

Exposure and dose relationships of airborne Engineered Nanoparticles (ENP) in the environment

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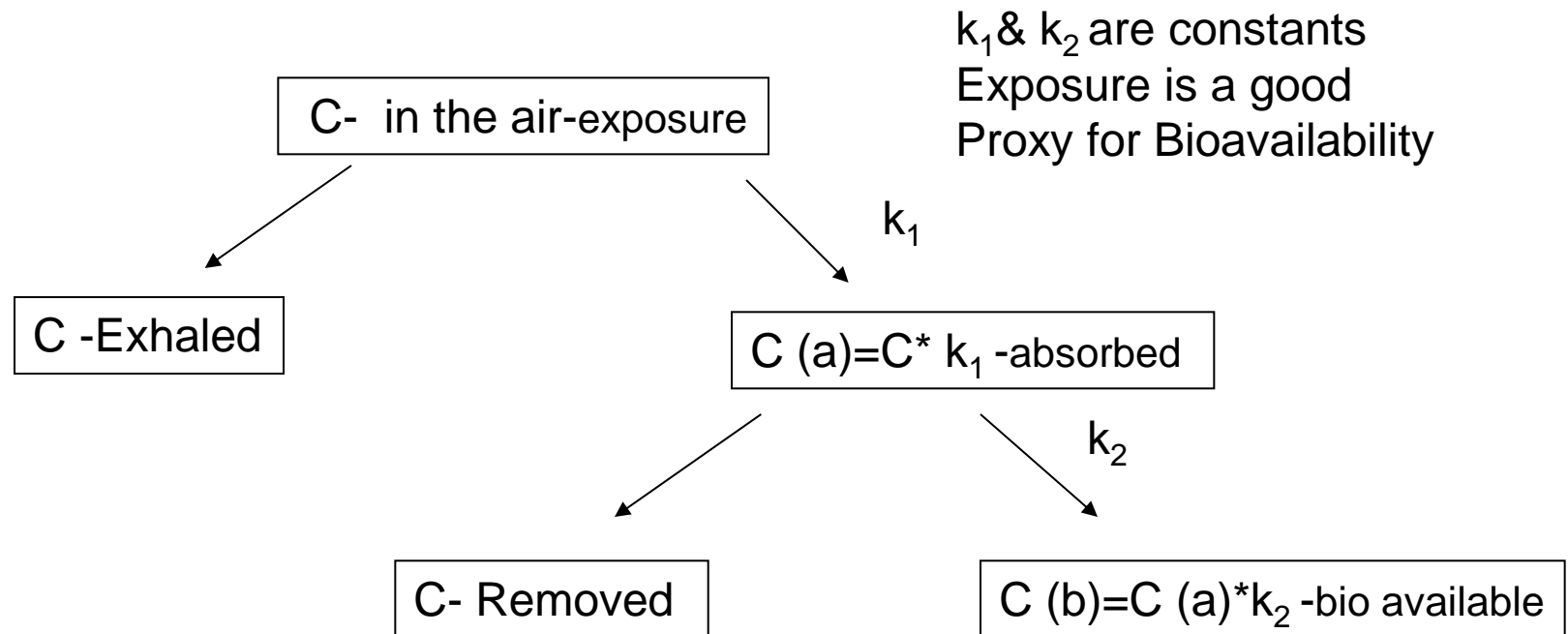
Risk Assessment- Airborne Exposure To ENP

Conventional model

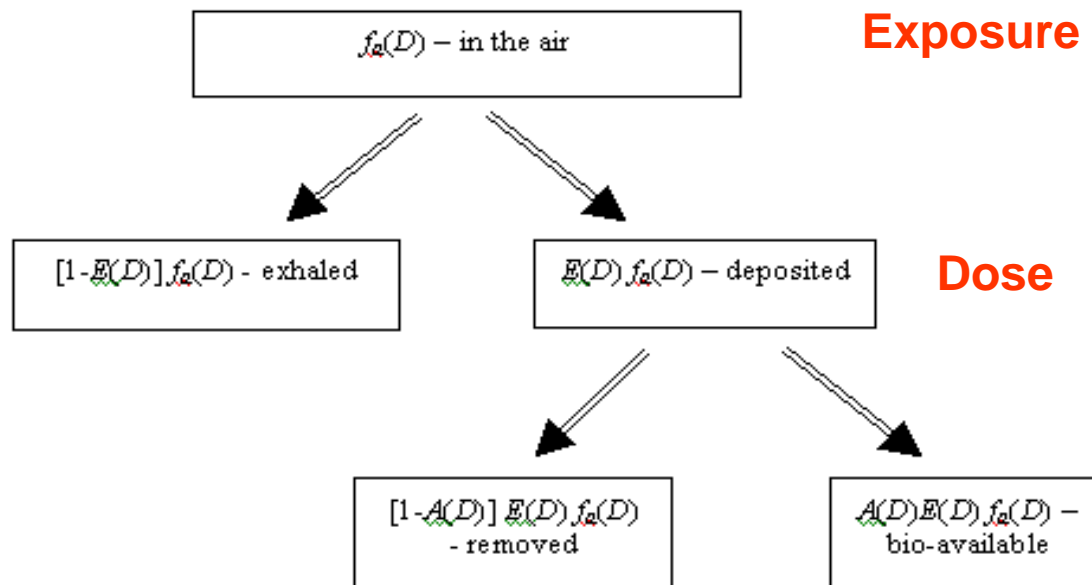
$$\text{Risk} = \text{Exposure} \times \text{Hazard}$$

- Are nanoparticles different?
- What should we measure?
- How should we measure it?

Gases and Vapours- Pathways to Body Organs



Aerosol **particle** pathways from the air to body organs



Airborne particles are different from gases and are characterised by size distributions which affect deposition in the respiratory system.

Bio-available dose

Challenges for health risk evaluation:

1. Detection of very low ENP concentrations against background aerosols:
 - Discrimination of the target ENP;
 - Sensitivity of the detection method;
2. Exposure – Dose relationship:
 - Evaluation of deposition dose in the respiratory system;
 - Bioavailability of deposited ENP

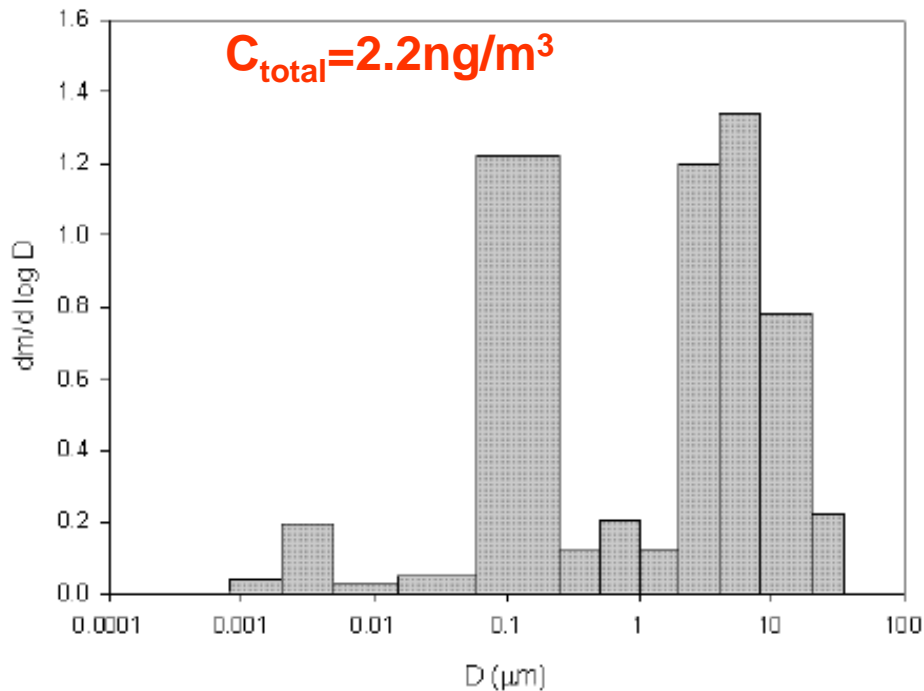
Nano-ID: A unique tool for a size-resolved ENP-selective detection



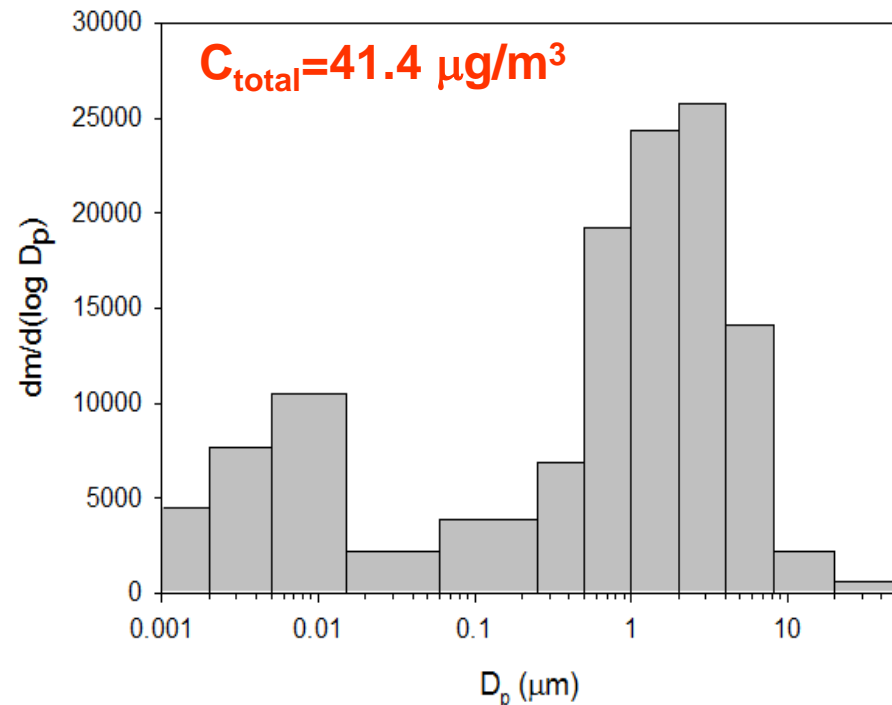
- Unique capabilities to size resolve airborne particles with diameters from 2nm to 30 μm
- Samples suitable for analysis techniques such as atomic absorption spectroscopy, IPRC, SEM and TEM, etc.

Challenge 1: Detection of very low ENP concentration against background obtained with Nano-ID

Ag ENP

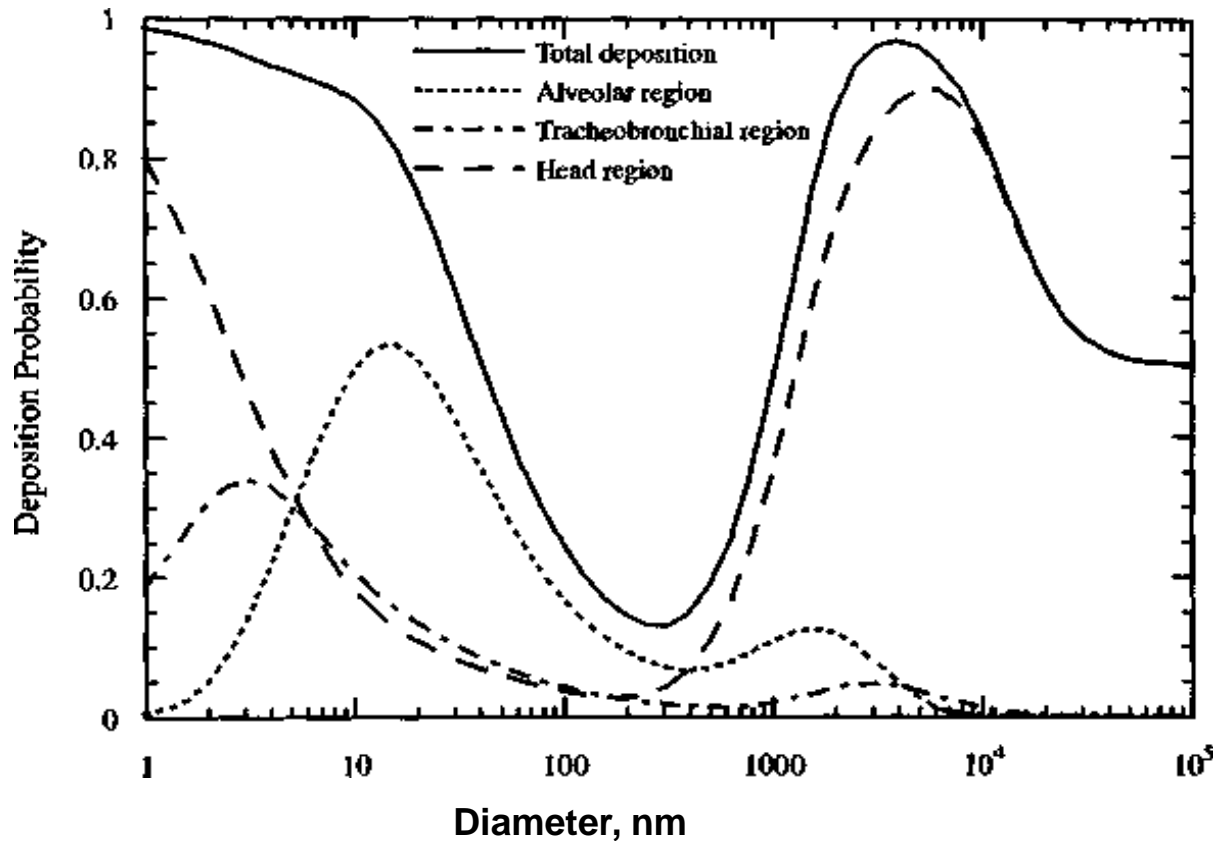


Atmospheric Aerosol (Background)



Challenge 2: Exposure – Dose relationship is size sensitive

Particle Deposition in the Respiratory Tract

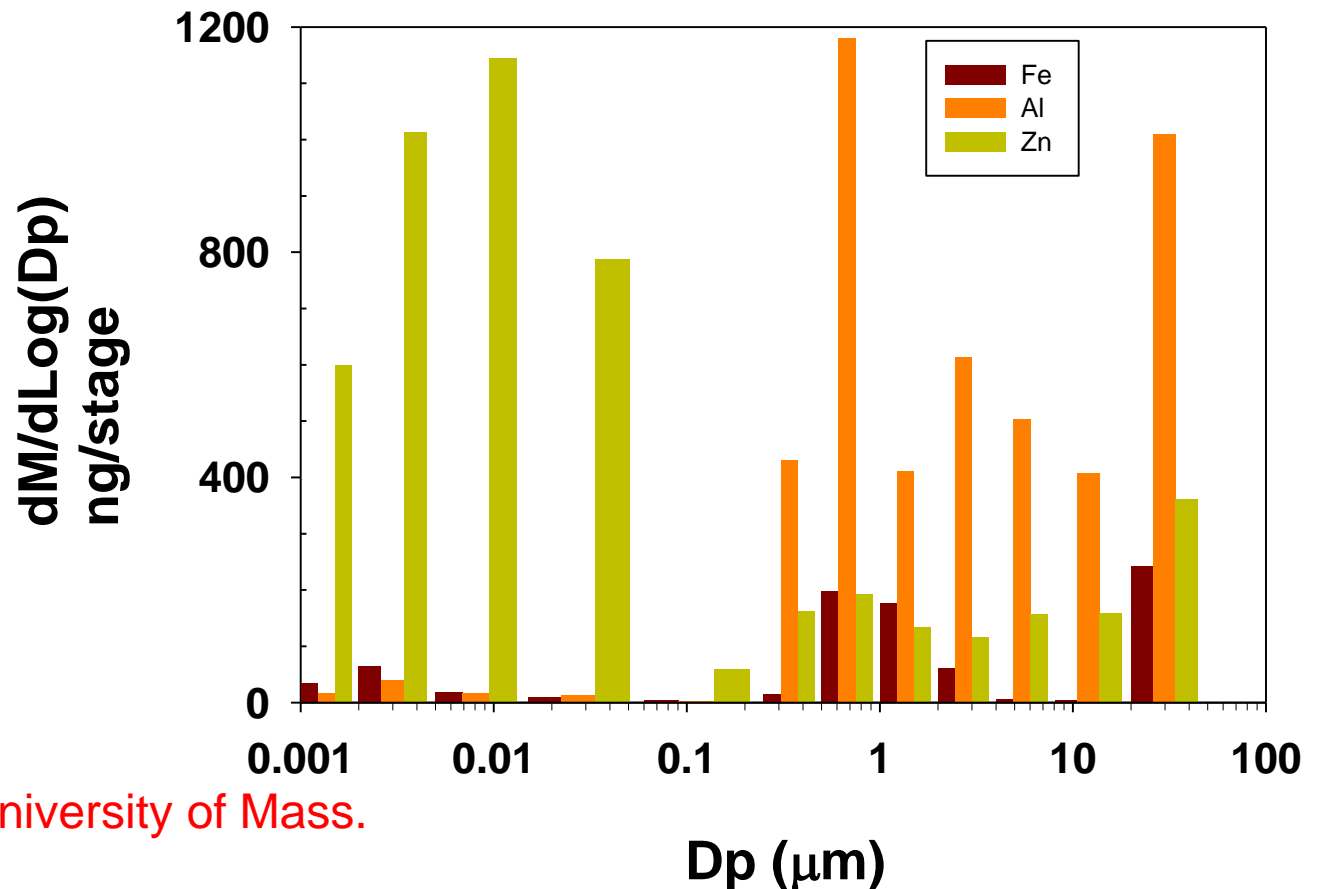


Probability of deposition in respiratory tract depends on particle size. Deposition efficiency DE is over 80% for particles $D=10\text{nm}$ whilst DE is only 15% for particles with $D=100\text{nm}$

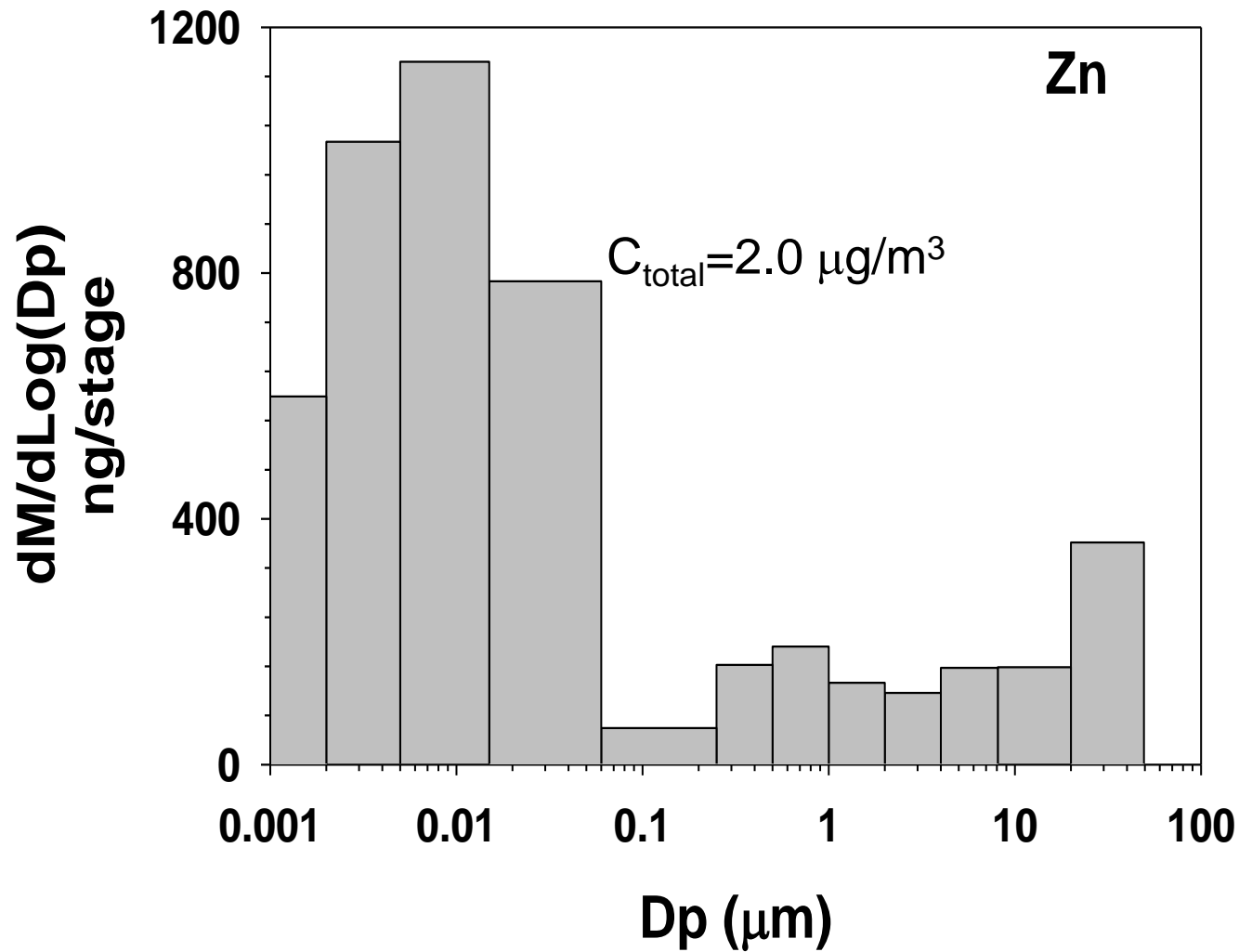
Aerosols are characterised by size distributions

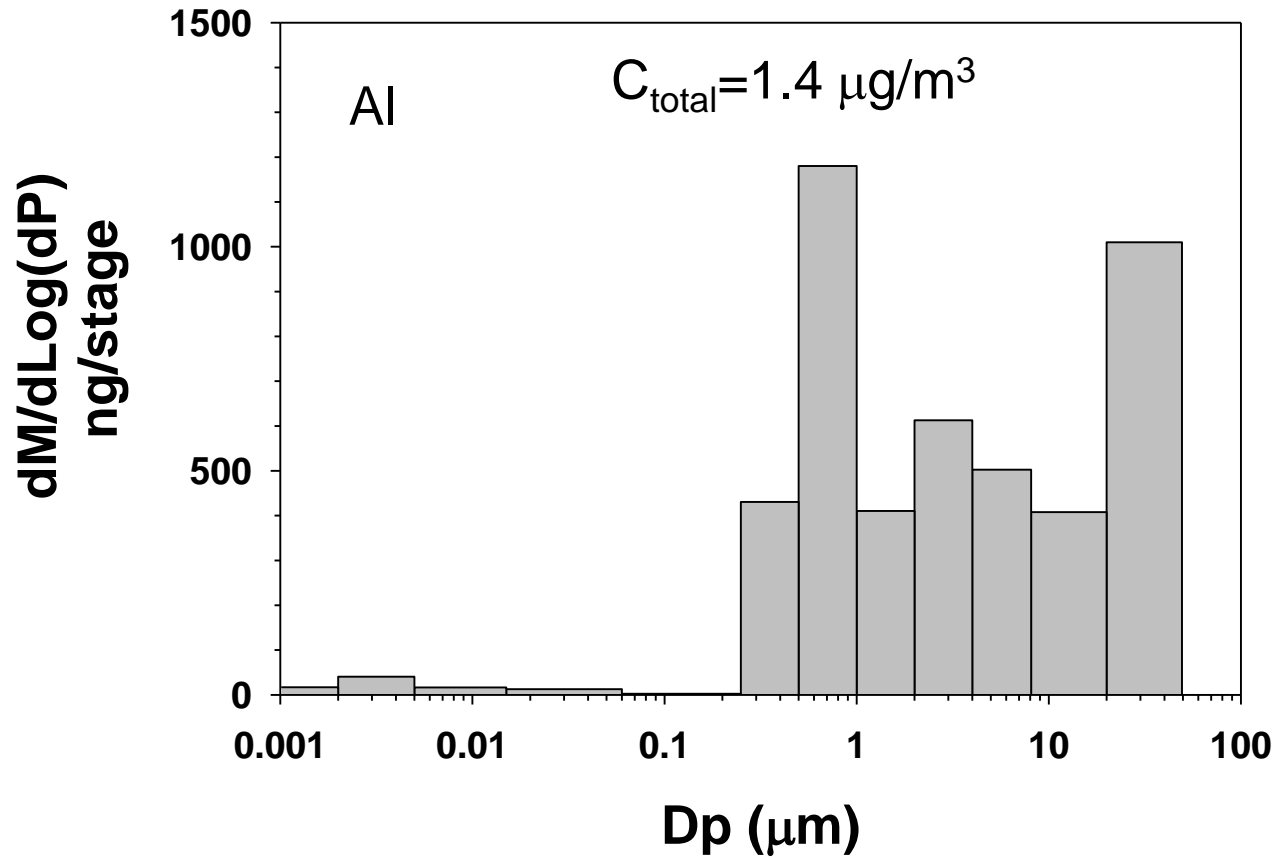
Normalized Mass Distribution of Welding Fumes using **Nano-ID**

PM10:
 •60% Zn
 •32% Al
 •6% Fe
 •2% other



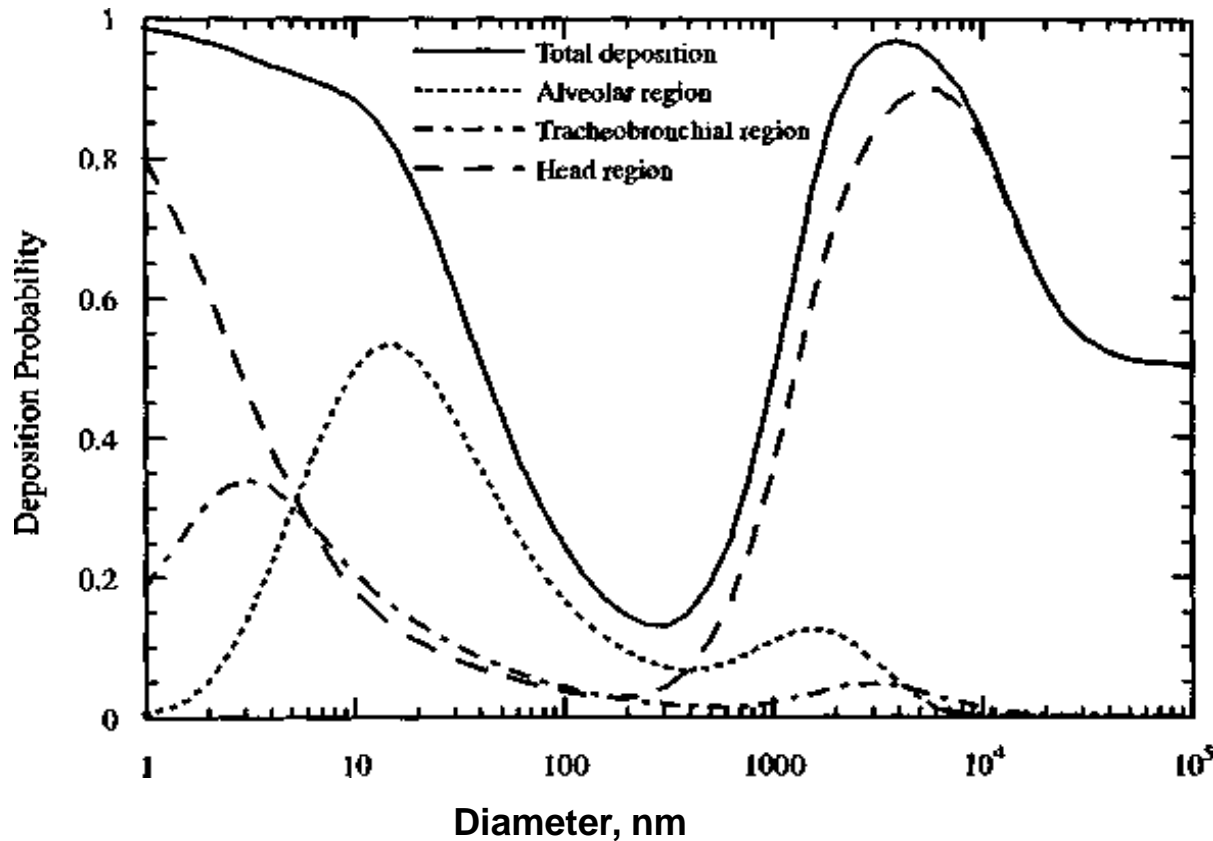
Courtesy D Bello University of Mass.
Lowell:





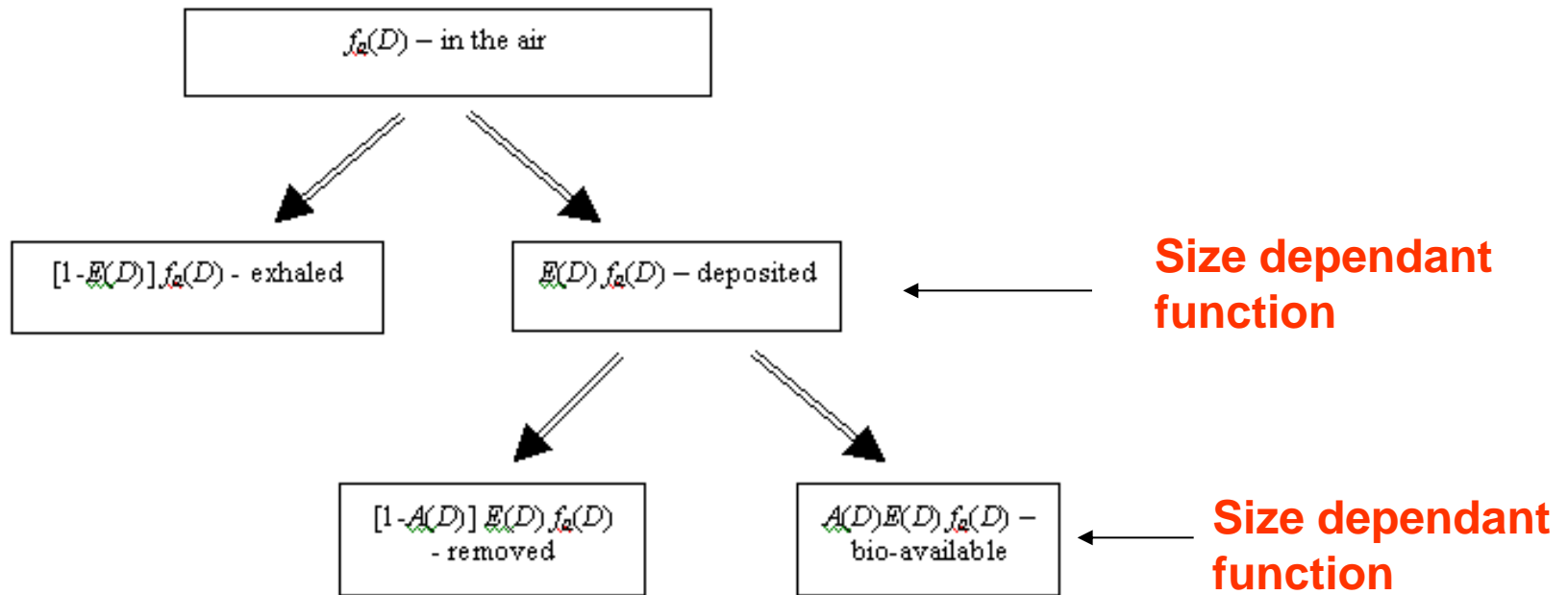
Challenge 2: Exposure – Dose relationship is size sensitive

Particle Deposition in the Respiratory Tract



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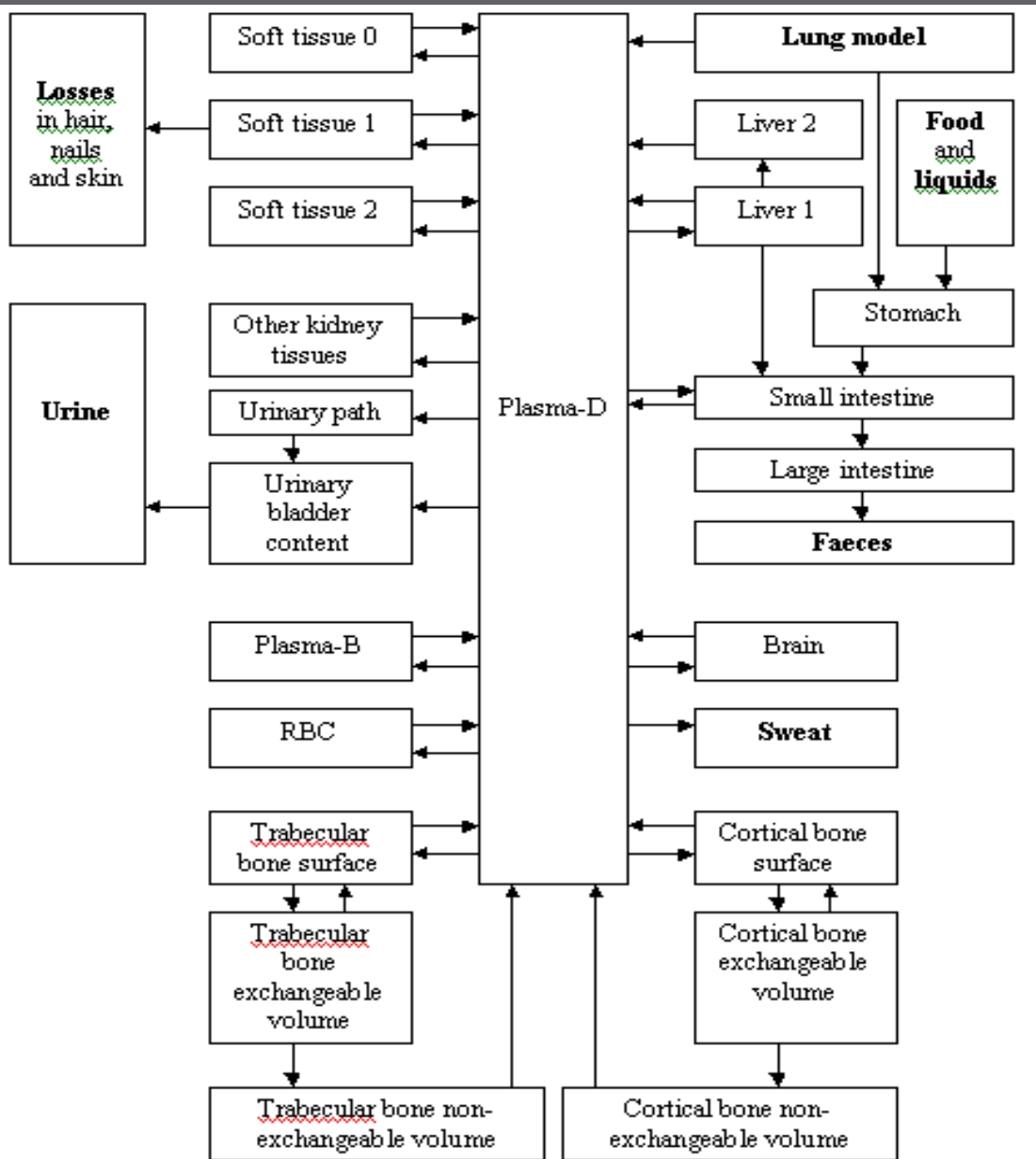
Aerosol particle pathways from the air to body organs.



Conclusions

- The relationship between airborne exposure and bio-available dose is complex and is **size dependant**
- Evaluation of health risk requires **size resolved** information
- Existing instruments such as **Nano-ID** can selectively detect ENP in the environment and give sufficient information to assess health risks of ENP
- Currently Nano-ID can be used as an affordable tool to quantify *in-situ* exposure-dose of ENP and associated health risk. It is compatible to most of suggested metrics (number, surface, mass).

Back-Up



ICRP biokinetic model for lead.

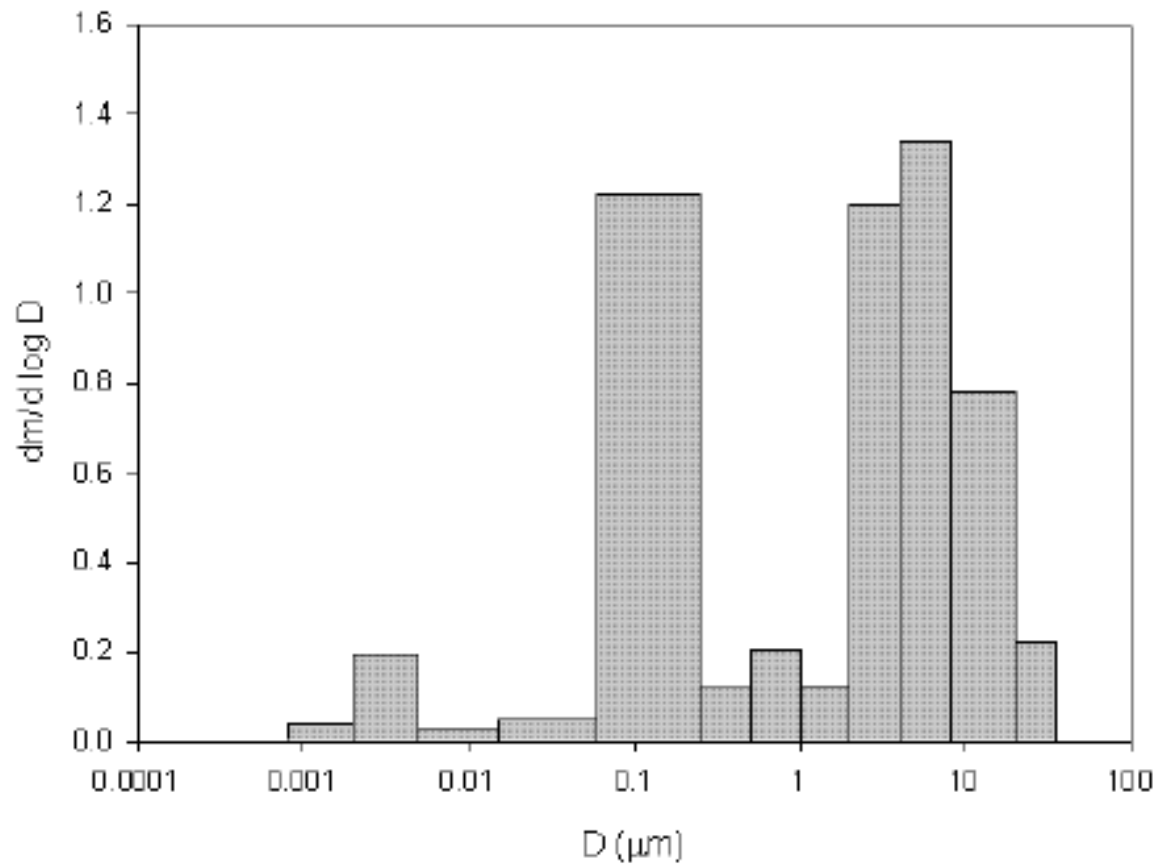
Samples of lead aerosol collected at crystal Glass workplaces
Data entered into ICRP Bioavailability model to Calculate blood lead levels

Biokinetic model for lead (Leggett, 1993).
ICRP - International Commission on Radiological Protection (1975)
Report of task group on reference man/ Oxford: Pergamon.

ICRP (1994) International commission on radiological protection.
Human respiratory tract model for radiological protection. Annals of the ICRP, Publication 66, Tarrytown, N.-Y.: Elsevier Science Inc.

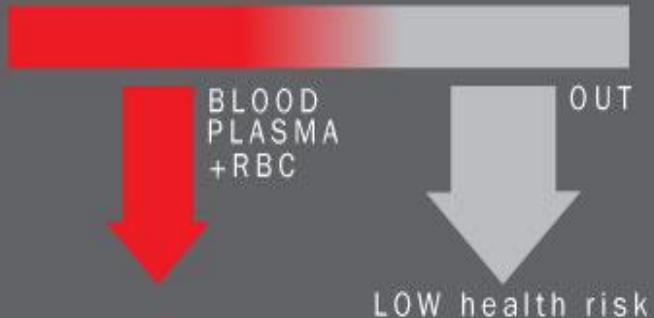
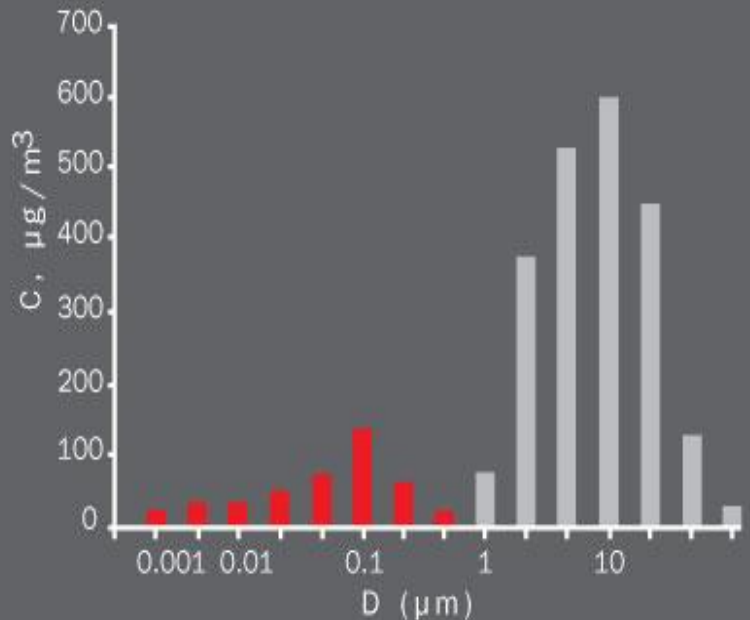
Ag distribution

Size distribution; not corrected

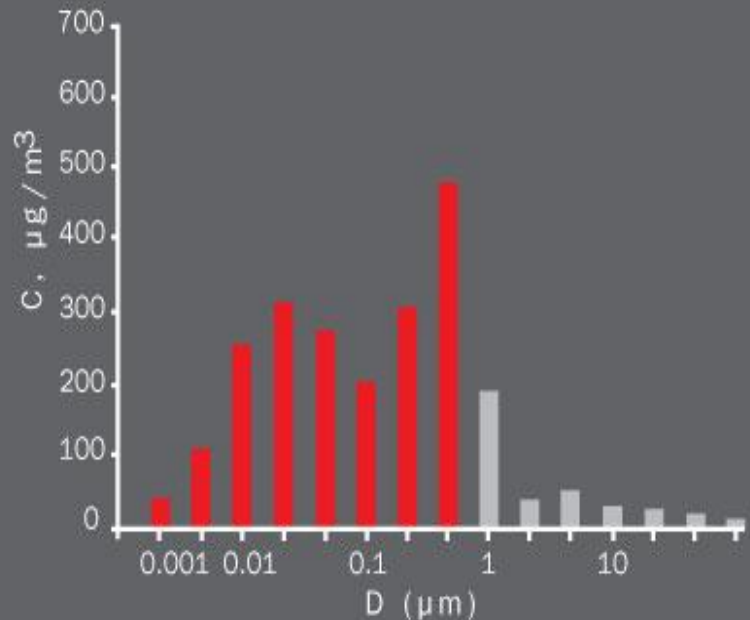


Studies of Lead Concentration, Particle Size and Lead in Blood

LEAD CONCENTRATIONS PARTICIPANT A



LEAD CONCENTRATIONS PARTICIPANT B

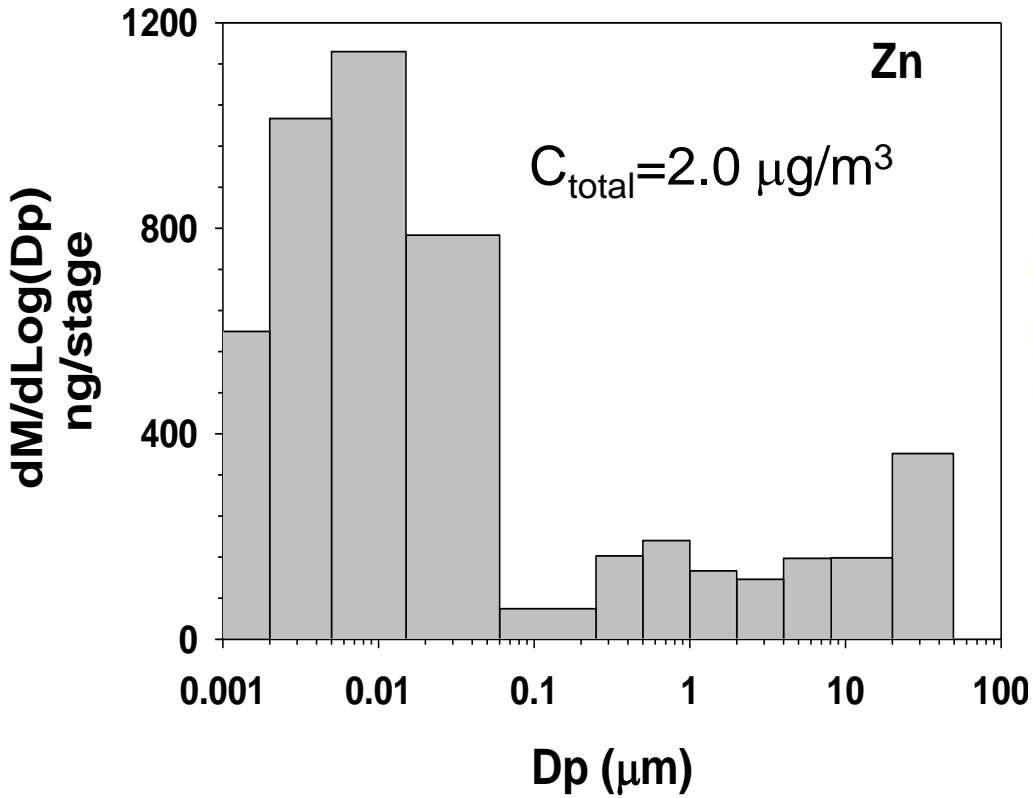


REFERENCES:

A NOVEL AEROSOLS SAMPLING INSTRUMENT

B. GORBUNOV, N. D. PRIEST, P.R. JACKSON* AND D. CARLIDGE* Cheng Y. S., J. A. Keating and G. M. Kanapilly (1980) Theory and calibration of a screen-type diffusion battery, J. Aerosol Sci., 11, pp. 549-556.

ENP



Atmospheric Aerosol (Ambient)

