Measuring Oil in Water: A Sanity Check

Mason Ide, Lew Brown, Peter Wolfe
Fluid Imaging Technologies, Inc.

Outline

- Common Methods Used – Advantages & Disadvantages
- Measurement Techniques Used in This Experiment
- Sample Preparation
- Measurement Results
- Conclusions – Things You Need to Know!

What is Oil in Water, and Why Measure it?

- “Oil in water” is not precisely defined
- Really only defined by a “method” of measurement!
- Initially driven by environmental concerns
- Now being driven more by economic concerns (extraction efficiency)

Two Major Types of Measurement Techniques

- “Indirect” - Most common techniques: Measure something that can be “correlated” to oil in water (IR absorption, UV fluorescence, etc.)

- “Direct” techniques: Directly measure oil in water (particle counters, imaging devices, ultrasound, etc.)

Common Measurement Methods 1: EPA 1664

- US Regulatory Method : the “yardstick”
- “Direct” method; chemical extraction & gravitimetric
- Only measures organics soluble in hexane, therefore not ALL “oil in water”
- Limited to laboratory environment and skilled personnel

Common Measurement Methods 2: IR Absorption

- “Indirect” method: C-H bond common to organics absorbs InfraRed (IR)
- Cannot use water as solvent as it also absorbs IR, so must use other solvent
- Must be calibrated using known concentration samples
- Limited to laboratory environment and skilled personnel

Common Measurement Methods 3: UV Fluorescence

- “Indirect” method: aromatics absorb UV and fluoresce at different emission wavelength
- Amount of fluorescence proportional to amount of aromatics present
- Advantage over IR absorption: no solvent required
- Other compounds (e.g. Iron) also may fluoresce

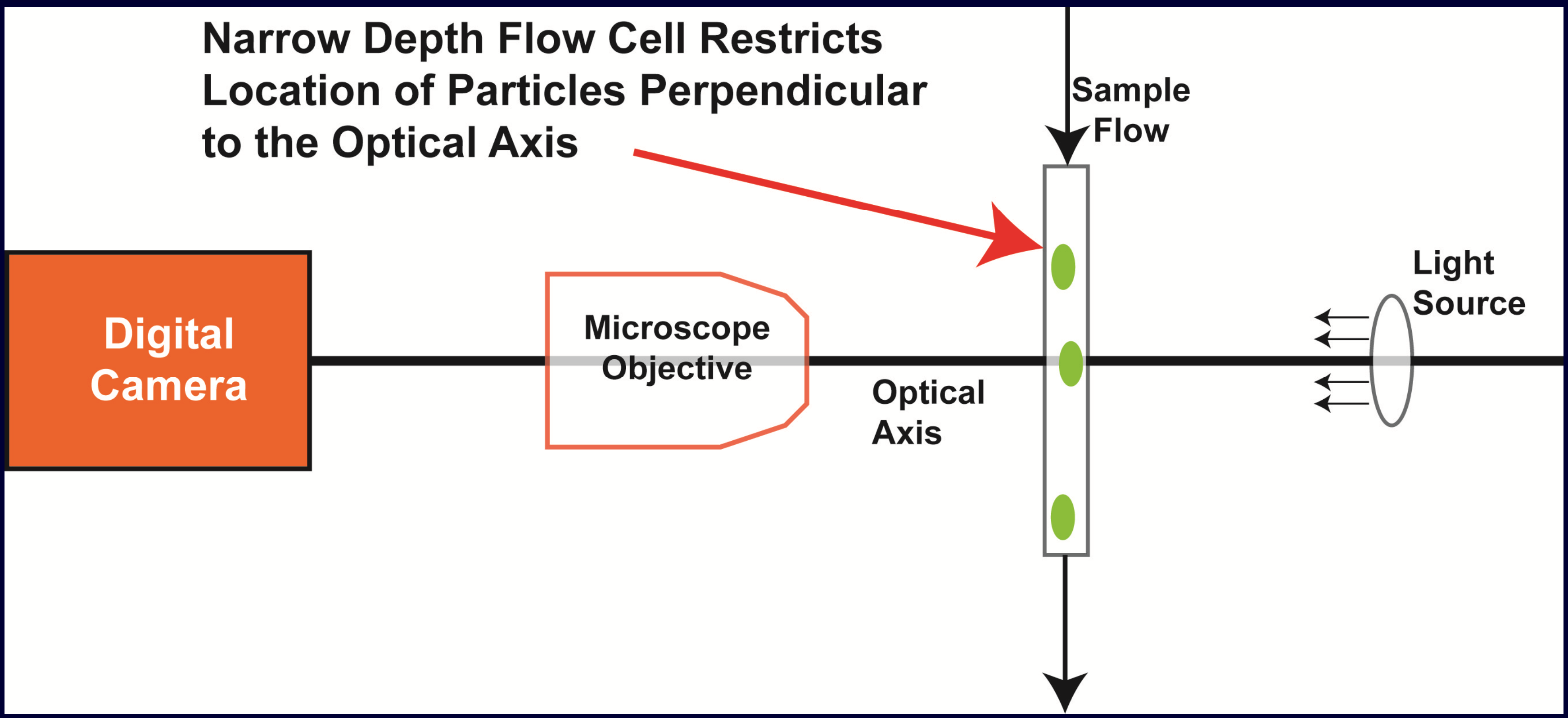
New Measurement Techniques 1: Particle Counters

- “Direct” measurments
- Turbidity: too “coarse”, not precise or repeatable for sparse samples
- “Electrozone counters”: also limited to laboratory environment
- Cannot distinguish between “droplets” and other particulates (e.g. sand, etc.)

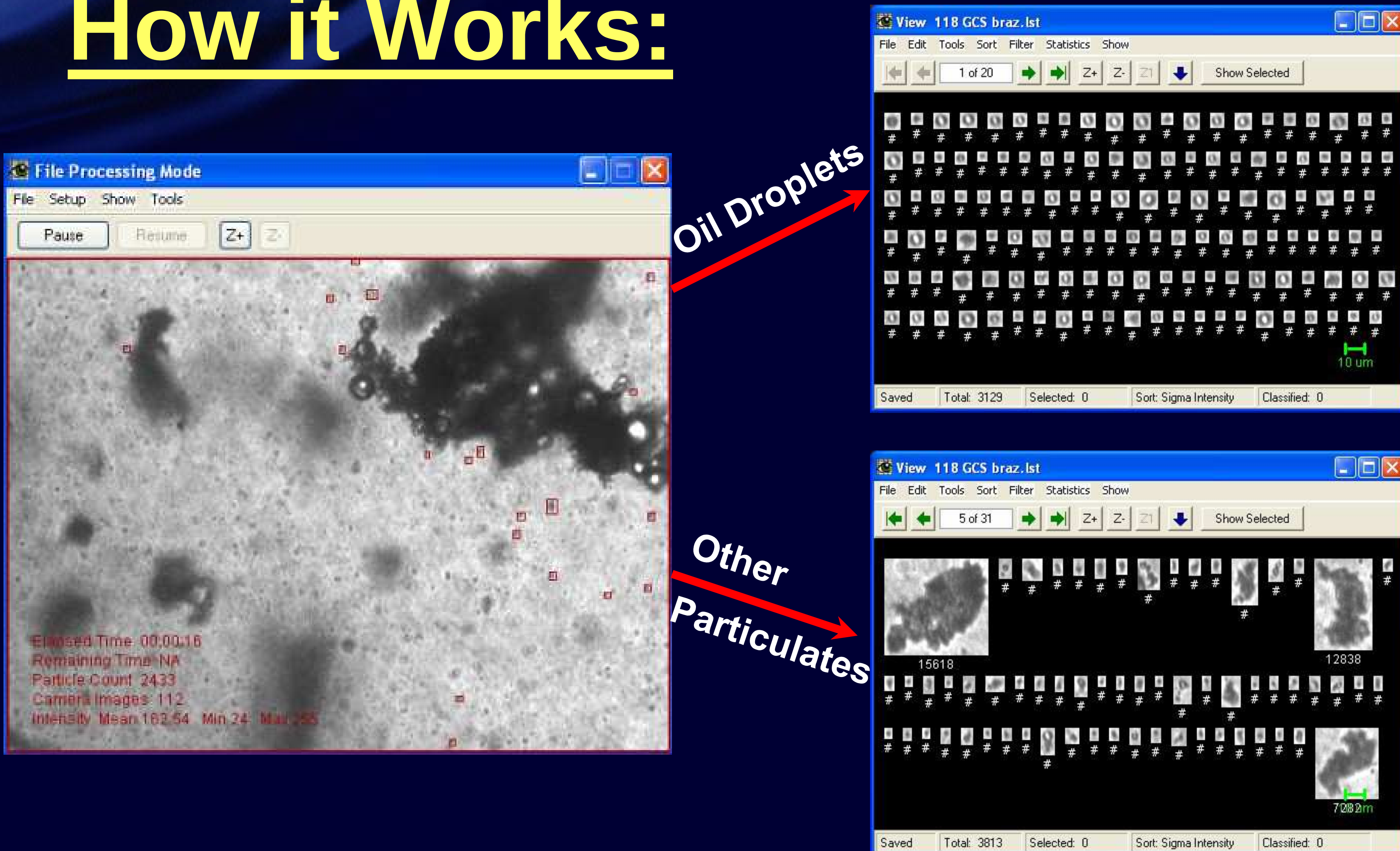
New Measurement Techniques 2: Imaging Particle Analysis

- “Direct” measurments
- Very rapid and repeatable, with potential to use in-situ or “at-line”
- Can differentiate between oil droplets and other particulates based upon shape
- Limited to ≥ 3μm in diameter due to optical considerations

Imaging Particle Analysis How it Works:



Imaging Particle Analysis How it Works:



Imaging Particle Analysis How it Works:

Oil Droplets

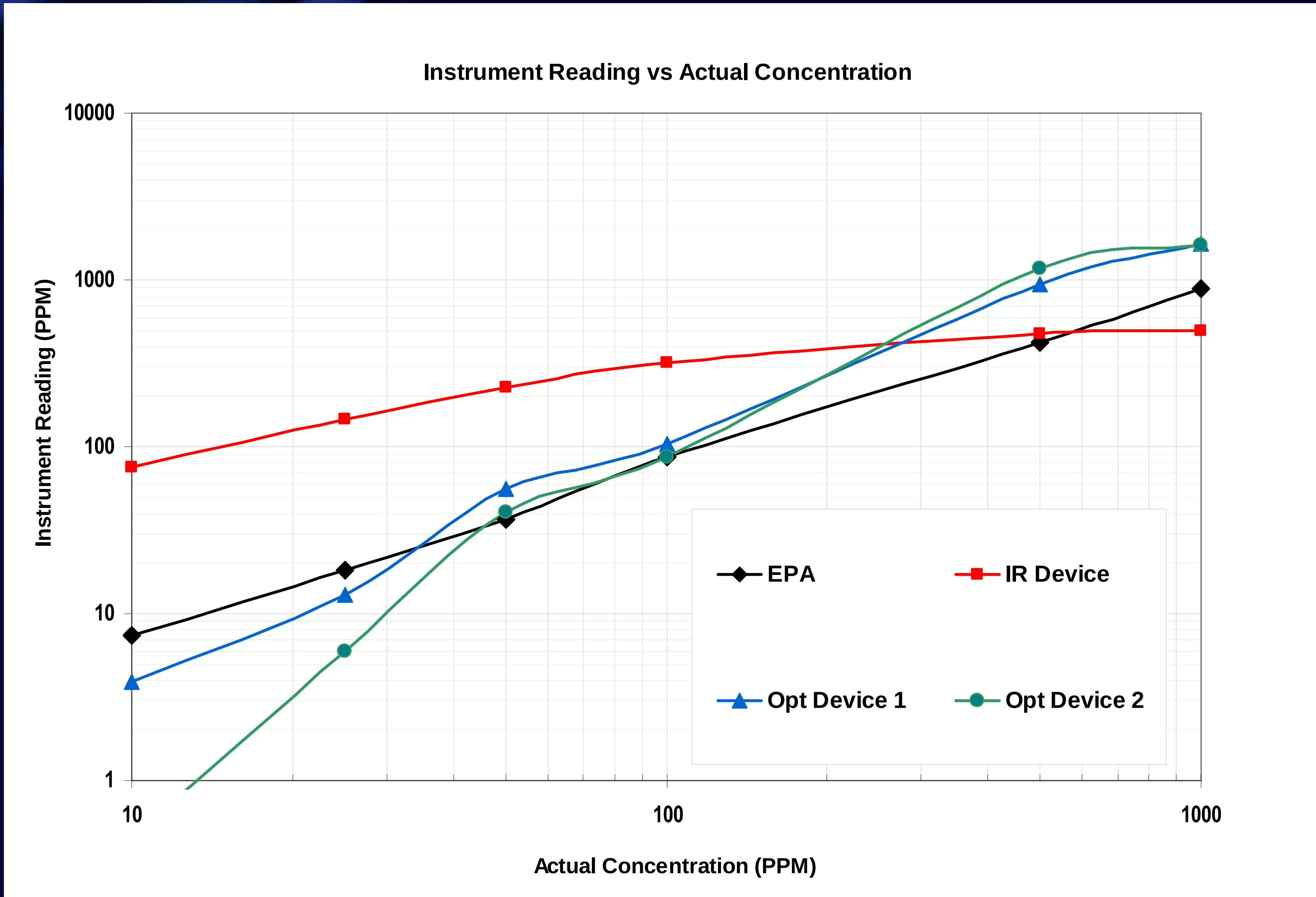
Sample Preparation

- SOP developed and closely followed
- Batches of sample mixed with known concentrations
  - 10, 25, 50, 100, 500, 1000 PPM
  - Each batch then separated into 4 identical samples for each test method
- 2nd Batch also made with known quantity of sand added to test “separability”

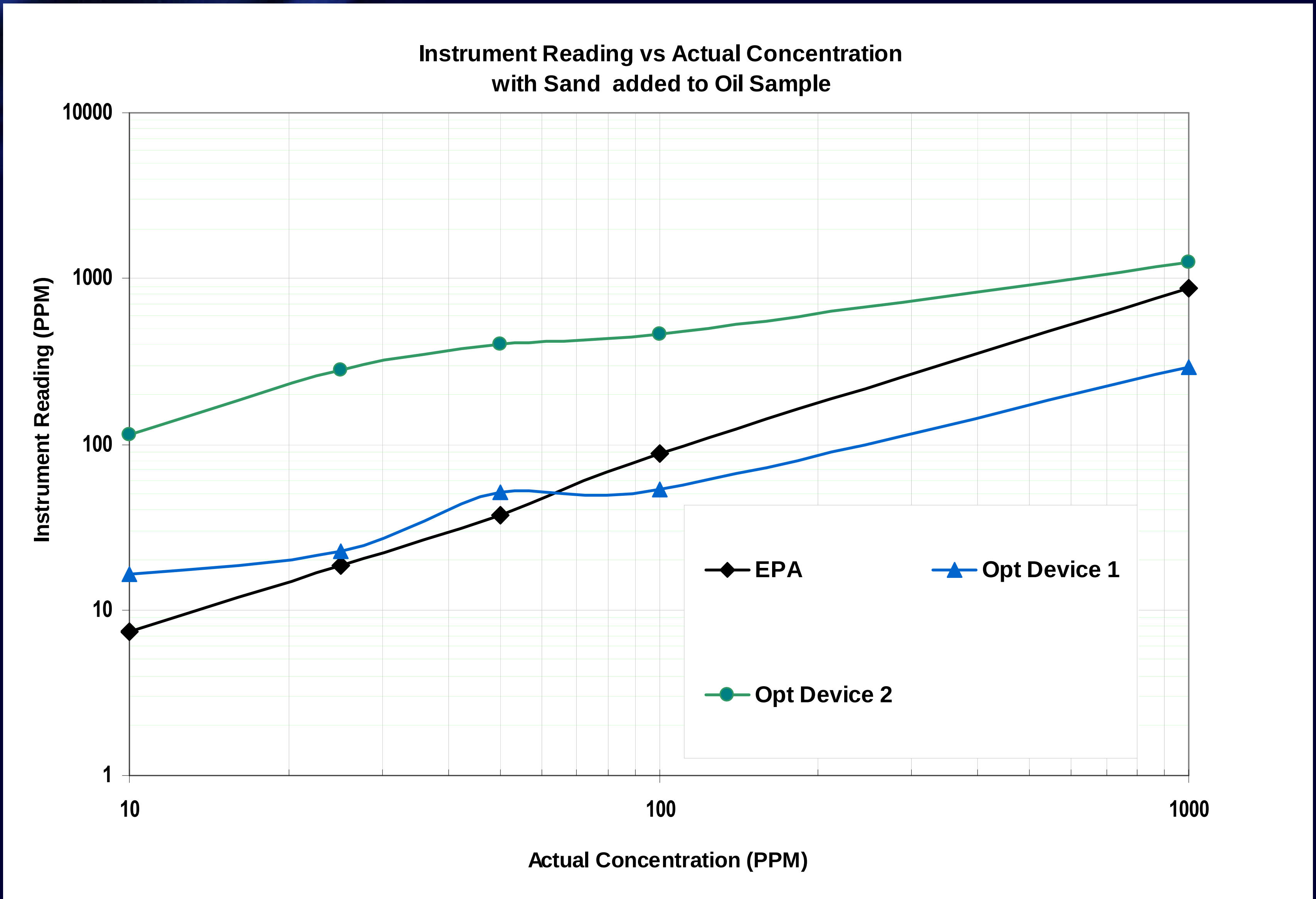
Methods Tested

- All methods used on same samples
  - EPA 1664
  - IR Absorption
  - Two different imaging particle analysis systems

Results 1 (oil only):



Results 2 (oil + sand):



Discussion of Results

- Imaging particle analysis system #1 most closely tracked EPA 1664 results
- Imaging system #2 only reasonably accurate for concentrations >50 PPM
- IR absorption consistently higher by order of magnitude for concentrations <500 PPM
- Imaging system #1 only one that tracked closely after addition of sand

Things to Remember!

- All techniques have positives/negatives
- A firm understanding of how the measurement method works is key
- Any method should be validated and calibrated against known test samples
- Known calibration samples should be "representative" of the actual environment to be measured for best correlations

Questions?

Thank you!