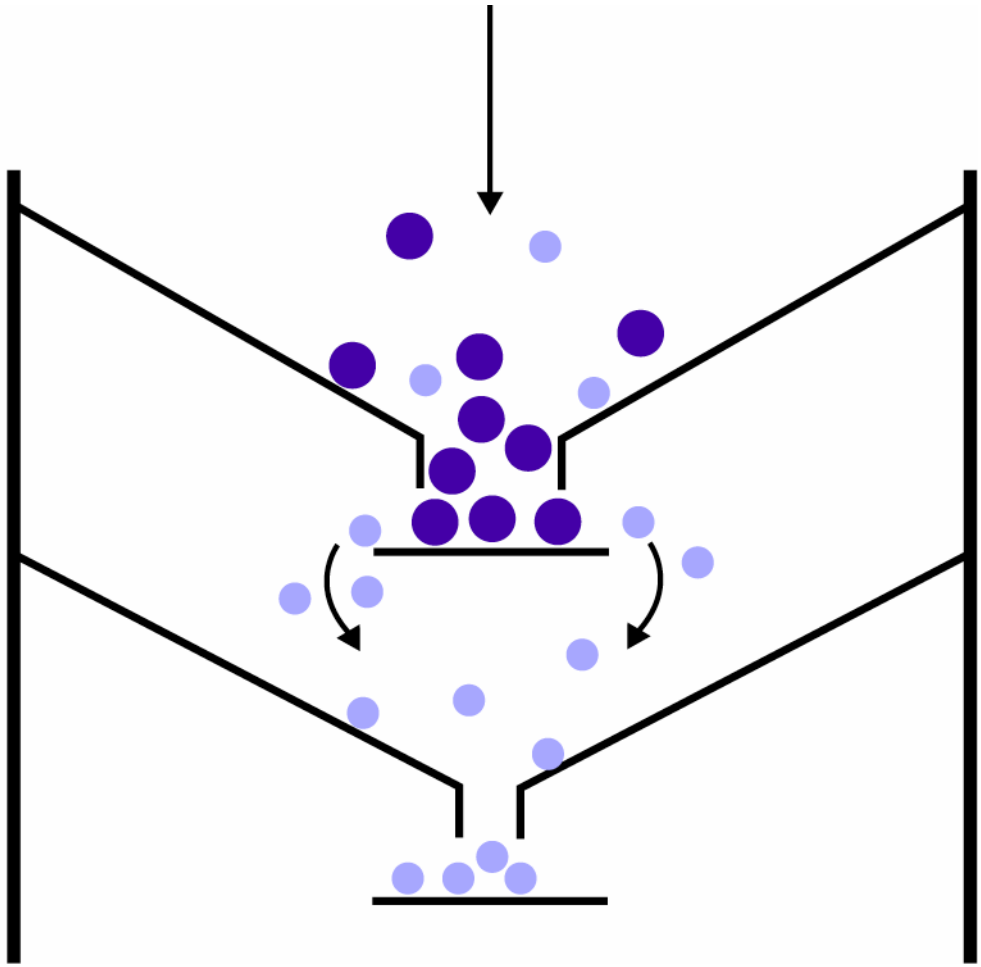
Size Selection: Impactors

- Multistage or single stage
- Multiple fractions of varying size ranges possible
  - Can be used to determine complete size distribution
- Flow rate dependent
- Commonly used for bioaerosol assessment
- Mostly area-type measurement because high flow rate required

S-Stage Impactor Schematic

Large jet, low velocity =
Large particle collection

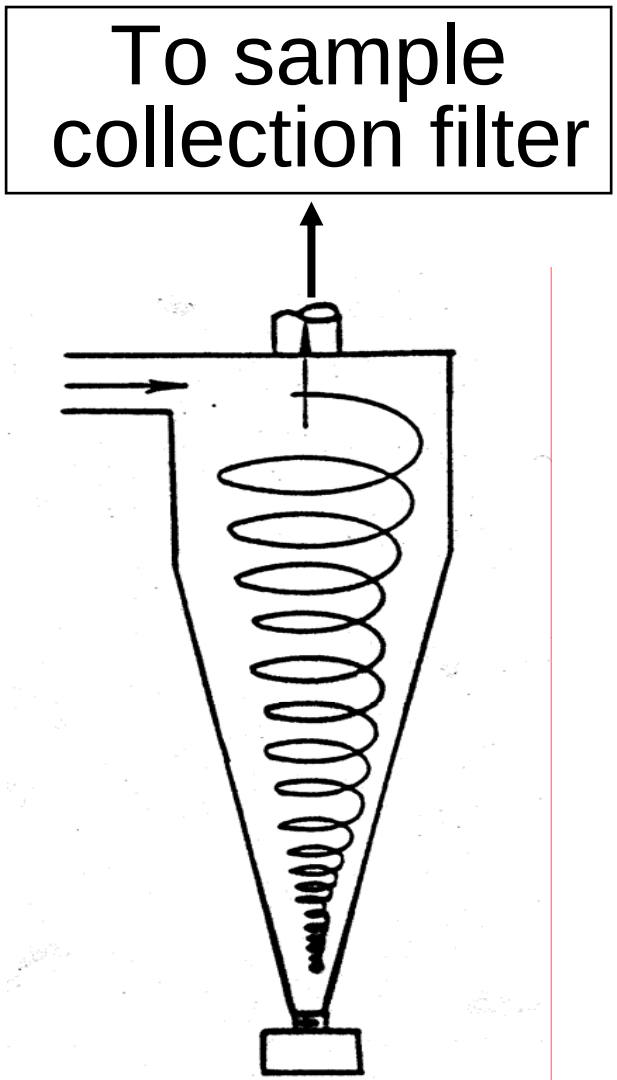
Small jet, high velocity =
Small particle collection



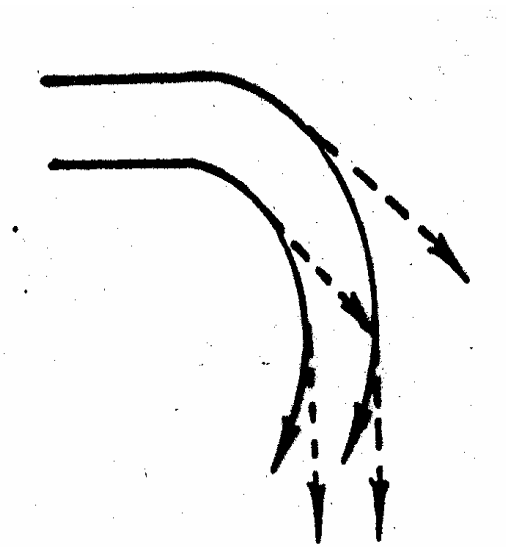
Size Selection: Cyclones

- Cyclones are commonly used size-selective samplers
- Used to define respirable particle sampling criteria
  - Cyclone removal mimics respiratory system when operated
  - Flow rate is critical

Cyclone Samplers

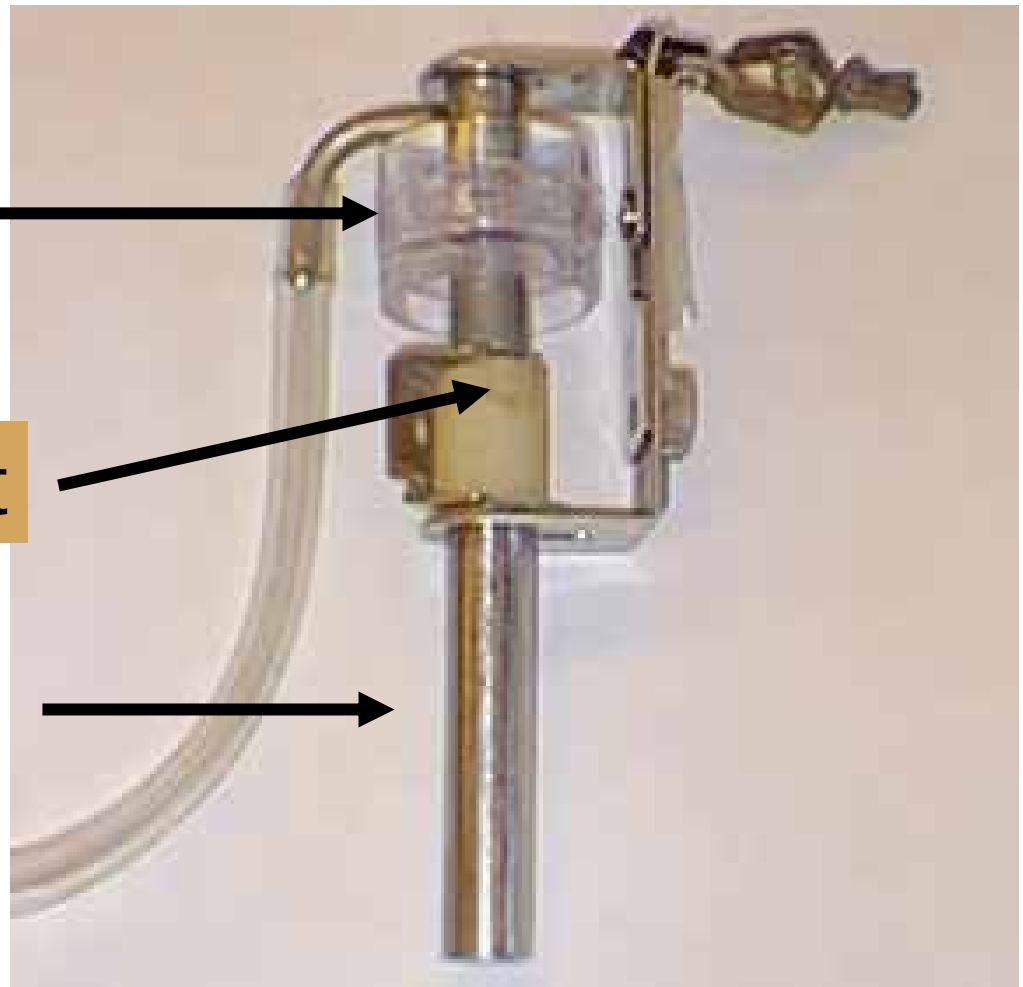


Inertial Impaction



Source: U.S. Government

10 mm Dorr-Oliver Cyclone

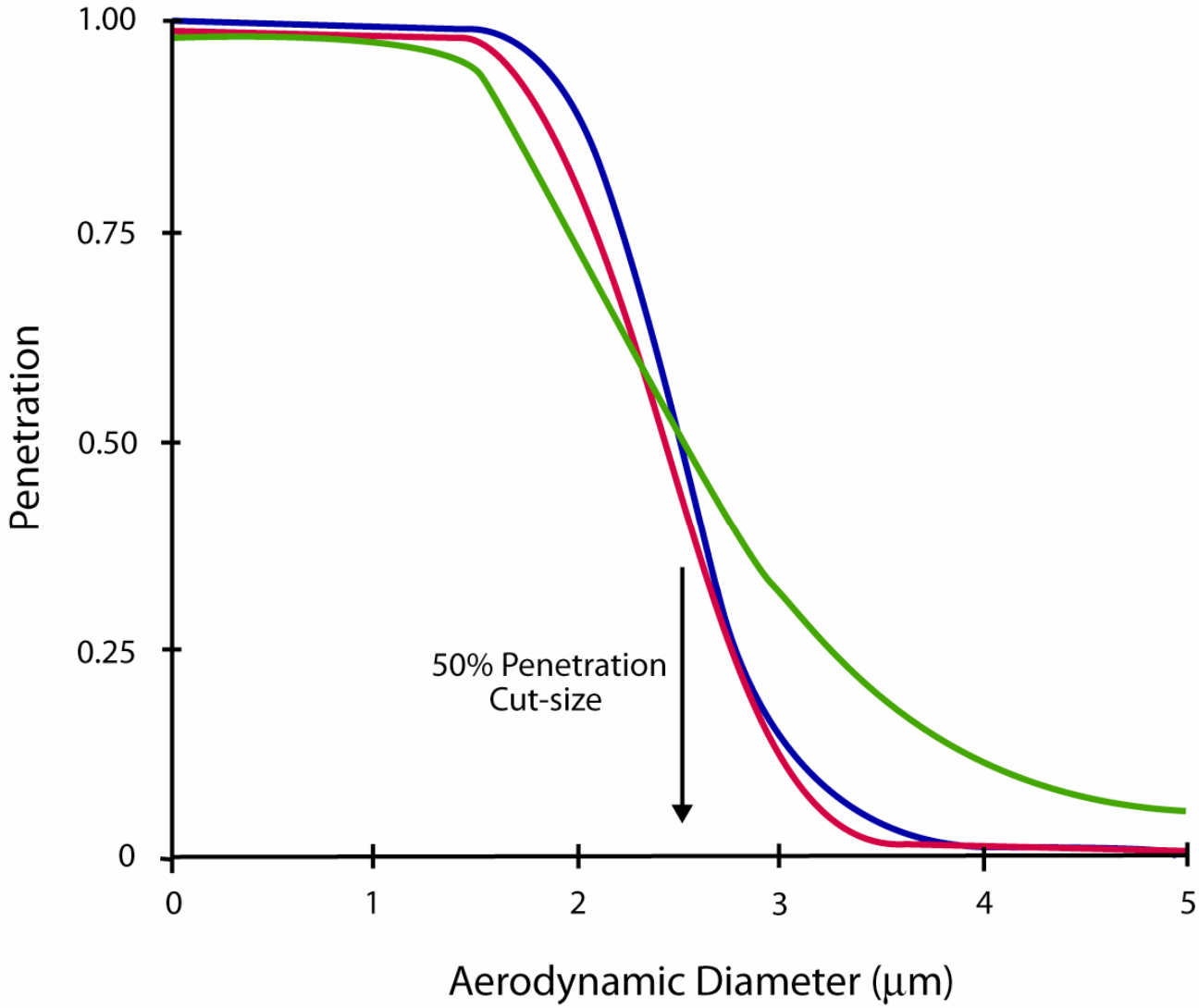


Source: Patrick Breysse

Personal P10 and PM2.5 Impactors

- EPA regulates particles <10 um (PM10) and <2.5 um (PM2.5)
- Sampled using impactors (personal and area samplers)
- Used in non-occupational sampling associated with ambient air pollution
  - Childhood asthma studies
  - Effects of PM on mortality
  - COPD Studies

Cyclone/Impactor Performance



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Section E

Direct-Reading Instruments

Direct-Reading Instruments

- Based on light scattering
  - Intensity of scatter light is proportional to concentration
  - Require calibration
  - Effected by humidity
- Incorporate data logger so can get concentration over time