

UPDATE ON AEROSOL SAMPLING APPROACHES FOR BERYLLIUM

**Presentation to the BWI-NIOSH
Project Lead Team Meeting**

18 October 2001

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- Mark D. Hoover, PhD, CHP, CIH
- Centers for Disease Control and Prevention
- National Institute for Occupational Safety and Health

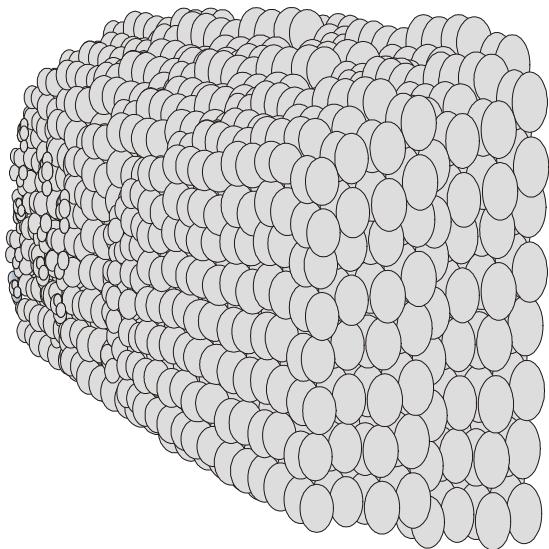
- WHAT DO YOU SAMPLE?
- HOW DO YOU SAMPLE?

BACKGROUND

Comparison of locations by deposited Be particle number and average Be mass concentration

Locations sampled	Deposited Be Particles / cc	Average Be Mass ug / m ³
Oxide furnace area	9900	0.015
Fluoride furnace area (Average)	9700	0.25
Cast shop	3700	0.036
Hydrolysis / filling area	1800	0.19
Wet plant (Processing Facility)	1400	0.058
Reduction furnace area	300	0.059
Bulk pickle	200	0.075
Ball mill (Processing Facility)	100	0.074
Beryl ore mine	9	0.24
Ore crusher	5	0.077
Milling operation	3	0.004
Administration and shipping	1	0.001

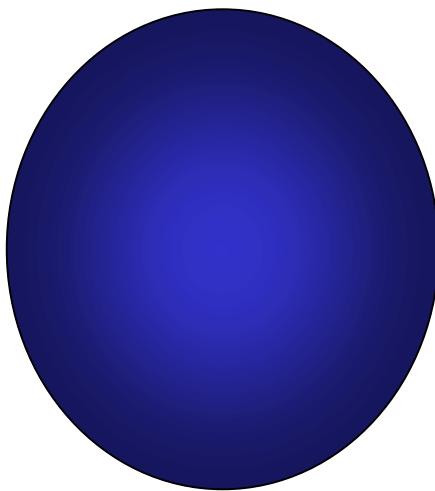
NUMBER



ONE MILLION
≡
0.01 μm PARTICLES

VS

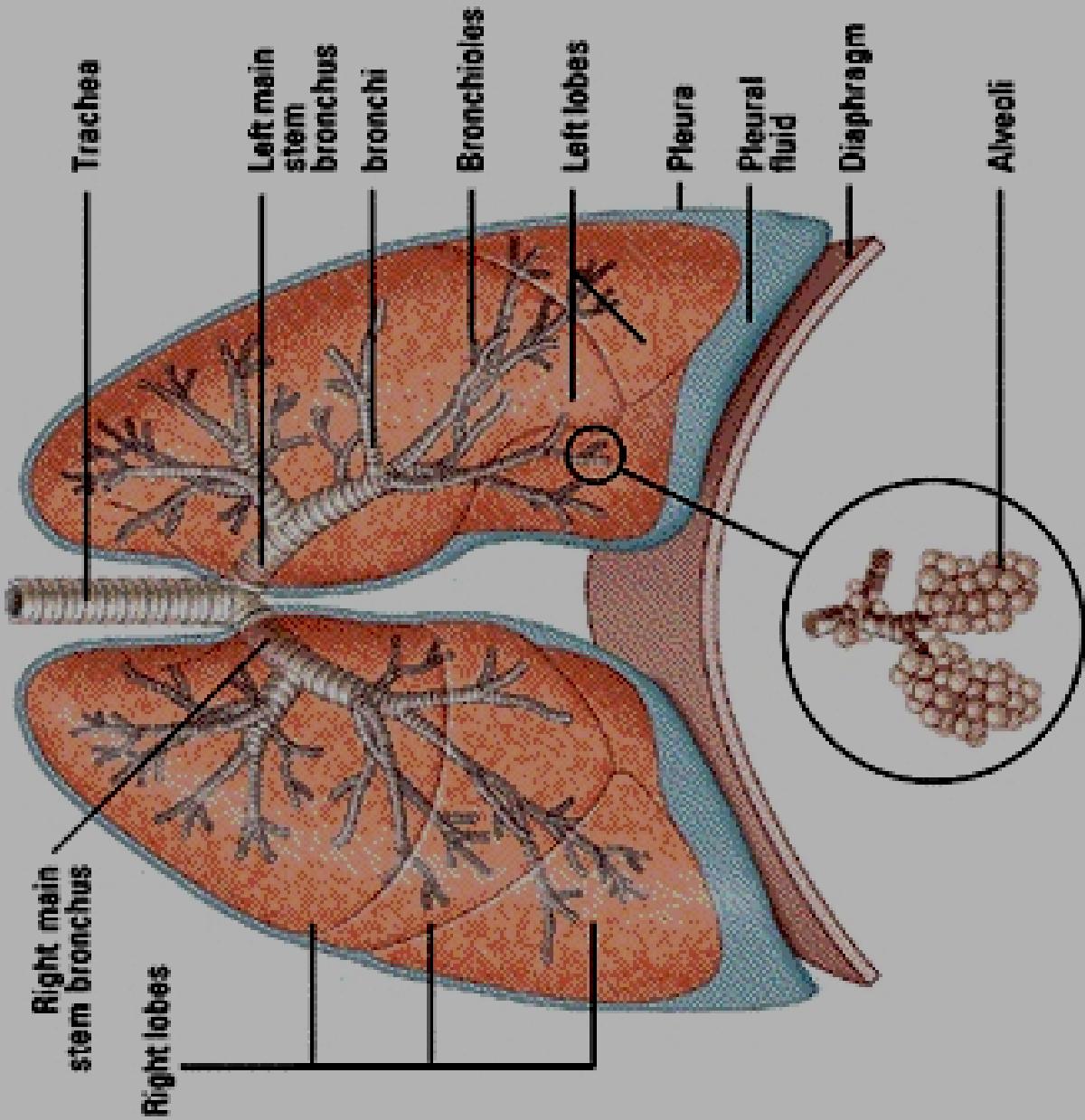
WEIGHT



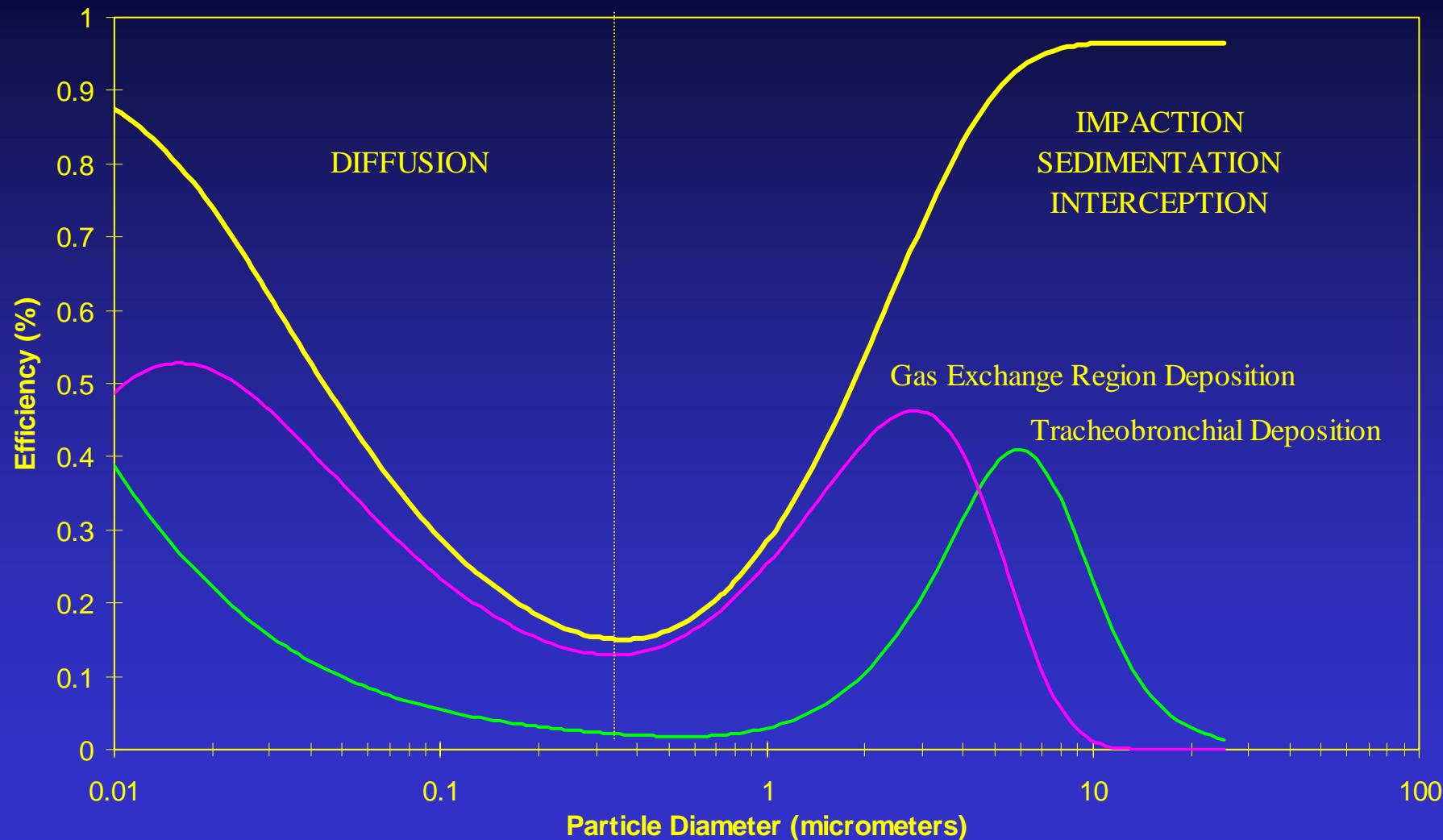
ONE $1 \mu\text{m}$
PARTICLE

BASIC PRINCIPLES

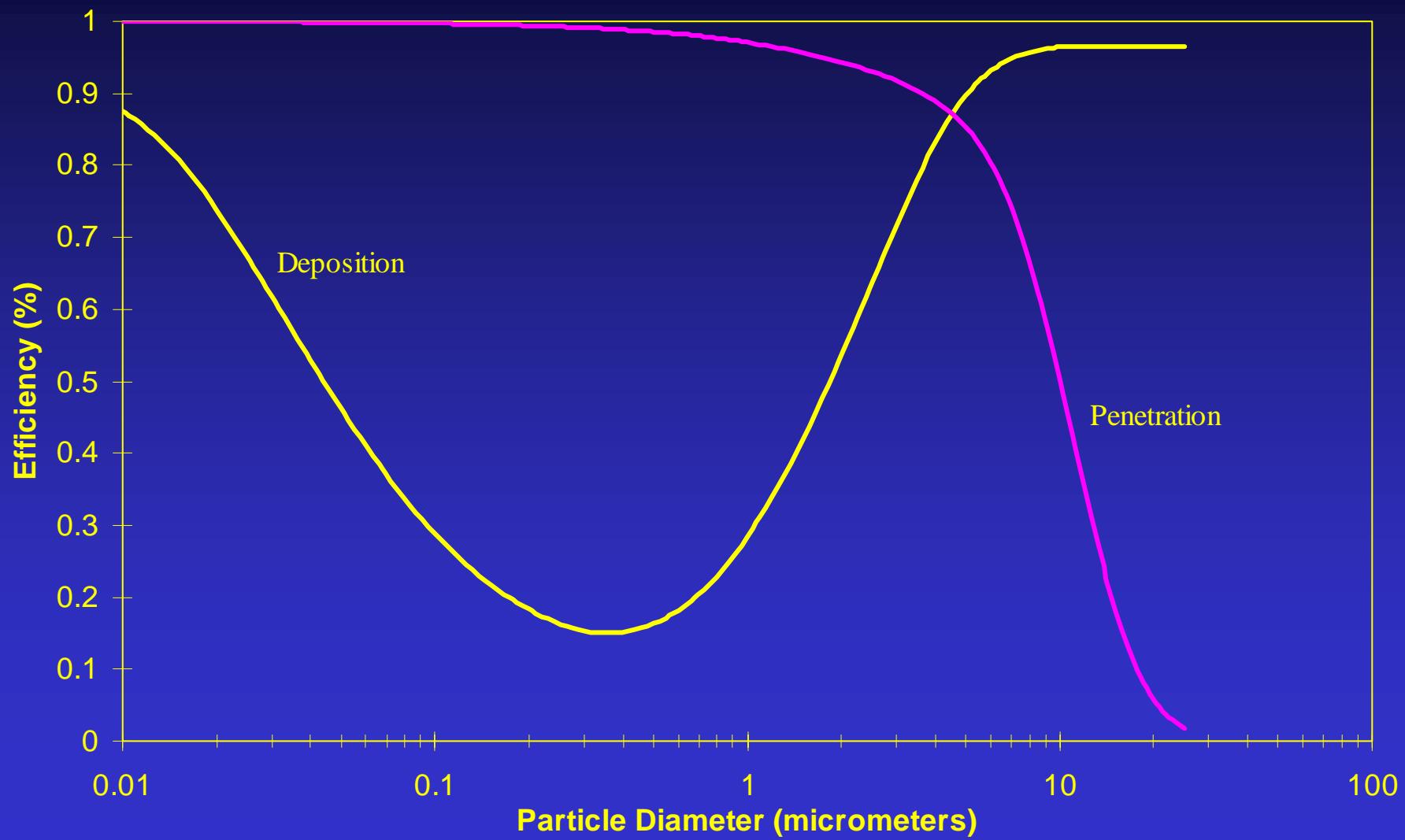
Lungs



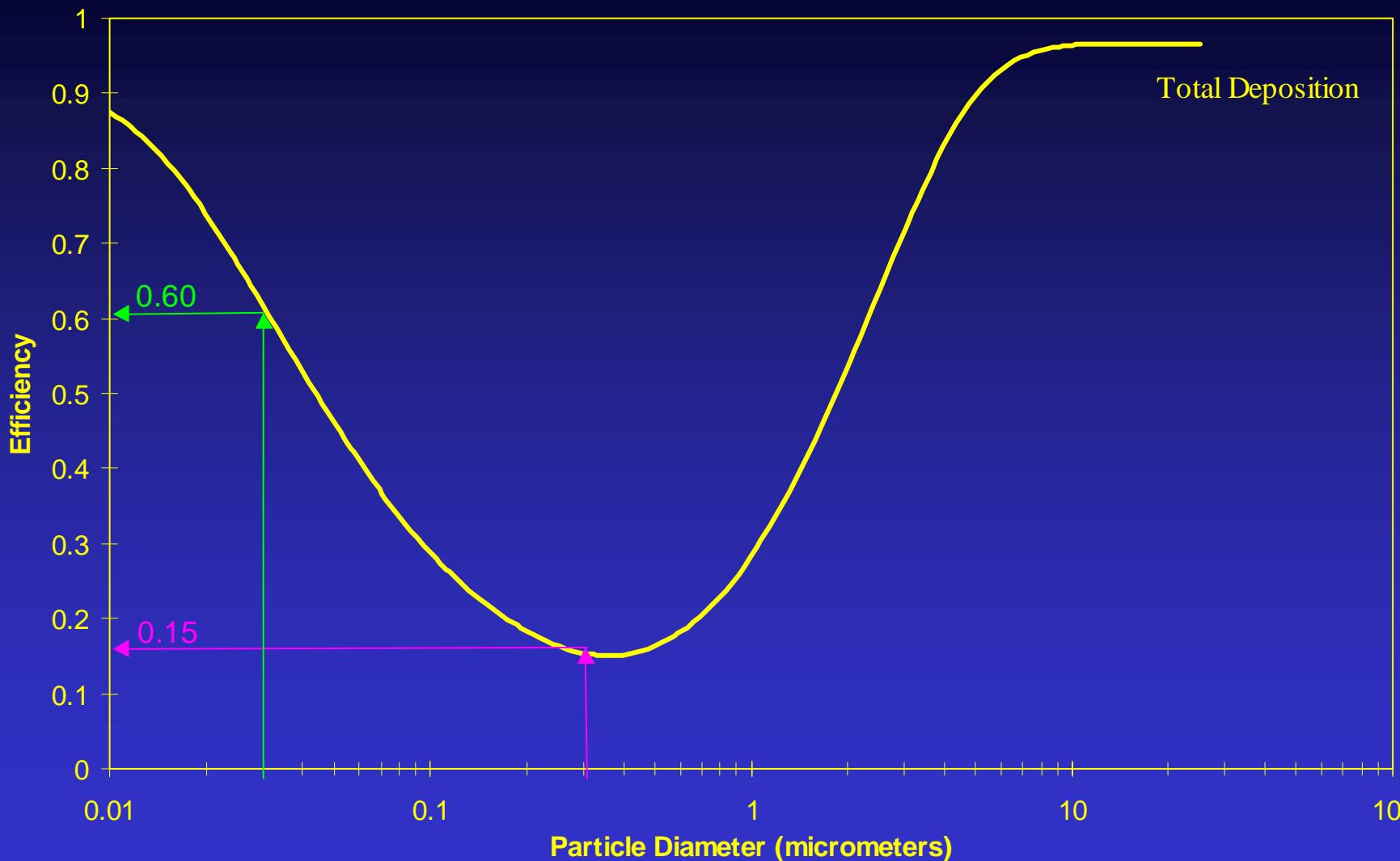
Total Deposition Curve



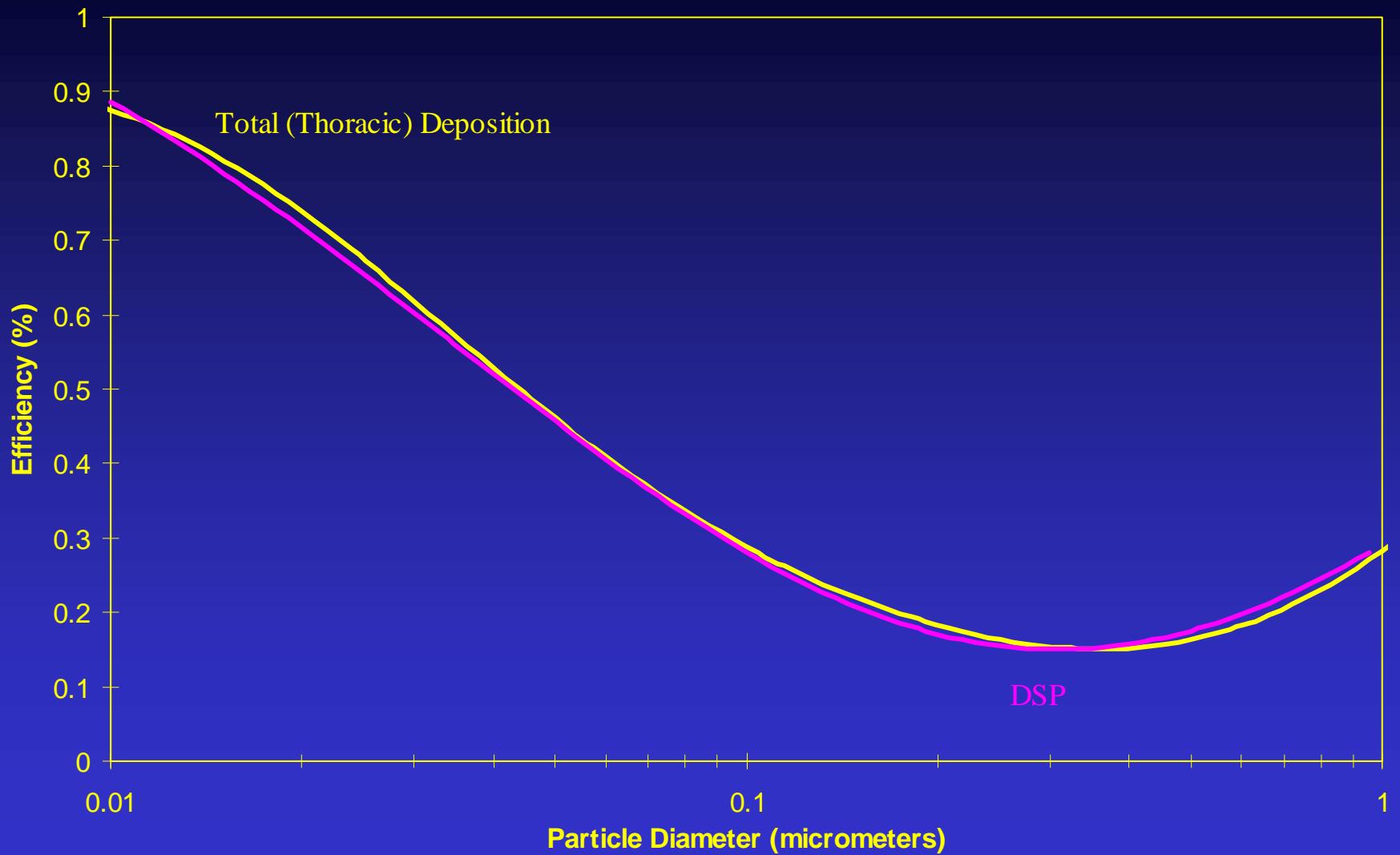
Total Penetration vs. Total Deposition

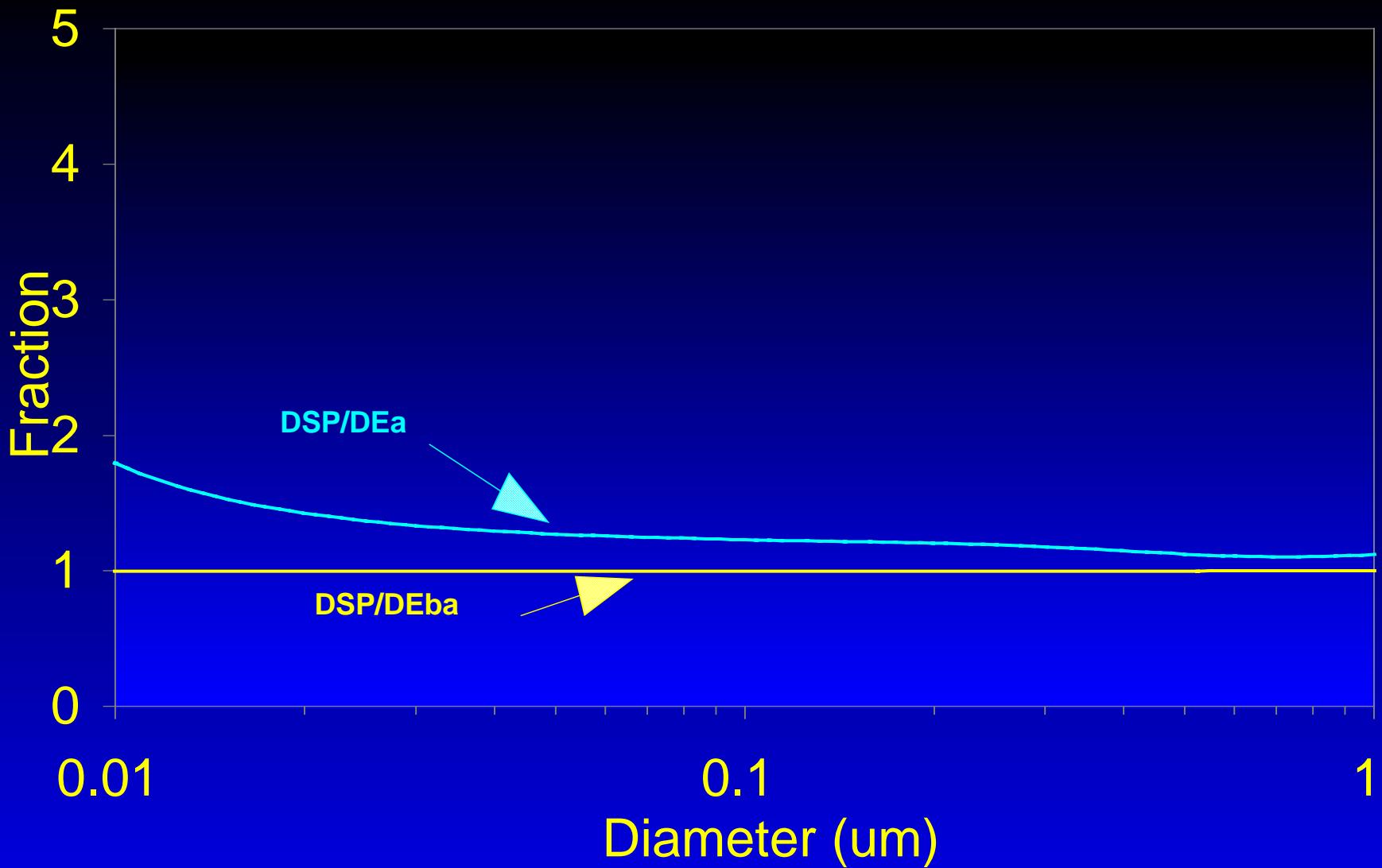


Dose Increase Due to Decreased Particle Size



Total Deposition Curve vs. DSP Criterion

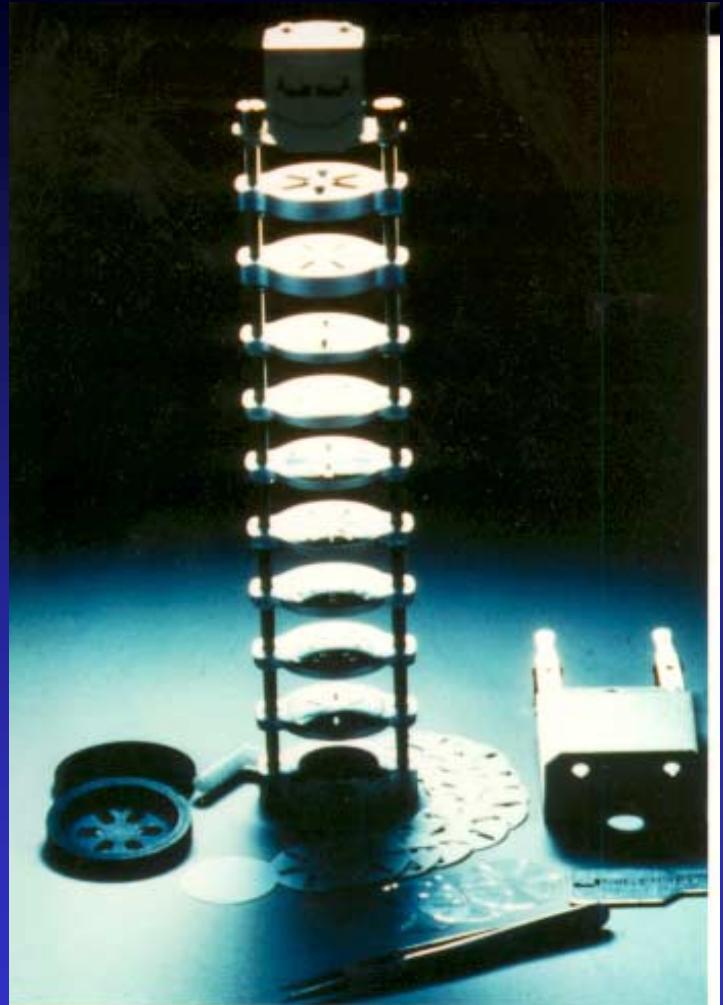




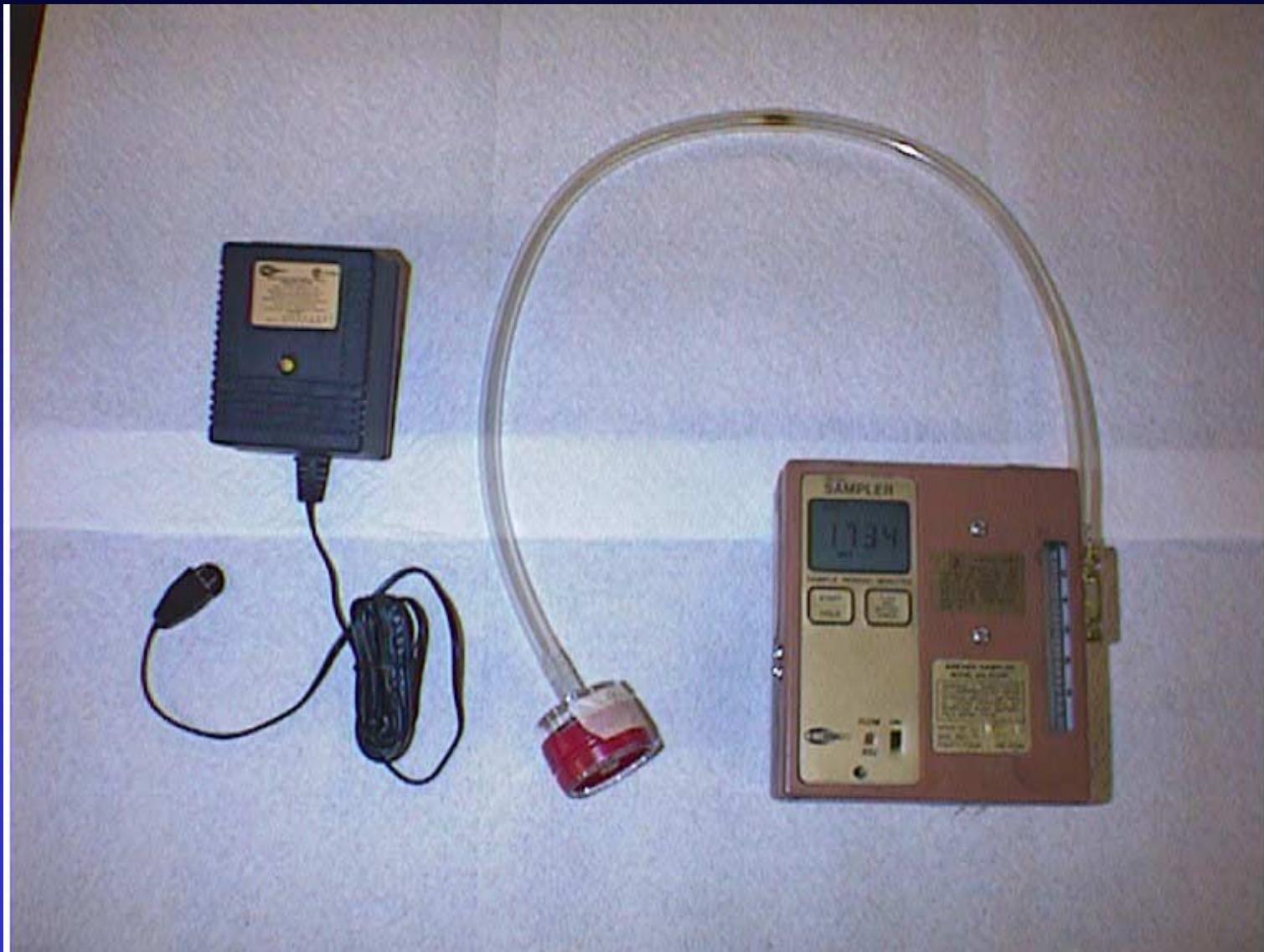
TECHNIQUES

LARGE PARTICLES

- PERSONAL IMPACTORS
- FILTERS
- CYCLONES



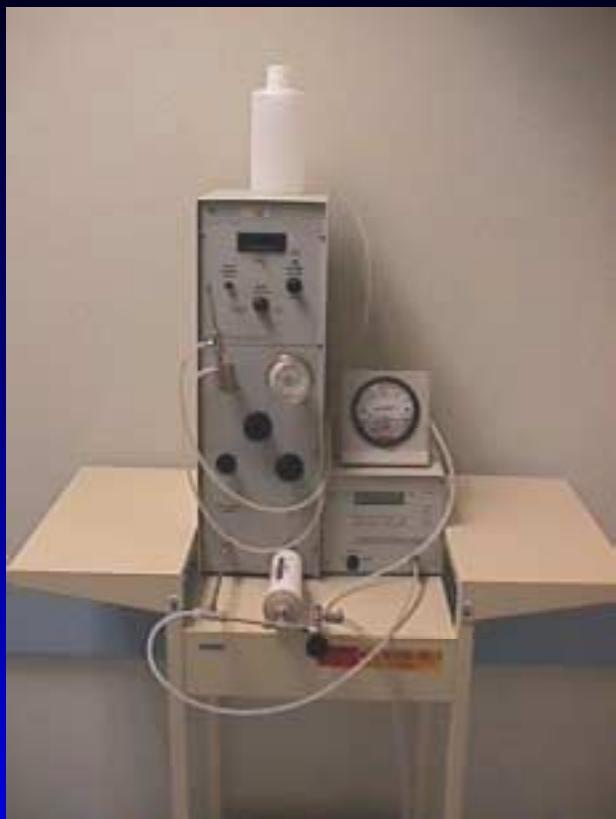
Personal Air Sampler with Digital Readout of Integrated Flow



Lovelace Multijet Impactor



SMALL PARTICLES



Micro Orifice Uniform Deposit Impactor



TOTAL MASS BY SIZE
BERYLLIUM MASS BY SIZE

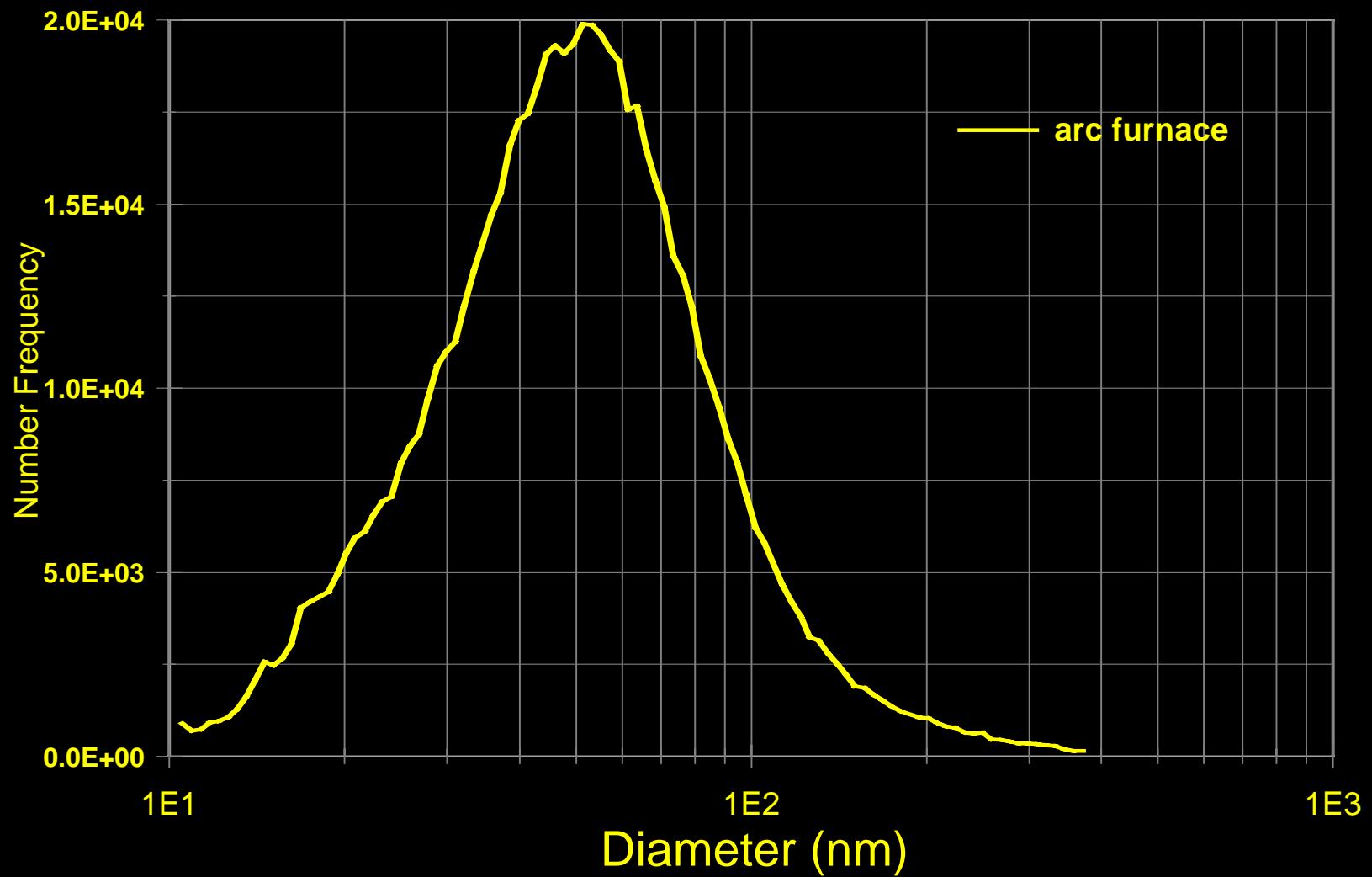
Scanning Mobility Particle Sizer



PARTICLE NUMBER BY SIZE



BERYLLIUM PARTICLE NUMBER CONCENTRATION



Condensation Particle Counter

RANGE : 0.03 – 1.0 μm

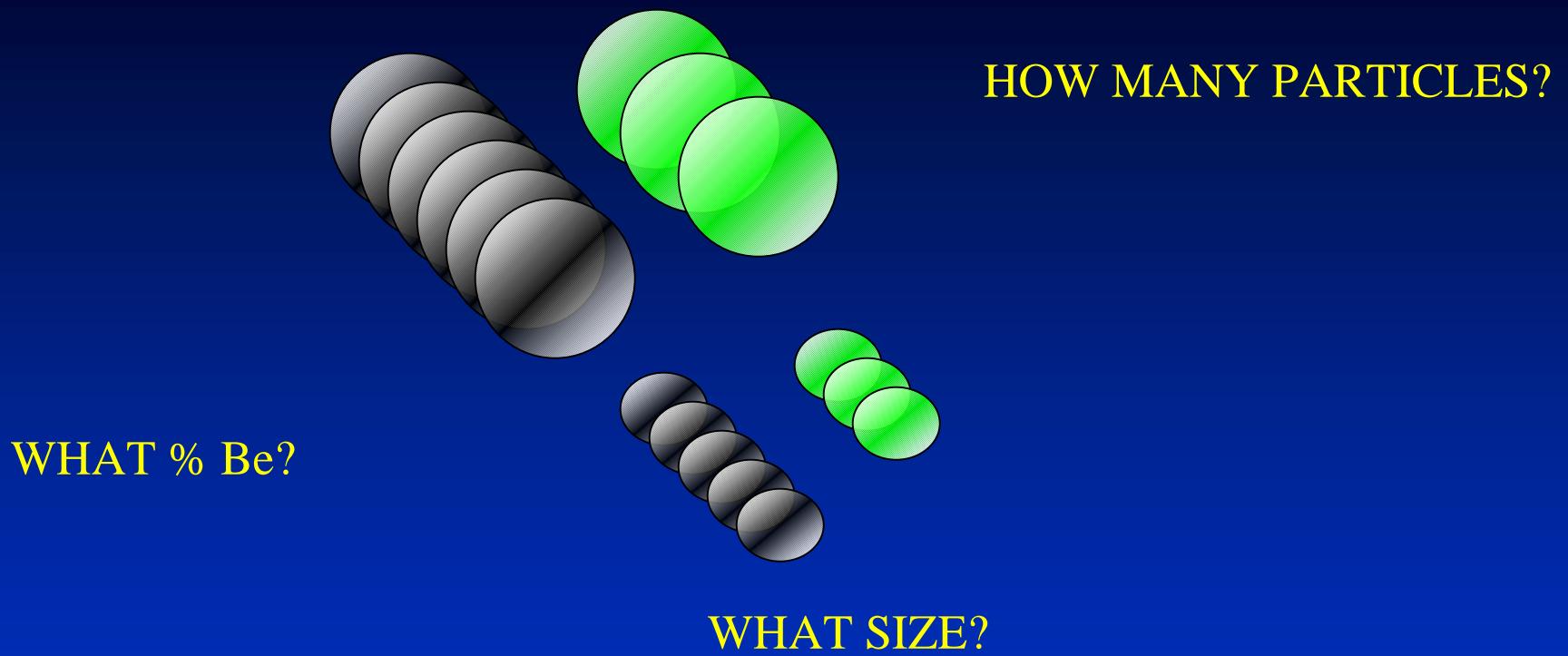
FLOW : 0.7 LITERS/MINUTE

DIRECT READING
WITH DATA LOGGING
CAPACITY AT 1 Hz



NEW TECHNIQUES

TASK – DETERMINE:



SAMPLE SIZE SELECTIVELY
FOR Be PARTICLE NUMBER.

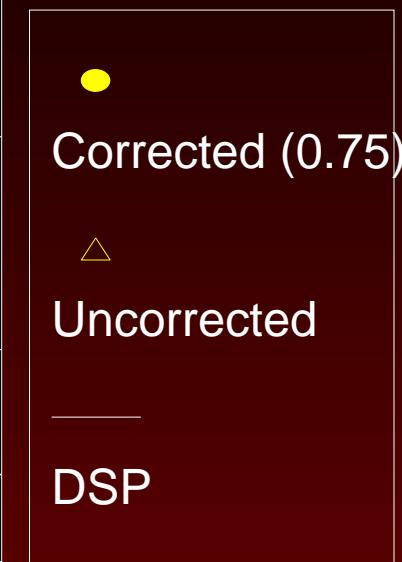
3 – 3um, 37mm Diameter,
polycarbonate track-etched filters
7 sets at 2.2 lpm

Efficiency (%)

100
80
60
40
20
0

0.01 0.1 1

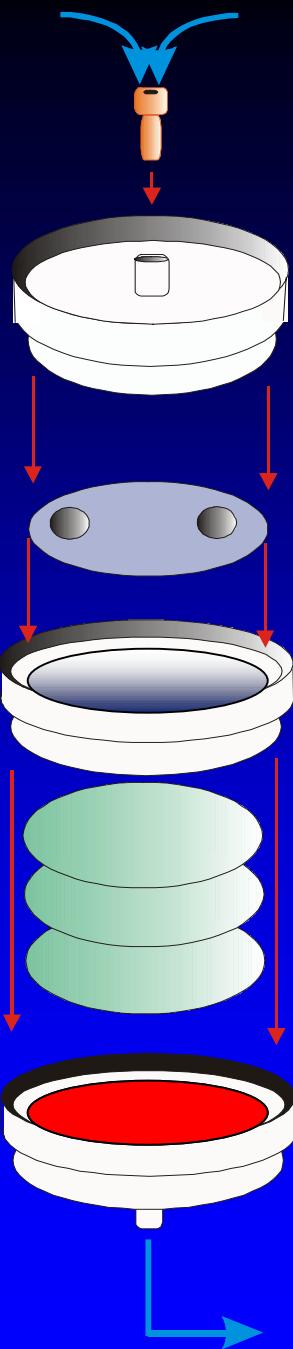
Thermodynamic Diameter (micrometers)



AIR

3 LAYER CONFIGURATION
MODIFIED FOR FIELD USE

TOP
MIDDLE
BOTTOM



IMPACTOR JET

PUNCHED-GREASED
FIBER PAD

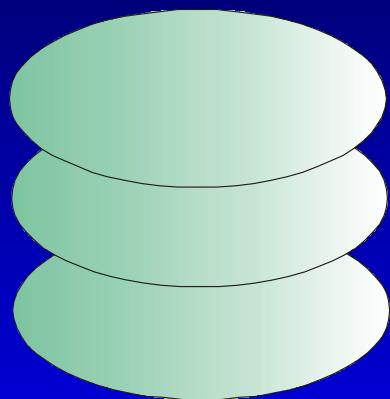
POLYCARBONATE
FILTERS

BACK UP
SCREEN

TO PUMP (2.2 LPM)

ANALYSIS

$$\% \text{ Be} = \frac{\text{BERYLLIUM MASS}}{\text{TOTAL MASS}}$$



POLYCARBONATE
FILTERS

GRAVIMETRIC
ANALYSIS

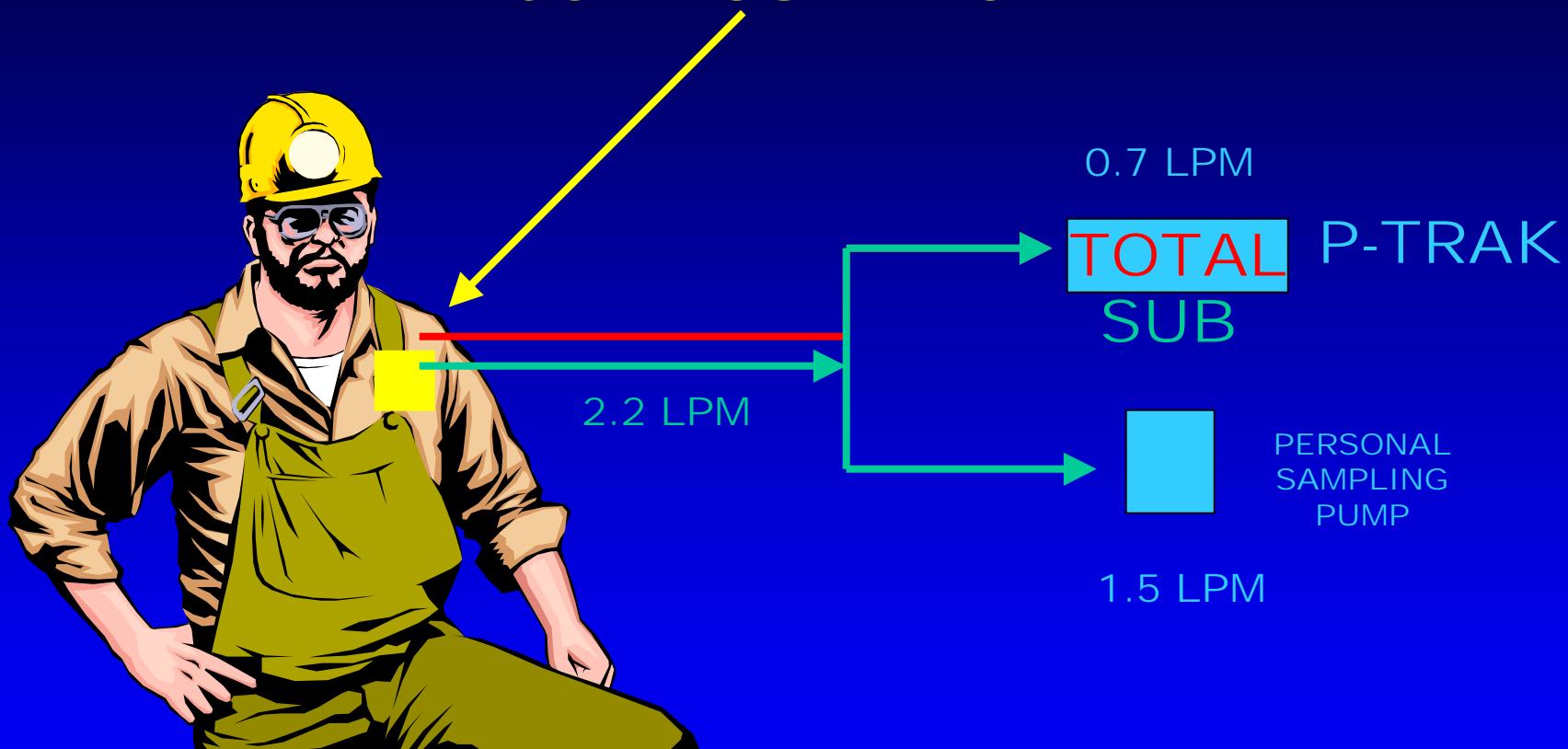
TOTAL MASS

CHEMICAL ANALYSIS

BERYLLIUM MASS

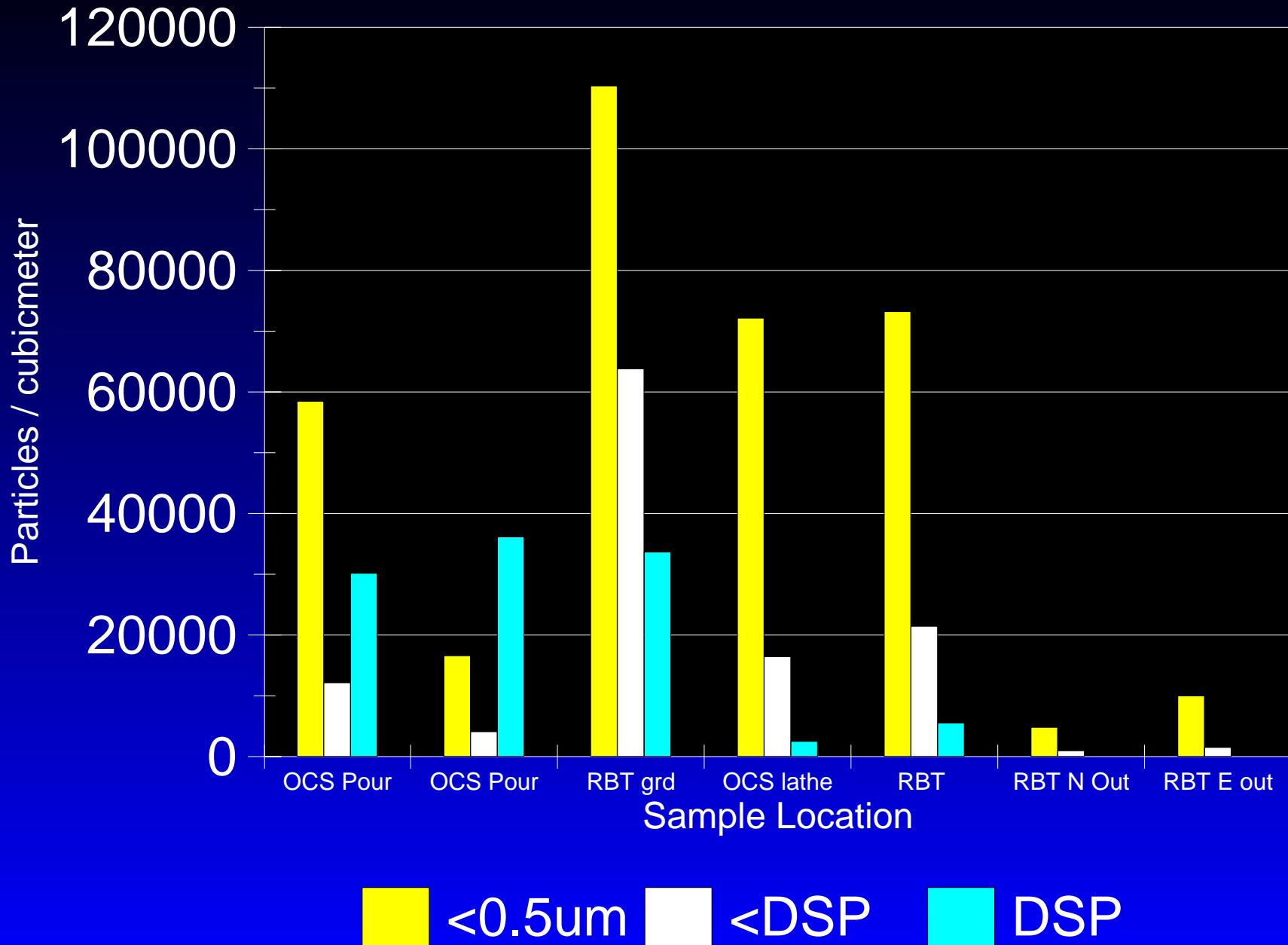
PERSONAL SAMPLING

FIELD SAMPLING CONFIGURATION



$$DSP = TOTAL - SUB$$

Time Averaged Samples



DIRECT READING INSTRUMENTS

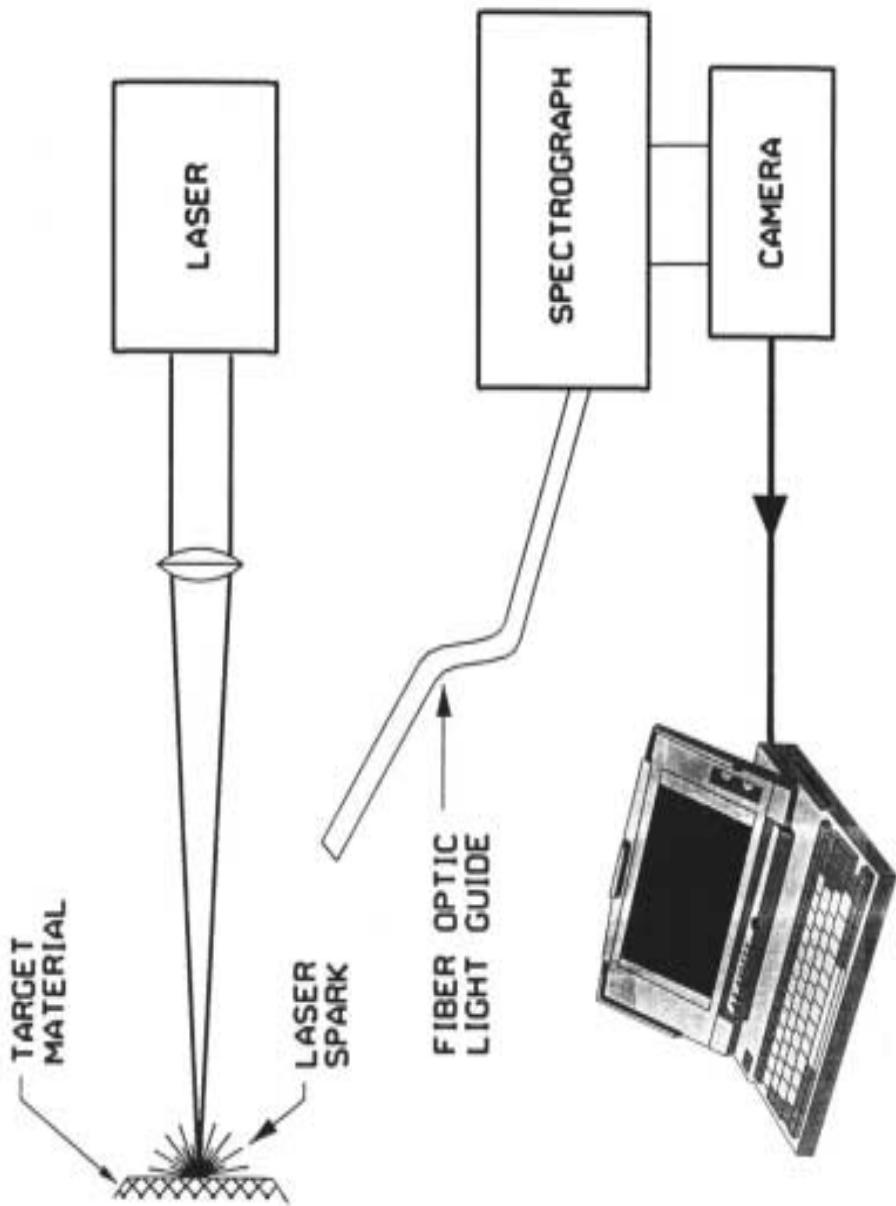
Beryllium Detection with Laser Induced Breakdown Spectroscopy





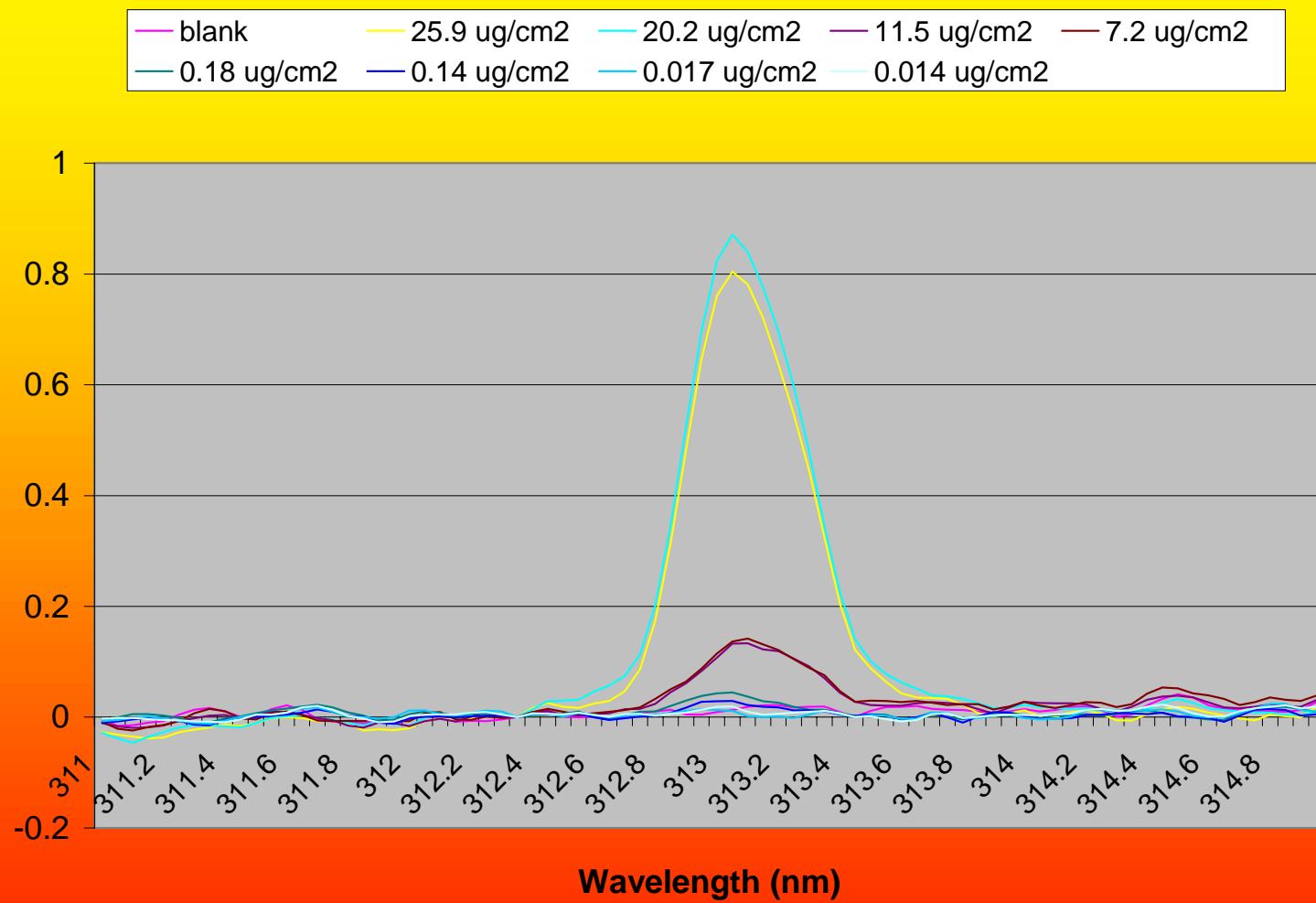
A photograph of a portable electronic device, likely a handheld computer or specialized field equipment. The device has a light blue-grey case with a dark grey base. The top cover features the company logo "ADA TECHNOLOGIES, INC." in purple text, with "ADA" in a larger, bold font and "TECHNOLOGIES, INC." in a smaller font below it. A small blue and white circular badge is visible near the bottom left of the cover. The device is shown from a three-quarter perspective, highlighting its design and branding.

ADA
TECHNOLOGIES, INC



LIBS CONCEPT

LIBS Calibration Spectra: Be



Phase I Detection Limits

Metal	Wavelength (nm)	Detection Limit ($\mu\text{g}/\text{cm}^2$)	Detection Limit (ppm)
Silver (Ag)	328	0.039	6.0
Arsenic (As)	193	4.363	750
Barium (Ba)	220, 232	0.186	32
Beryllium (Be)	313	0.002	0.36
Cadmium (Cd)	226.8	0.361	62
Cobalt (Co)	345	1.835	320
Chromium (Cr)	520	0.453	78
Mercury (Hg)	253.7	1.445	250
Manganese (Mn)	402.8	1.927	330
Nickel (Ni)	342	7.707	1300
Lead (Pb)	405.8	0.326	56
Thallium (Tl)	535	0.373	64
Uranium (U)	bands at 260 and bands at 370	NA	NA
Vanadium (V)	249, 265, 280	0.051	8
Zinc (Zn)	204, 207	0.09	16

Los Alamos MIPS Air Particulate Monitor



Possible Be Realtime Monitor Options

- Los Alamos LIBS
- ADA Tech LIBS
- SEA LIBS
- Coyote Surface LIBS
- ELS Voltametry
- Los Alamos MIPS
- MIT MIPS
- All units are basically prototype versions

SUMMARY

- LARGE PARTICLES APPEAR LESS IMPORTANT
- SMALL PARTICLE TECHNOLOGY IS AVAILABLE
- TECHNOLOGY MUST BE PERSONAL OR PORTABLE
- TECHNOLOGY MUST ALLOW FOR CHEMICAL ANALYSIS