Introduction to the Measurement of Nanoparticles

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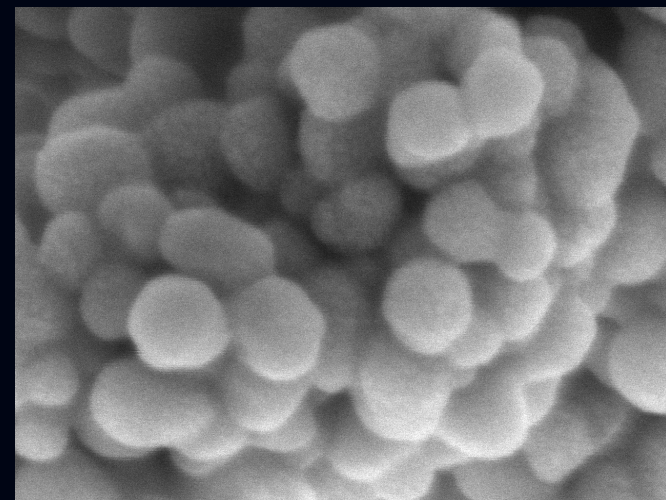# How did we usually measure?

- Mass concentration
- Total particle number concentration
- Particle size distribution

Nanoparticles

New Interests on Nanoparticle Aerosols?

Source: Maynard and Kuempel, "Airborne nanostructured particles and occupational health (2005)"

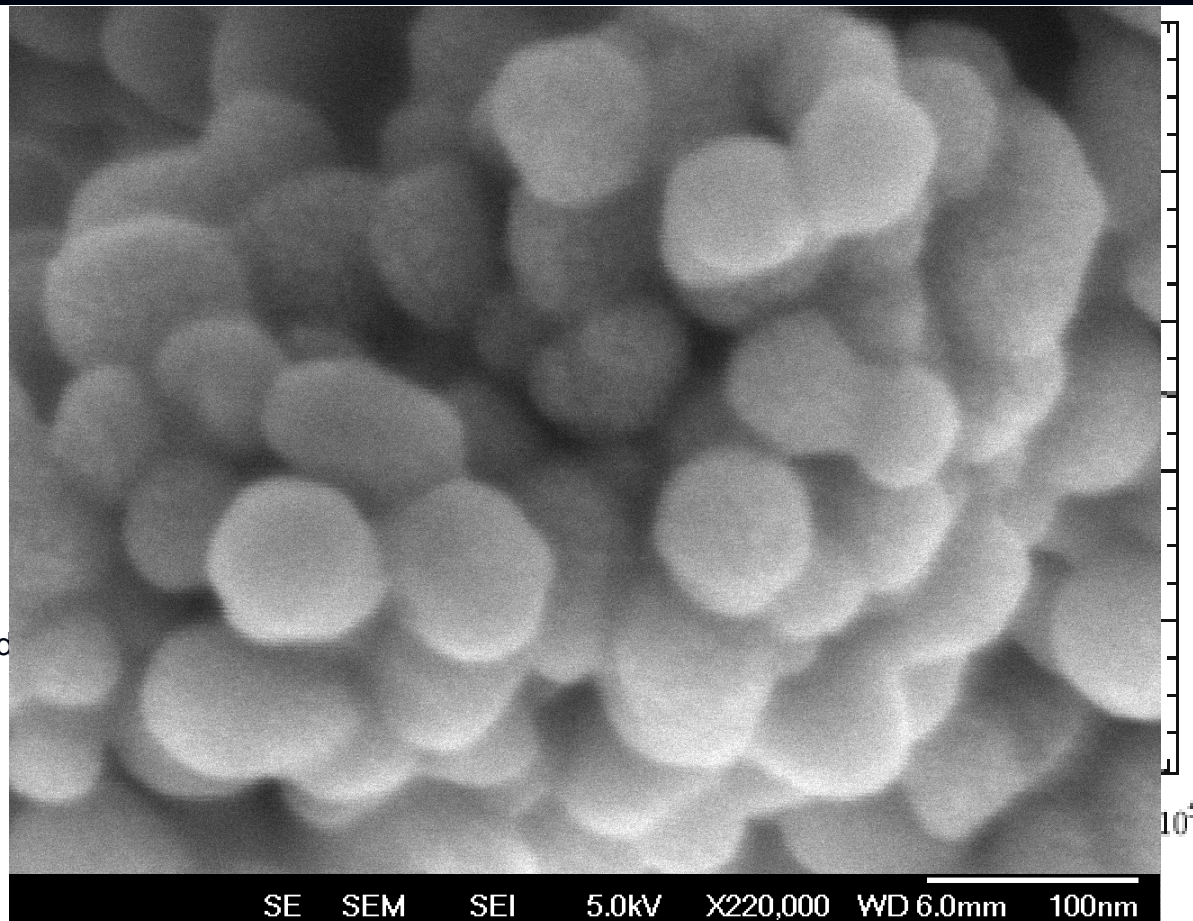SE   SEM   SEI   5.0kV   X220,000   WD 6.0mm   100nm

Figure 2. Modeled total particle deposition probability in the respiratory tract, and deposition probability in the alveolar region (ICRP, 1994). Deposition has been modeled assuming an adult breathing through their nose at 25 l/min (light exercise), and exposed to spherical particles with a density of 1000 kg/m^3.

New Interest on Nanoparticle Aerosols?

- Mass concentration

- Surface area concentration

- Number concentration

- Particle size distribution

- Total particle number concent

- Morphology

- Elemental composition
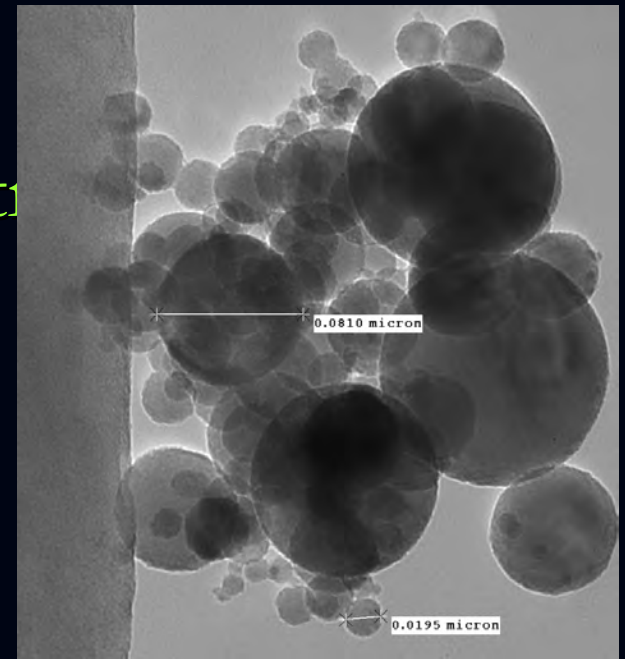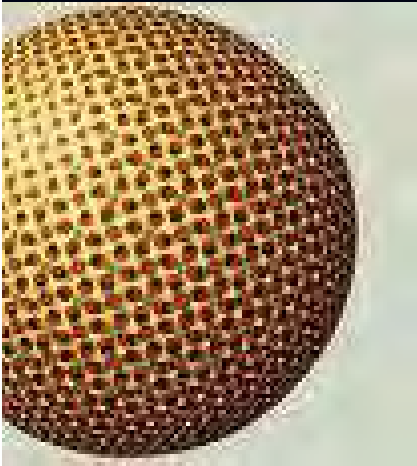
Mass Concentration

- Gravimetric measurement
- Simplest property to measure
  – sampling pump plus filter
- Can also use direct-reading instruments, e.g.
  - TSI 8529 DustTrak™ Aerosol Monitor Measures real-time concentration from $0.001 – 100$ mg/m^3

- **Usually not appropriate for nanoparticles, since the mass concentrations typically are very low**

Surface Area Concentration

- **May be of particular interest for nanoparticles, since some health effects are thought to be a function of particle surface area**

- Can measure total surface area concentration, or surface area as a function of particle size, e.g.
    - TSI 3550 Nanoparticle Surface Area Monitor
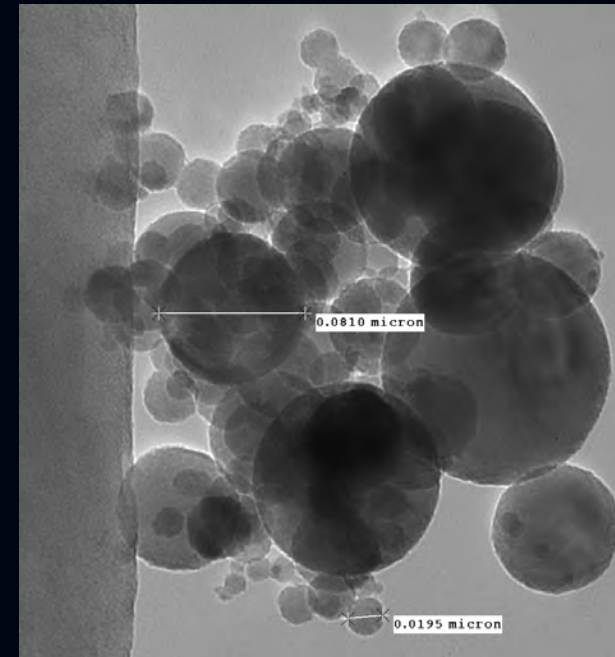   Measures total surface area for particle diameters from 10 – 1000 nm

Number Concentration
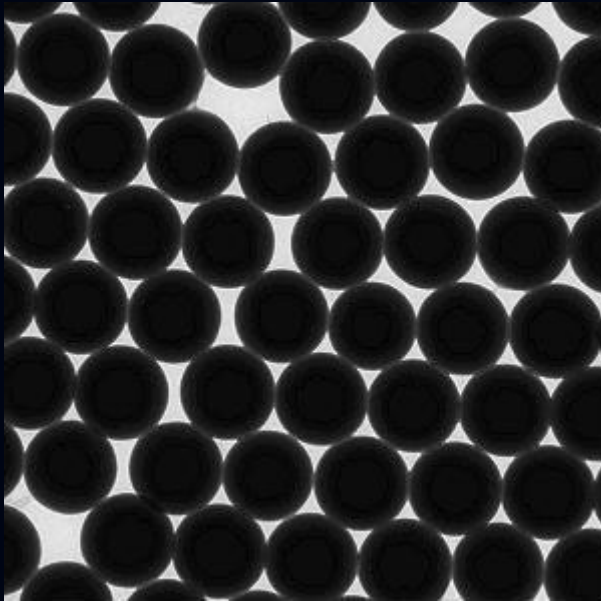
- Measure the quantity of nanoparticles

0.0810 micron

0.0195 micron

- Number concentration is useful to understand the quantity of nanoparticles
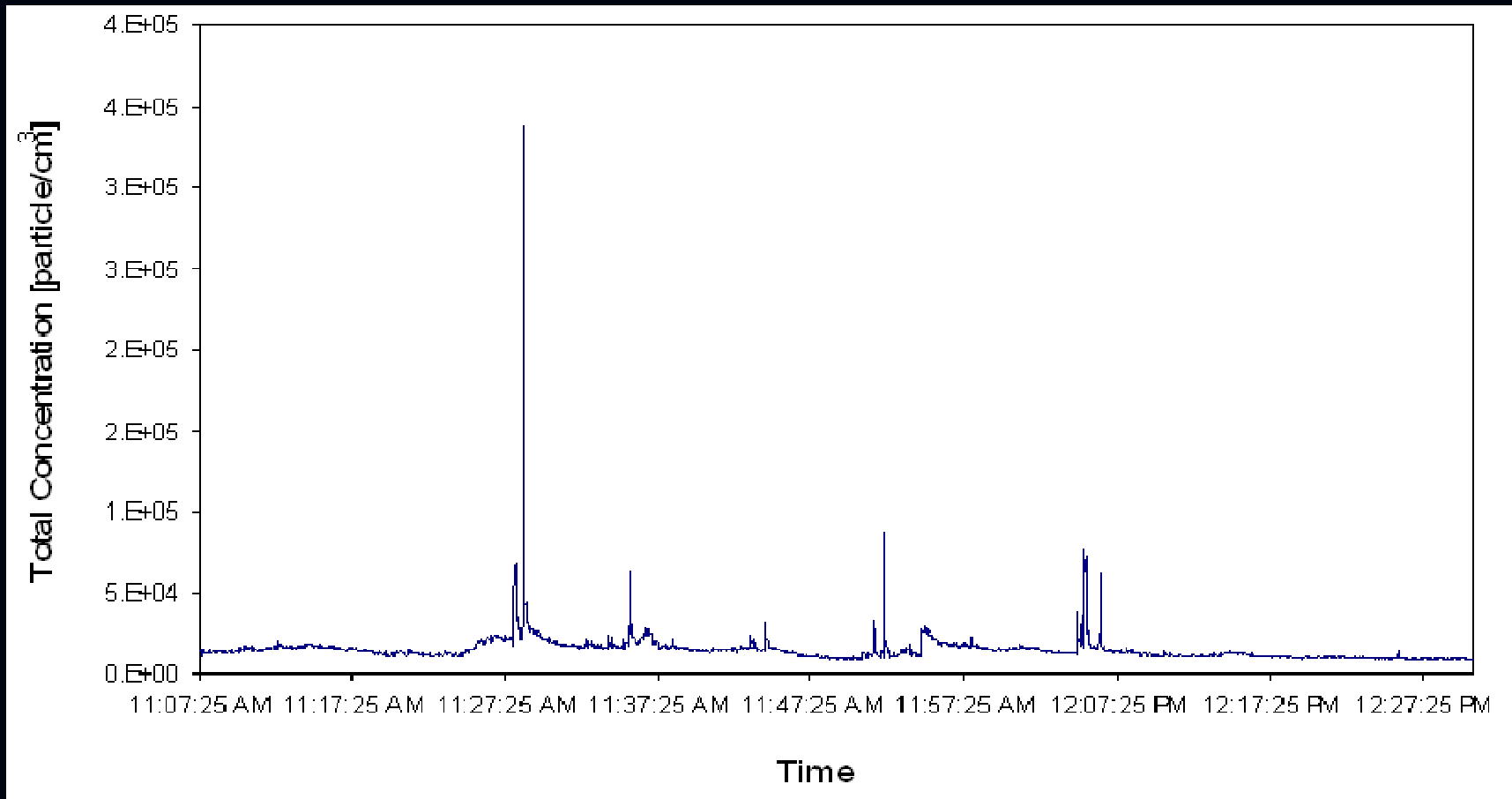
Total particle number concentration

Direct reading instruments that measure total particle concentration over a certain size rang

- Several are available in the nanoparticle size range, e.g.
- TSI 3007 Condensation Particle Counter
  - Hand-held, battery-powered
  - Measures total concentration in the size range from 10 nm - > 1 μm
  - Maximum concentration – 10^5 particles/cm^3
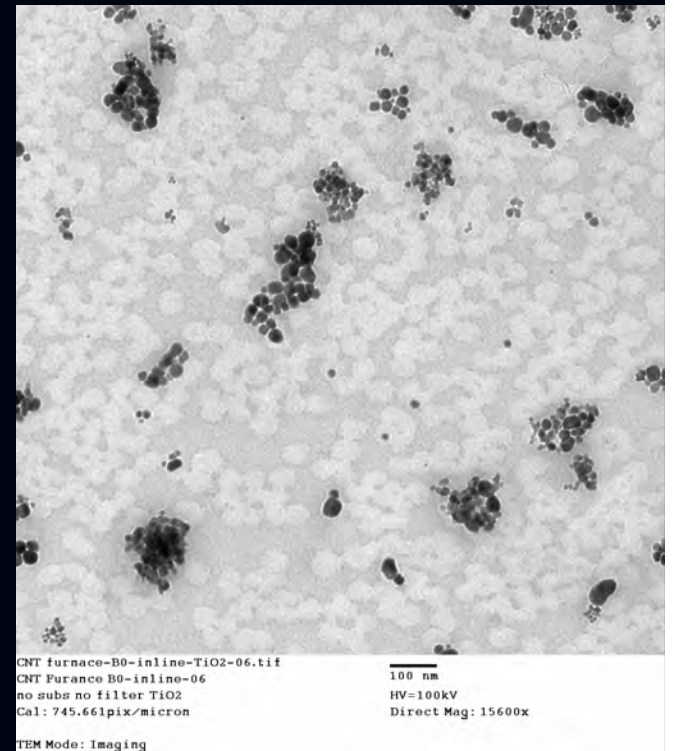 - Discussed in the NIOSH session to follow

Total particle number concentration

Total number concentration is useful for quick surveys, locating particle release points, relative concentrations in different areas of a facility, etc.

Particle size distribution

- Probably the most useful information for evaluating nanoparticle exposure
- Also the most difficult, expensive and time-consuming information to collect
- Also gives you total particle concentration and surface area distribution information

CNT furnace-B0-inline-TiO2-06.tif
CNT Furance B0-inline-06
no subs no filter TiO2
Cal: 745.661pix/micron
TEM Mode: Imaging
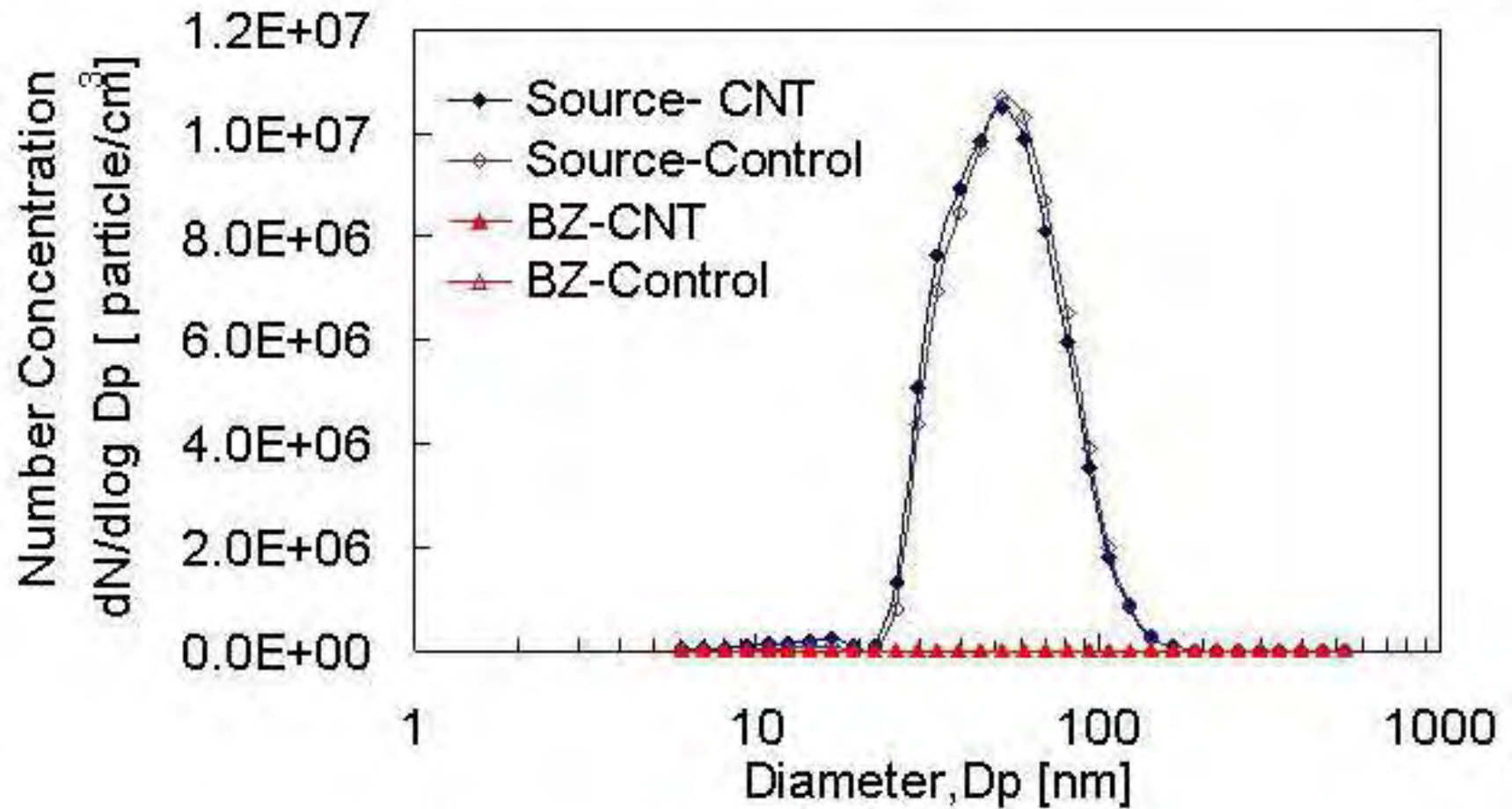
100 nm
HV=100kV
Direct Mag: 15600x

Particle size distribution

- Several are available, e.g.
    - TSI 3091 Fast Mobility Particle Sizer™ Spectrometer
        - Discussed in my session to follow
    - TSI 3936 Scanning Mobility Particle Sizer™ Spectrometers
   - Discussed in the NIOSH session to follow

Particle size distribution

Particle Morphology and Elemental Analysis

- Usually, information on particle size is not sufficient for characterizing nanoparticle aerosols
- Information on particle **shape** and **elemental composition** is needed in order to fully characterize the aerosol – e.g., to determine the source of the particles
- TEM, SEM, XRD
  - Nanoparticles require electron microscopy
  - Detailed discussion in next session
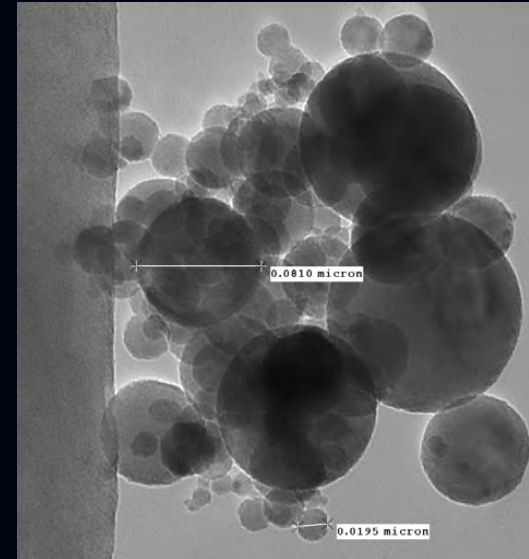
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THANK YOU and QUESTIONS!

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