Beryllium Sensitization and the Pursuit of an Effective Exposure Metric

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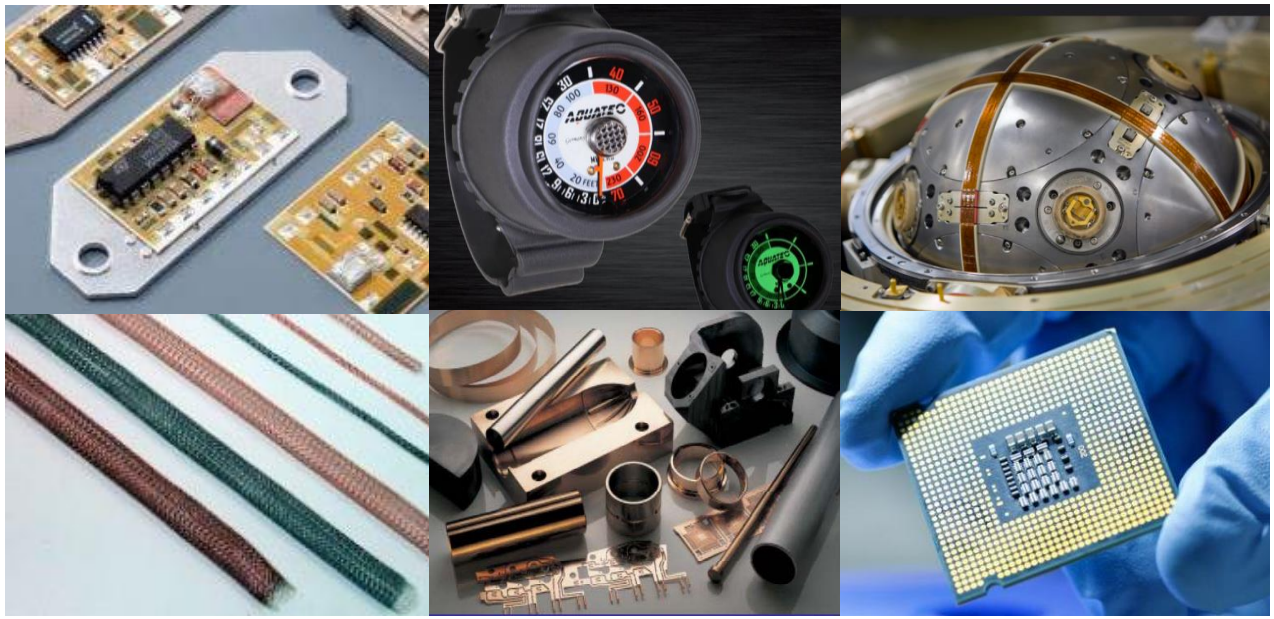
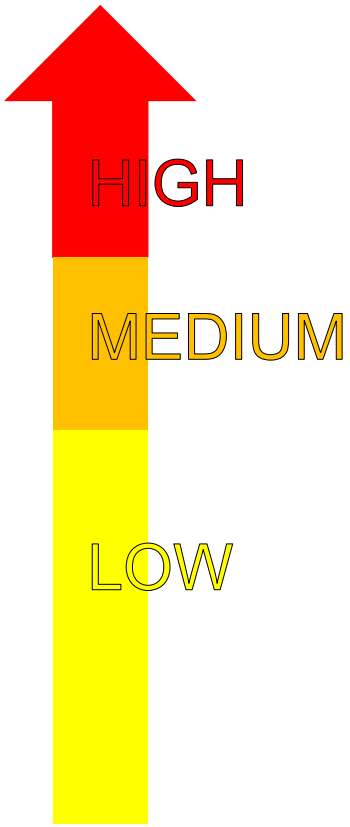


Indicators of Risks

Mass based exposure limits may not be the best indicator of risk

NIOSH Be Metal/Alloy/Oxide Processing Study

	DSP Beryllium Particles / cc	Average Be Mass µg / m^3
Fluoride Furnace	20,500	0.02
Oxide Furnace	18,500	0.25
Casting Operations	5,500	0.07
Reduction Furnace	4,800	0.06
Solution Preparation	2,200	0.06
Bulk Pickle	150	0.08
Ball Mill	100	0.07
Light Gauge Foil Room	70	0.004
Beryl ore mine	9	0.24
Ore crusher	5	0.08
4-HI Mill	3	0.004
Administration and shipping	1	0.004



M.McCawley, "Ultrafine "Beryllium Number Concentration as a Possible Metric for Chronic Beryllium Disease Risk", App. Occ. & Env. Hygiene, 2001

NIOSH CuBe Study

CBD Rate vs Exposure Levels

Job Title	Sensitized (%)	CBD (%)	Median Exposure ($\mu g/m^3$)	95th Percentile [1] (UTL) ($\mu g/m3$)
Point and Chamfer	21	21	0.03	0.2
Wire annealing/pickling	13	10	0.12	2.32
Wire drawing	14	10	0.06	0.32
Rod and wire packing	10	9	0.03	0.11
Straightening	8	8	0.03	0.17
Strip Annealing	11	8	0.02	0.21
Strip rolling	11	7	0.02	0.09
Administration (plant)	10	7	0.02	0.05
Slitting	8	6	0.02	0.16
Strip pickling	7	6	0.03	0.14
Inspection	6	6	0.02	0.05
Maintenance mechanics	6	6	0.02	0.07
Metallurgy lab	4	4	0.06	----
Shipping Receiving	4	2	0.02	0.04
Die grinding	0	0	0.02	----
Wastewater treatment	0	0	0.11	----
Administration (office)	0	0	0.01	0.09

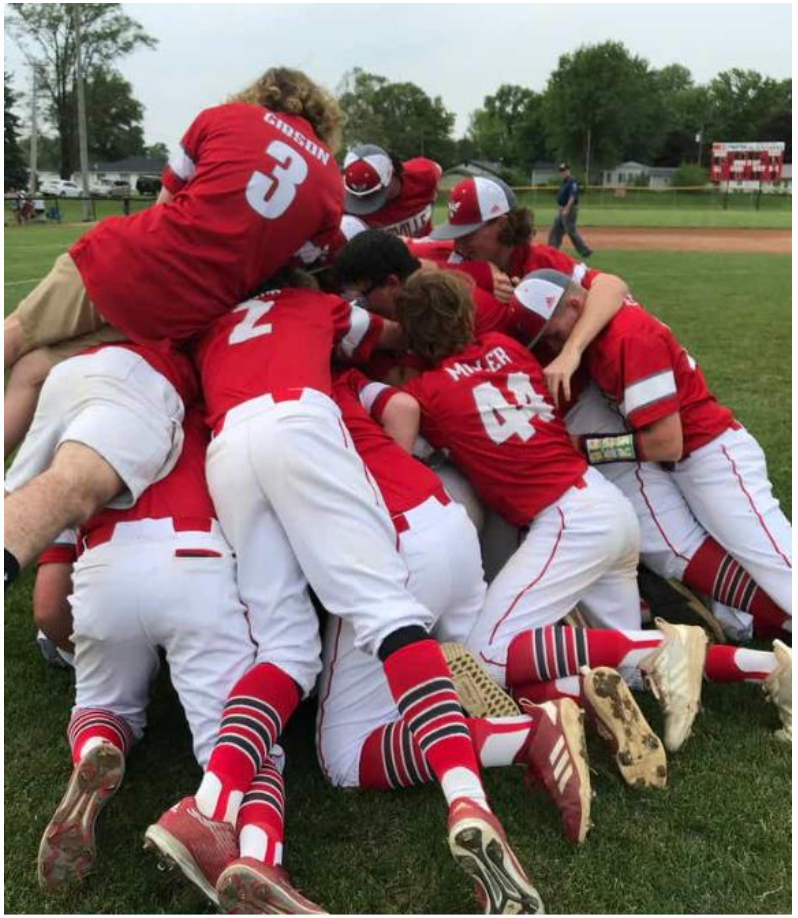
Exposure Risk

Total airborne beryllium particle number deposited in the lung is a probable true indicator of risk combined with skin exposure

M. McCawley et al., “Ultrafine Beryllium Number Concentration as a Possible Metric for Chronic Beryllium Disease Risk”, App. Occ. & Env. Hyg., 2001, 16(5)

Why?

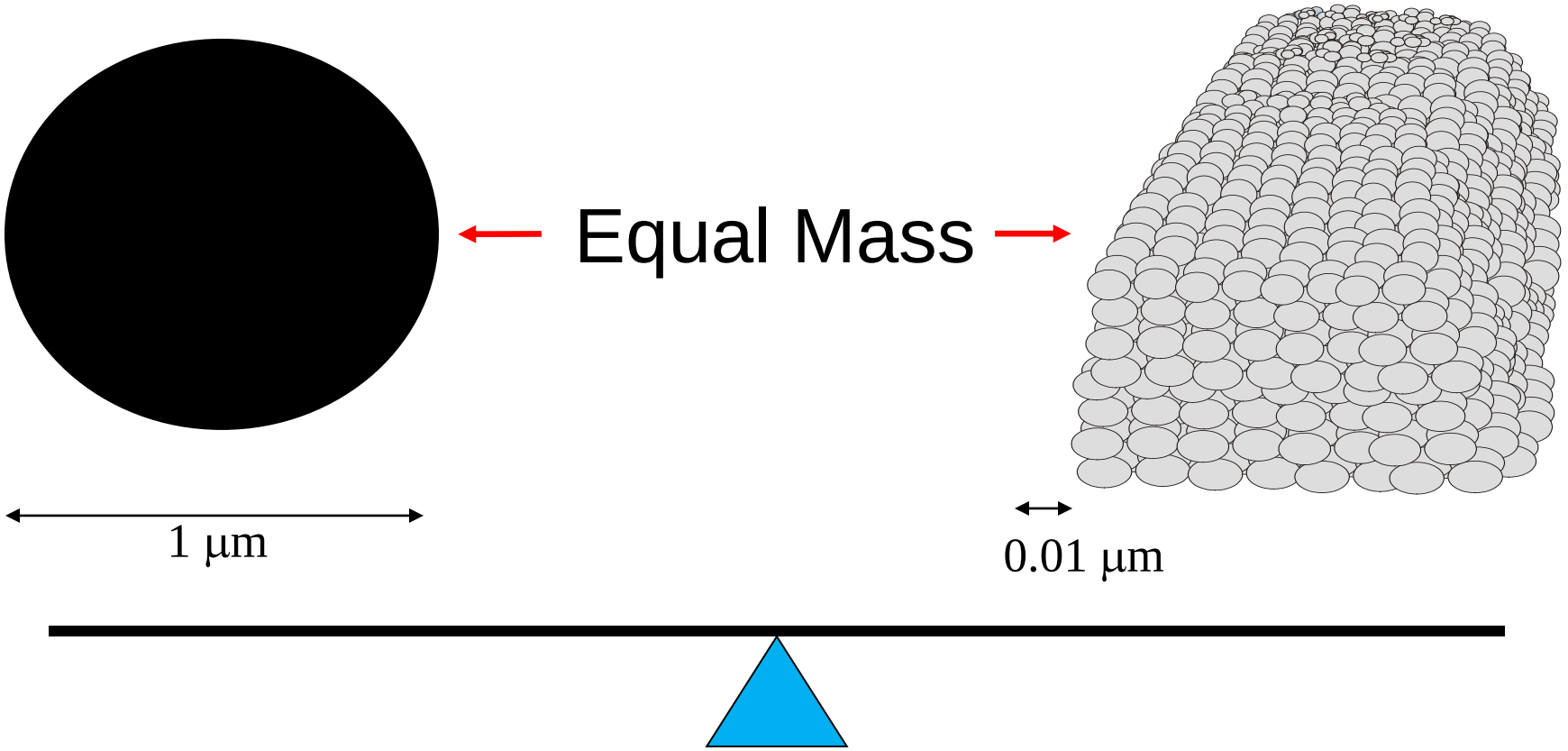
Each location in the lungs where a beryllium particle is deposited can be a site of damage caused by a buildup of dead immune cells.



Ultra-fine Particles don't weigh much!

1 particle

1,000,000 particles



What does work?

Deposited Submicrometer Particulate
based exposure measurements showed good correlation with BeS/CBD cases

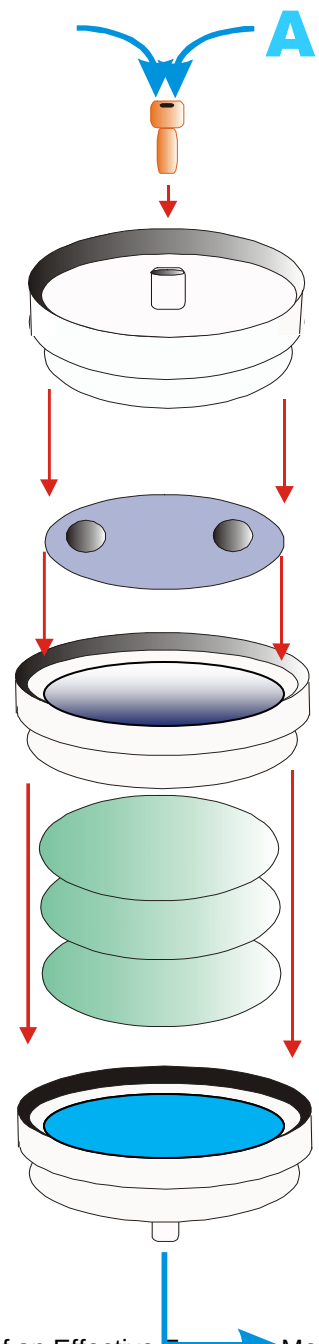
but

it is complicated!

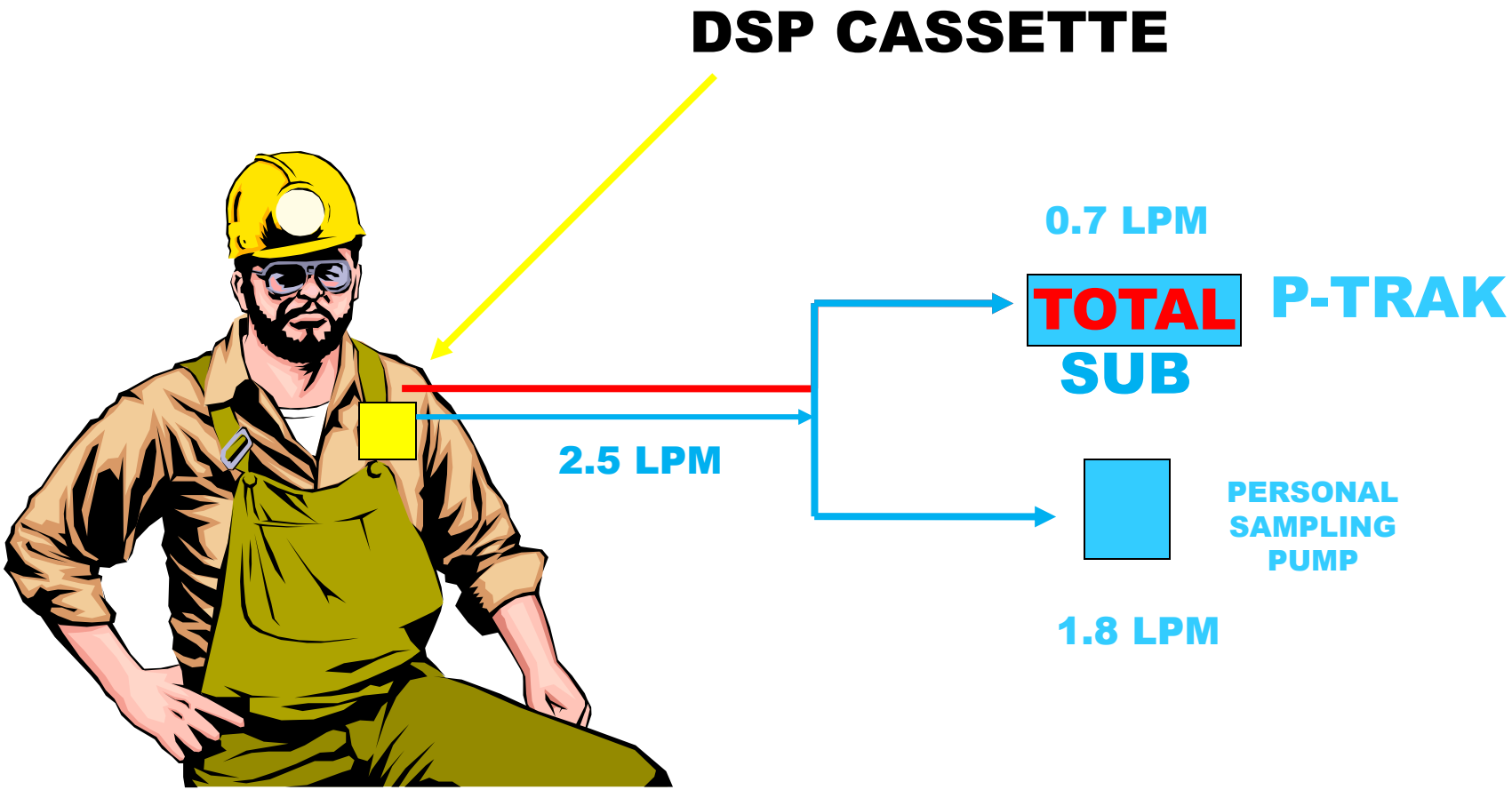
Deposited
Submicrometer
Particulate

or

DSP CASSETTE



Particle Count Measurements



DSP = TOTAL - SUB

Condensation Particle Counter

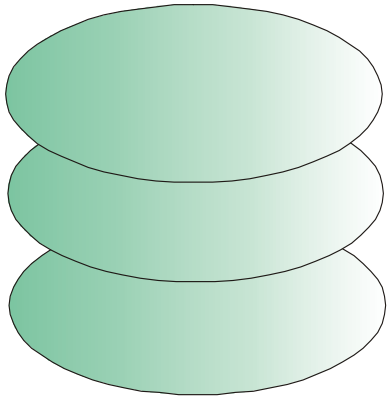
(P-TRAK)

RANGE : 0.03 – 1.0 um

FLOW : 0.7 LITERS/MINUTE

DIRECT READING
WITH DATA LOGGING
CAPACITY AT 1 Hz

ANALYSIS



POLYCARBONATE FILTERS

GRAVIMETRIC ANALYSIS → TOTAL MASS

CHEMICAL ANALYSIS ↓

BERYLLIUM MASS

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

% Be * DEPOSITED PARTICLE COUNT = DEPOSITED Be COUNT

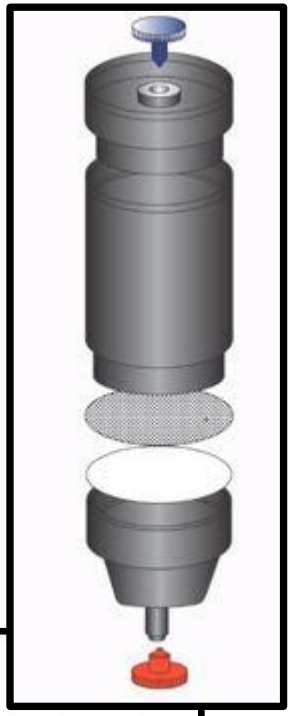
Let’s try something less complicated!

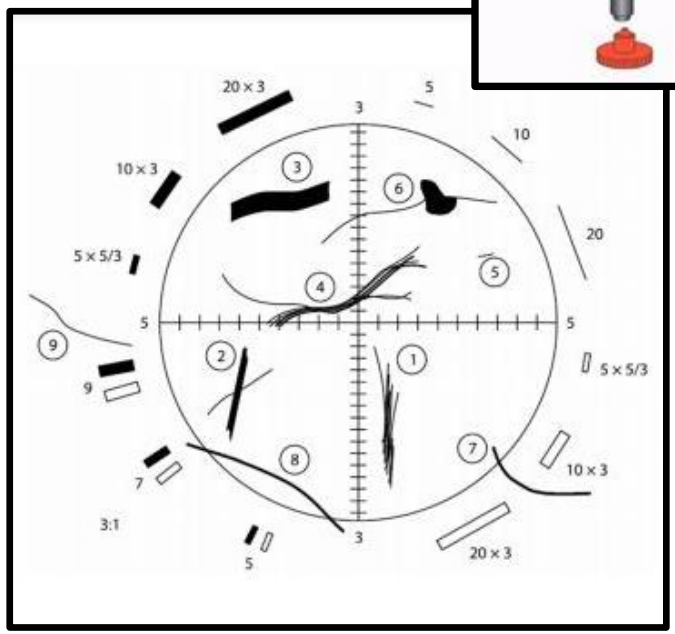
An alternative example of Airborne Particle Counting

- Pattern a new method based on the asbestos sampling and analysis method (NIOSH 7400)
- Fibers per volume of air are counted using a phase-contract microscope and a trained microscopist.

NIOSH 7400 Method Details

- Particles collected on a 25 mm MCEF filter in a non-conductive cowl.
- Filter is cut in a pie shape 1/6th) of the filter.
- Section of filter placed on a glass slide and "digested" to make the material transparent using acetone vapor
- Count 100 fields or 100 fibers whichever comes first using a phase contrast microscope at 400x magnification
- Fibers must have a length to width aspect ration of 3:1 and be at least 5 µm in length
- Can be performed in the field!





Recommendations

- Support the development of a particle number-based exposure metric.
- Collaborate with academia, regulators, H&S organizations.
- Consider expanding the method's use to other metal allergens to gain more interest and support (aluminum, cadmium, chromium, cobalt, mercury, molybdenum, nickel, palladium, platinum, titanium).

Thank you for your attention

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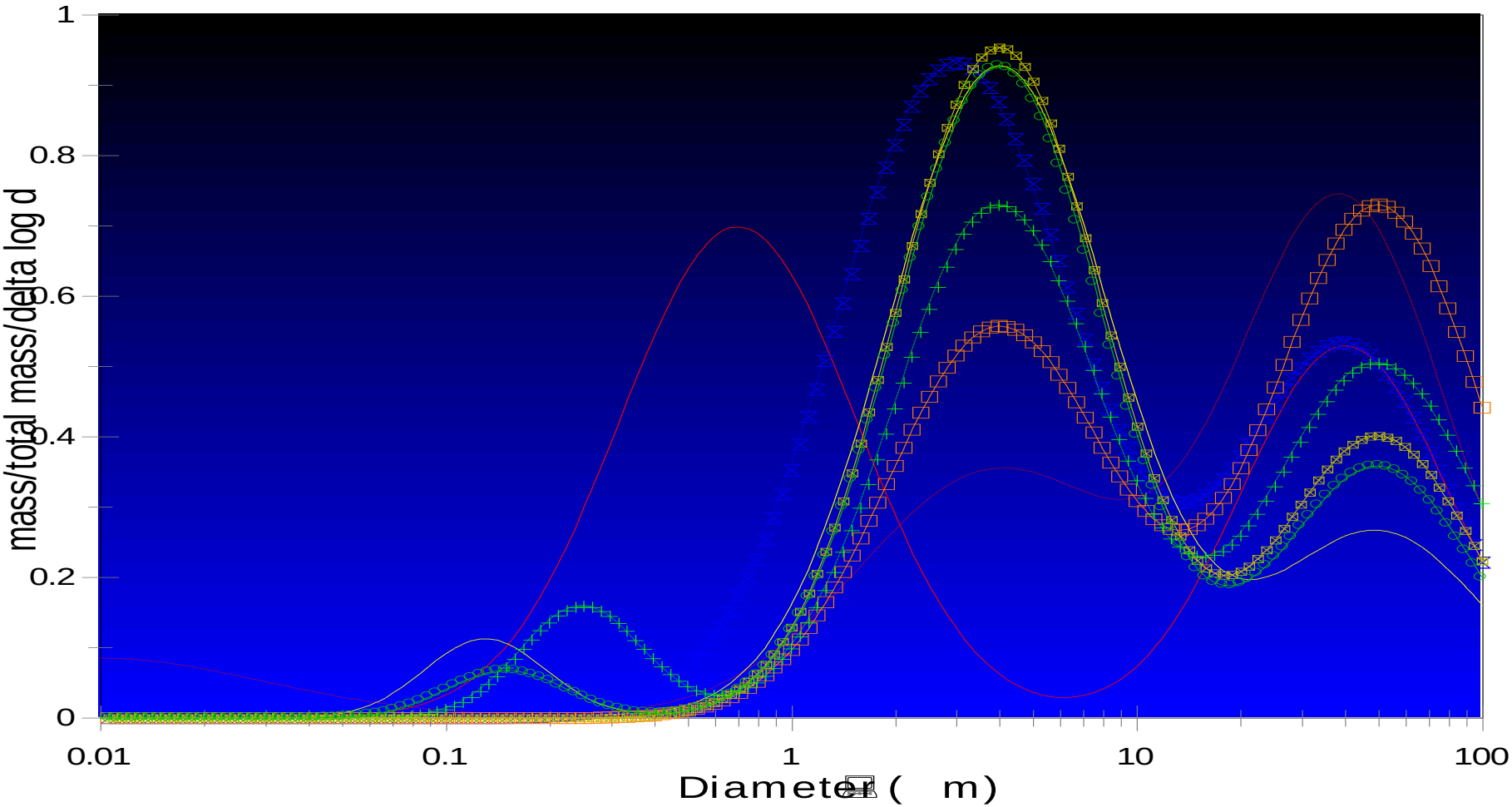
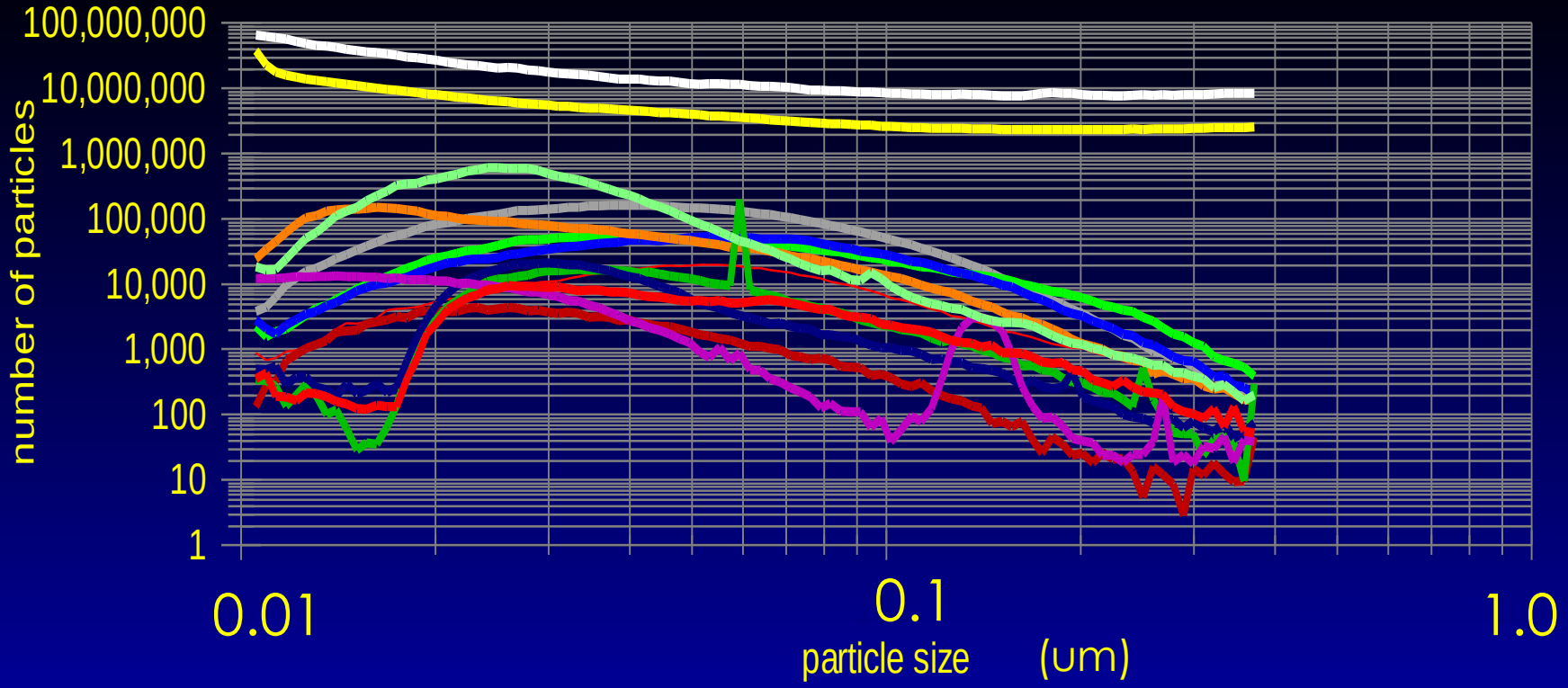
Backup up slides

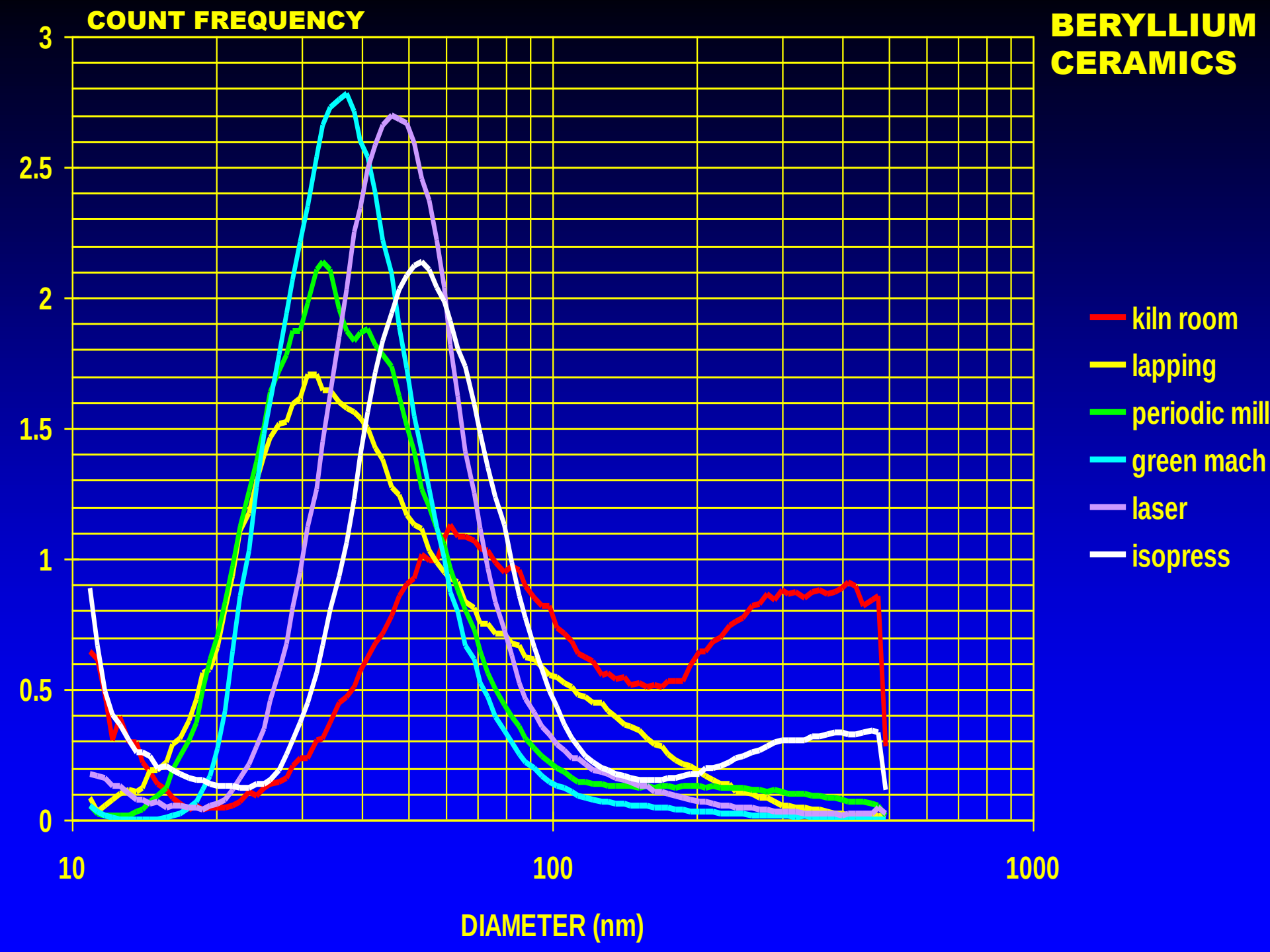
MASS


1
0.8
0.6
0.4
0.2
0
mass/total mass/delta log d
0.01
0.1
1
10
100
Diameter (m)
oxides
fluoride furnace
reduction furnace
resource recove
arc furnace
induction furnace
rod bar & tube
old cast shop

The first "clue"



arc furnace
reduction fce
solution prep
rod repair
old cast shop
impact grind
fluoride fce #1
4 hi
oxides
cast shop 2
Be machining
NCS rub and skim
fluoride fce #2


COUNT FREQUENCY
BERYLLIUM CERAMICS
3
2.5
2
1.5
1
0.5
0
10
100
1000
DIAMETER (nm)
kiln room
lapping
periodic mill
green mach
laser
isopress

COPPER BERYLLIUM STRIP MILL