Image Based Particle Size Analysis in Water

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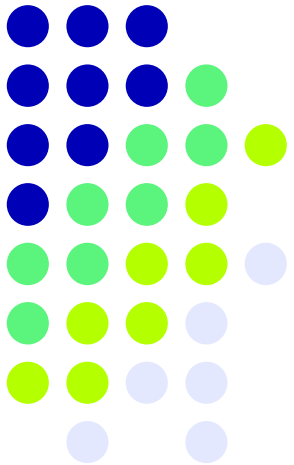
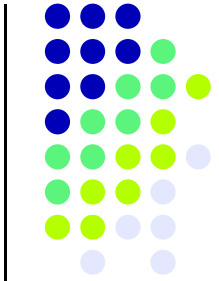
President, J.M. Canty Inc.

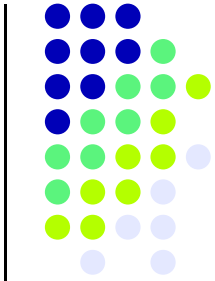


Dynamic Imaging in CIP and WFI Detechs



- Oil in Water (Organics)
- Metals (Rouge)
- BioBurden
- Solids

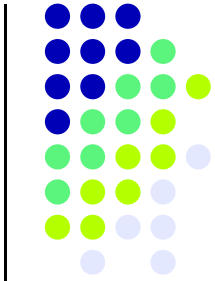
Multi Function



- Turbidity
- Particle Count by item ,Solids , biological,metals and air etc.
- Particle Size and Concentration PPM or PPB
- Color
- % Solids

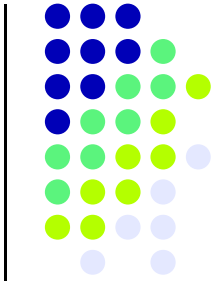
- ALL IN ONE TECHNOLOGY

Key Equipment Components



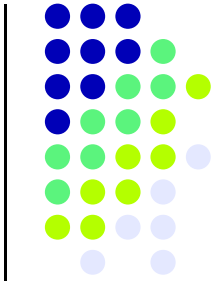
- Lighting,Lighting,Lighting-Fiberoptic
- Imaging sensor Ethernet
- Fused Glass –High Pressure High Temperature , No build up
- Sample Mounting 10mm(1/2in)-200mm(4 in)
- Inline ½-8in (10-400)mm pipe
- HP insertion probe 6in and larger
- Pressure to 10,000 Psi (650 bar)
- Temperature to +800 deg f and -400 deg f
- Software Windows XP and Vista

Optical Resolution



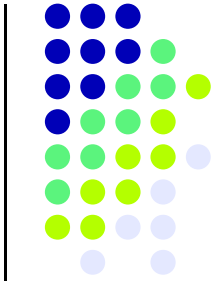
- Particle Size down to .7 Micron up to 2000 micron
- Back Lighting
- IR Filtered-cold light no bake on effect
- Voltage and amperage controlled for Color

Illumination –Controlled, consistent lighting



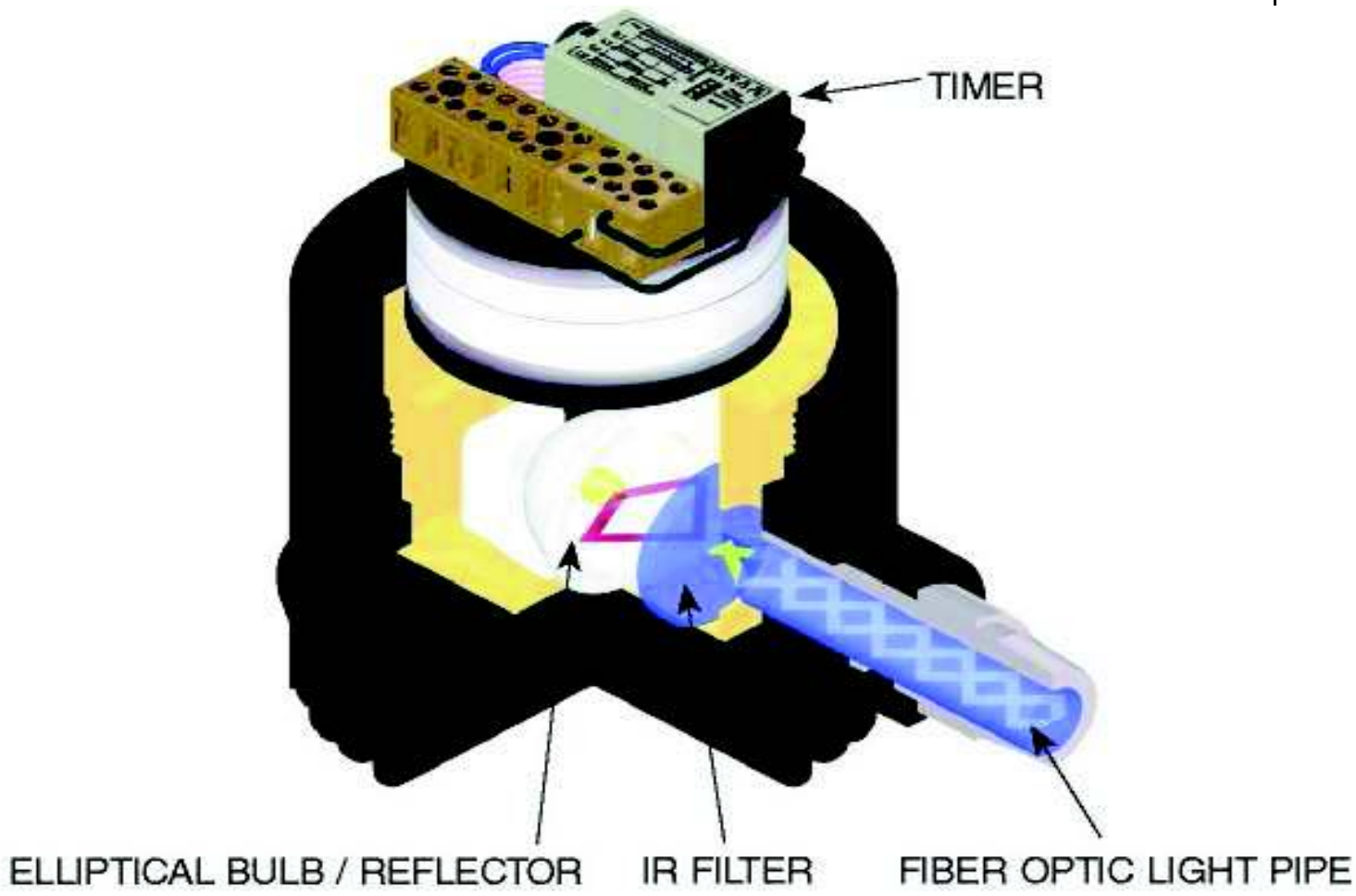
- When particle analysis is performed thresholding will allow for some lighting variations
- Color requires voltage and amperage stabilization to do a true RGB image analysis
- ASTM E12 Color measurement standards
- Turbidity reading is also provided

Particle Characterization

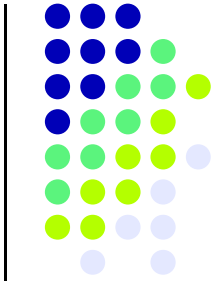


- Particle Color tells what type of solid is flowing through
- Rouge –Red
- Bioburden –green/brown
- Oil-brown/black ,Circular and center white spot
- Gas-black circule with a high fill ratio transparent center

Fiberoptic Cold light



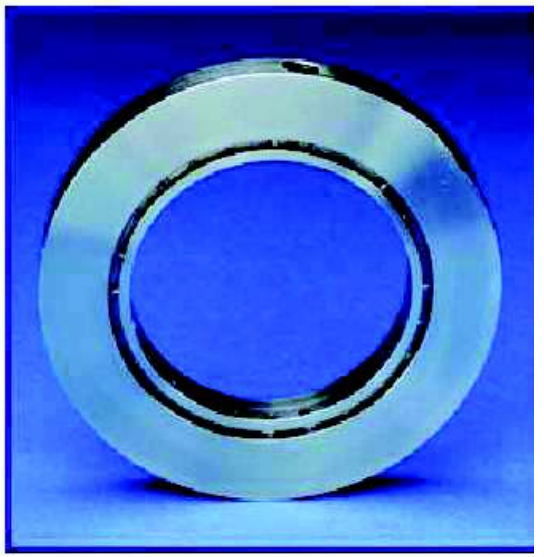
ASME BPE Design



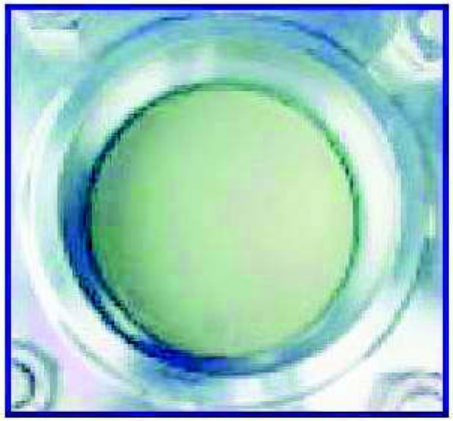
- Designed for Cleanability and Sterility
- FUSED glass no crevices
- Cold light
- Insertion Fiber Optic Lightpipe and Imaging Lens

Spray Ring Technology

- Not needed for inline analysis

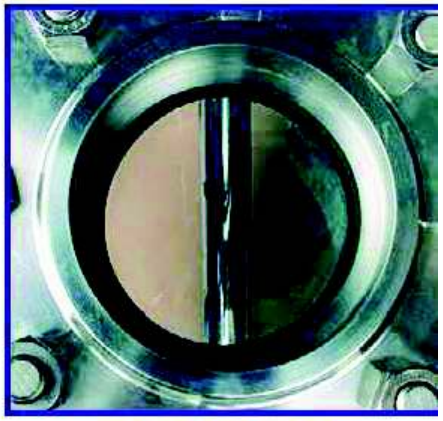


Spray images



COATED VIEW

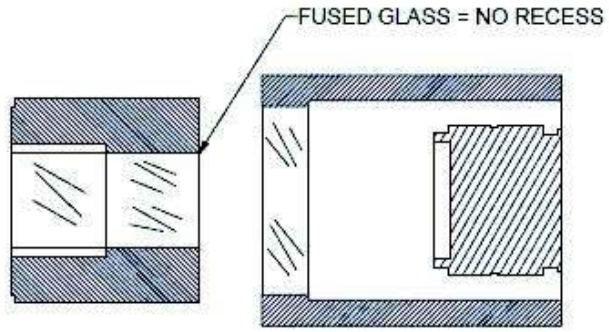
JET SPRAY RING ACTION



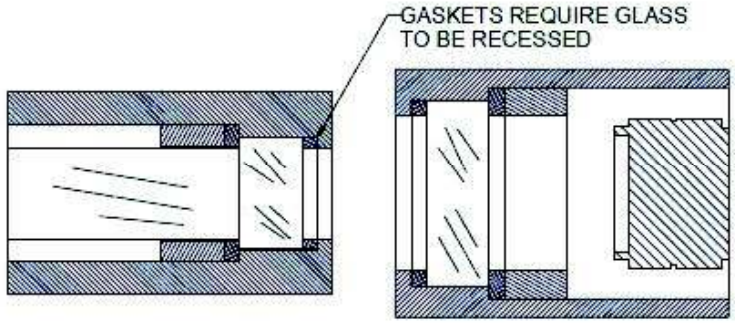
CLEAR VIEW

HOUR BAKE-ON TEST

CANTY COLD LIGHT



CANTY FUSED GLASS



COMPETITION PLATE GLASS

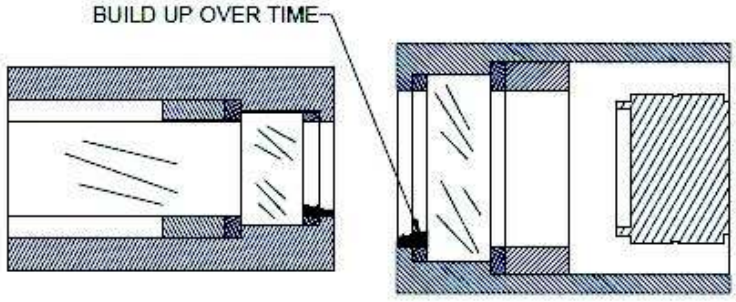
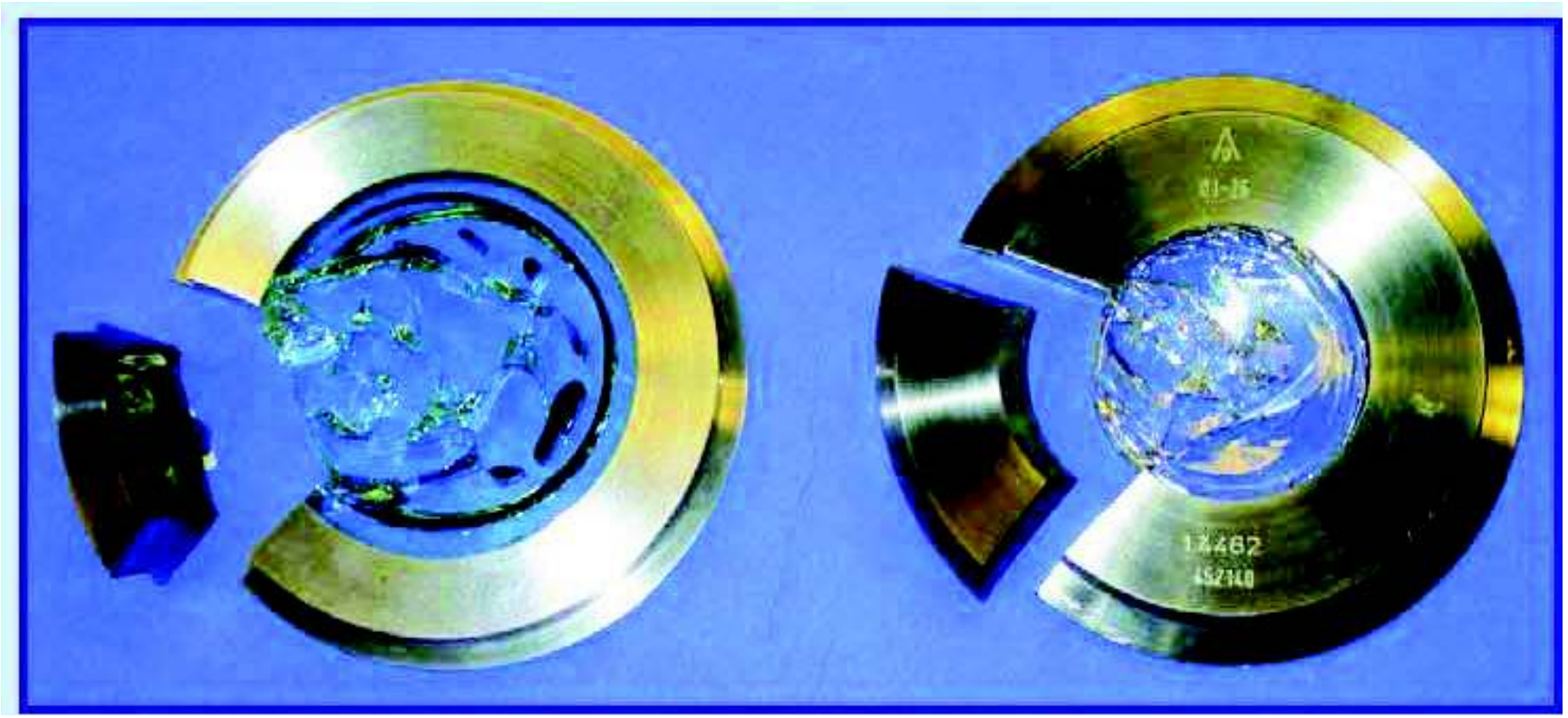


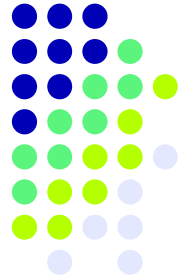
PLATE GLASS WITH BUILD UP

Fused Glass Technology

- Pressure to 10,000 Temp -450 to 800 deg F

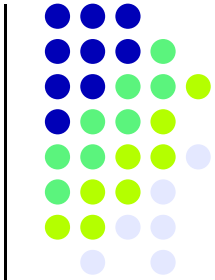


Inline Imaging Flow Channel



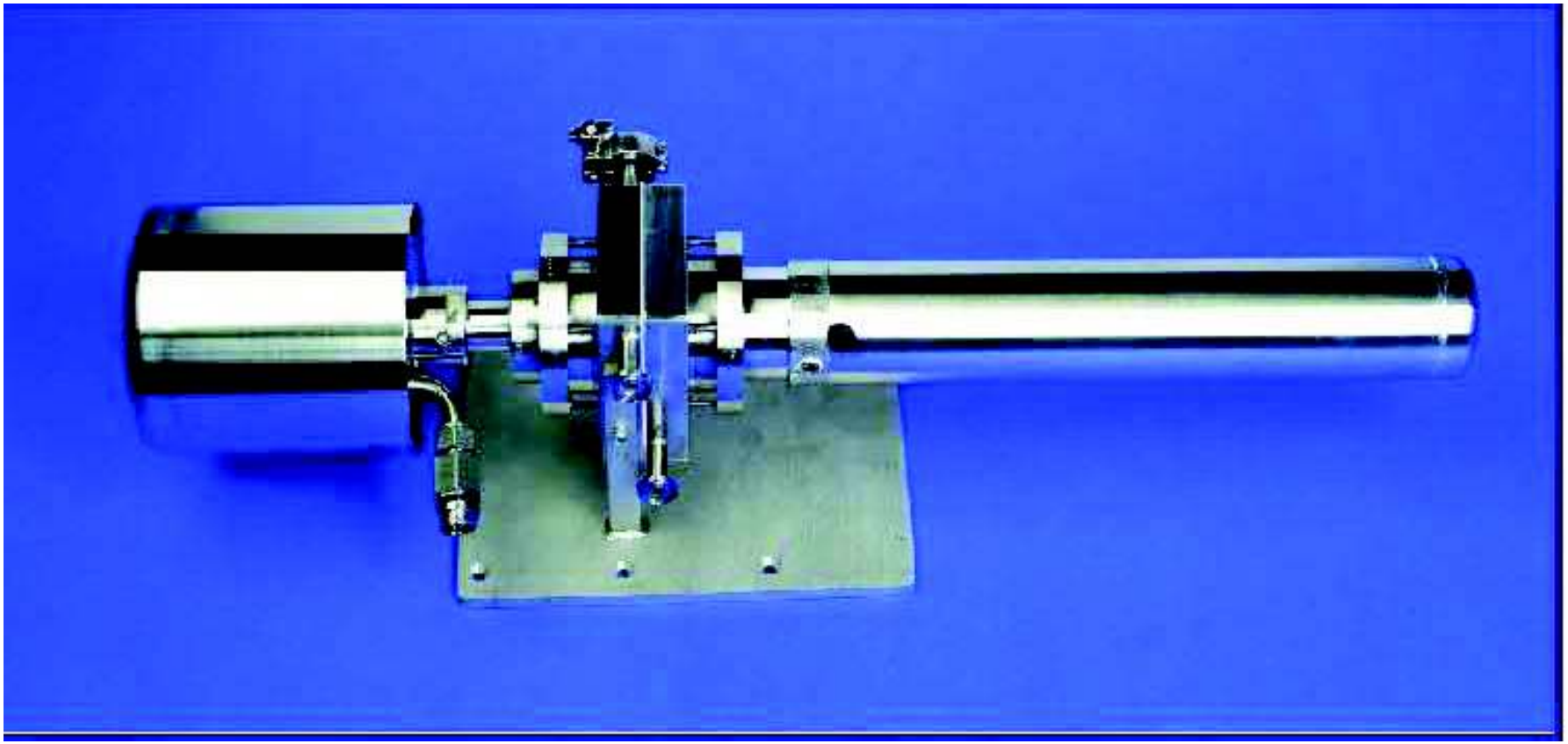
- Portable unit used throughout the plant and City for trouble shooting.
- Inline unit for continual monitoring
- No sample lines to fowl in the inline and the insertion models eliminate some of the key problems on the current systems.

Weatherproof Construction



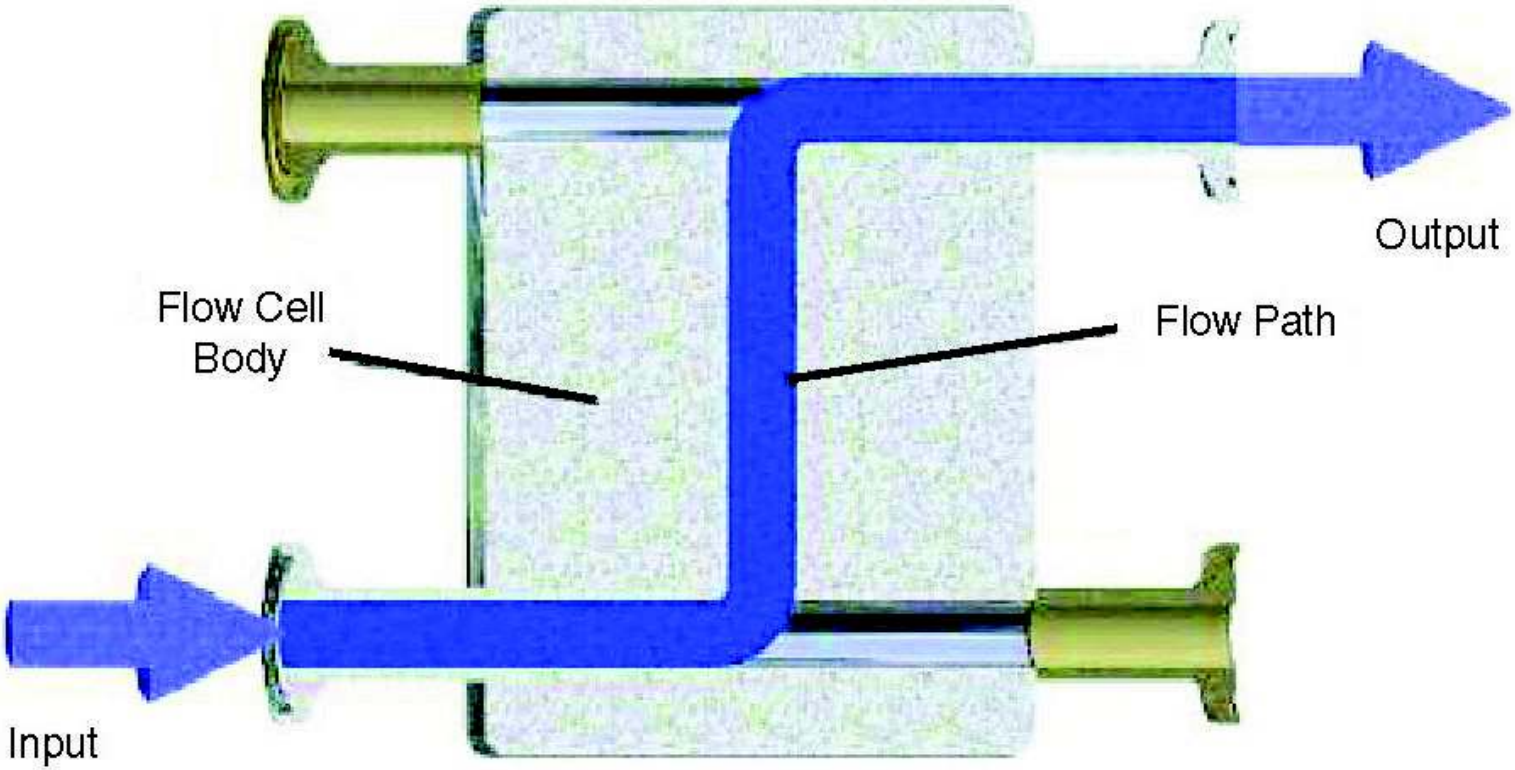
- The imaging units are used on offshore Rigs through out the world. In harsh areas like the North Sea and into the robust nature of Tar Sands.
- Chemical use adds some extremely harsh corrosion and viscosities (polymer)

Portable MicroFlow



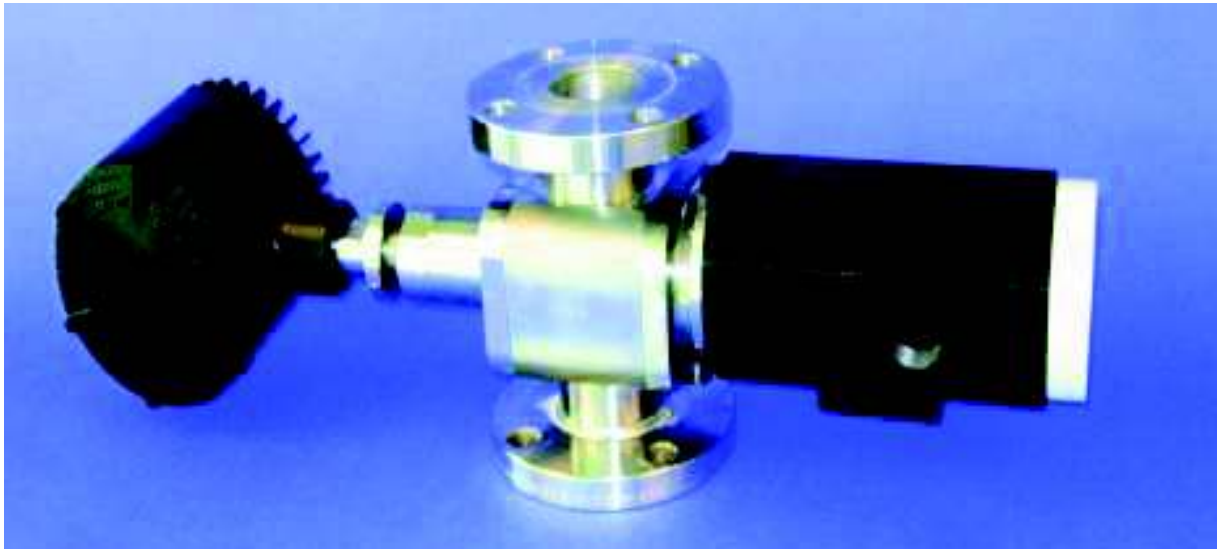
MicroFlow laminar flow pattern

- 4 port option for dilution and Flushing



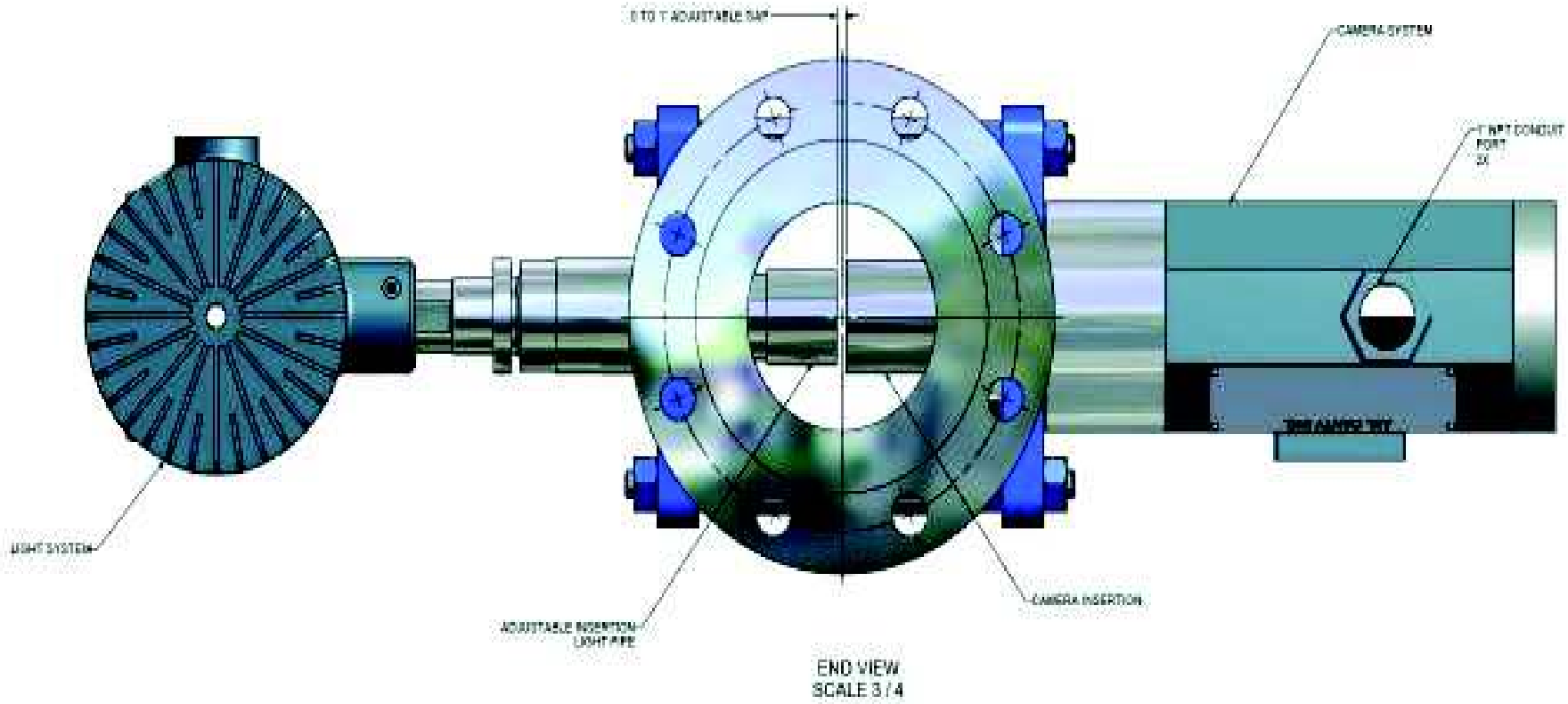
Inline Equipment

Equipment requirements for oil/water analysis applications range from lab based, to in line to submerged. The following images illustrate systems that can be used in these various situations.

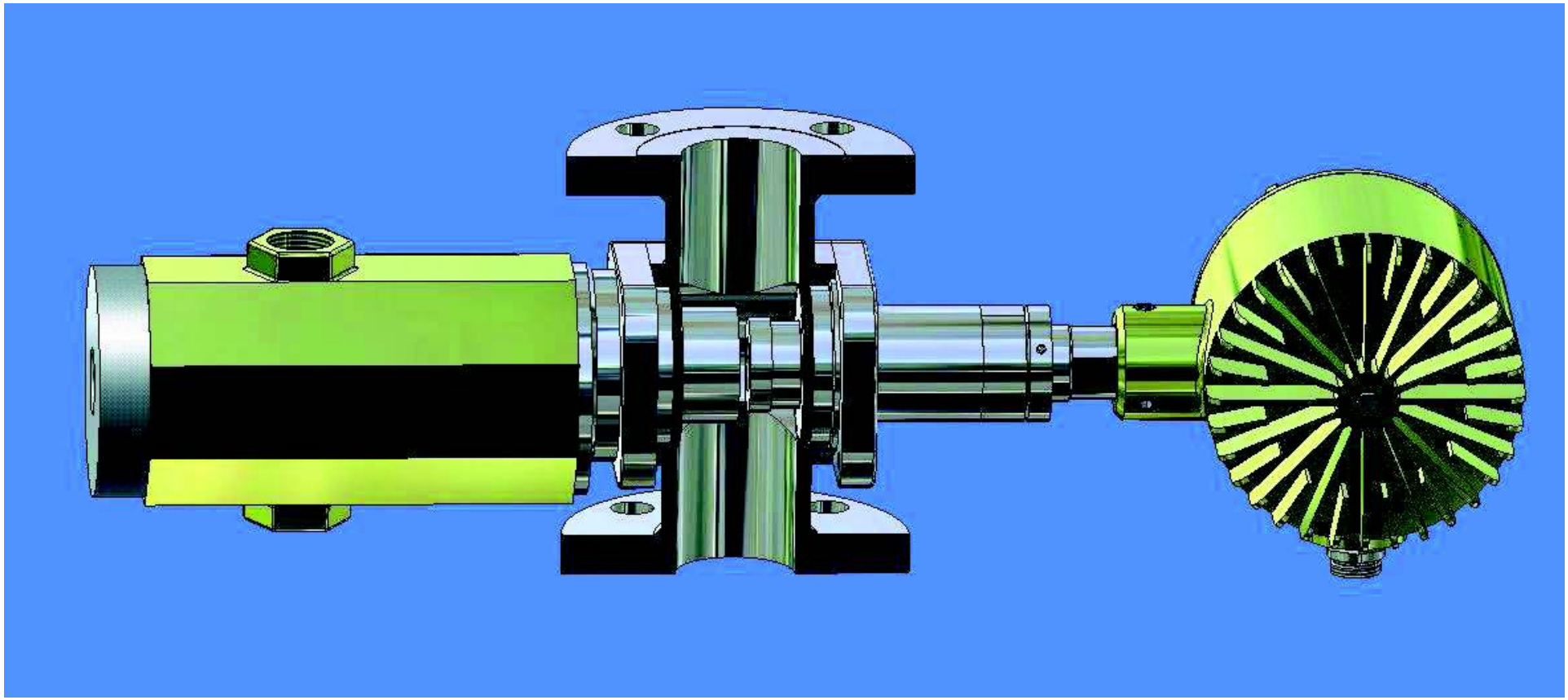


In line analyzer with flanged pipe connections. Common installation

Inline full pipeline up through 30in

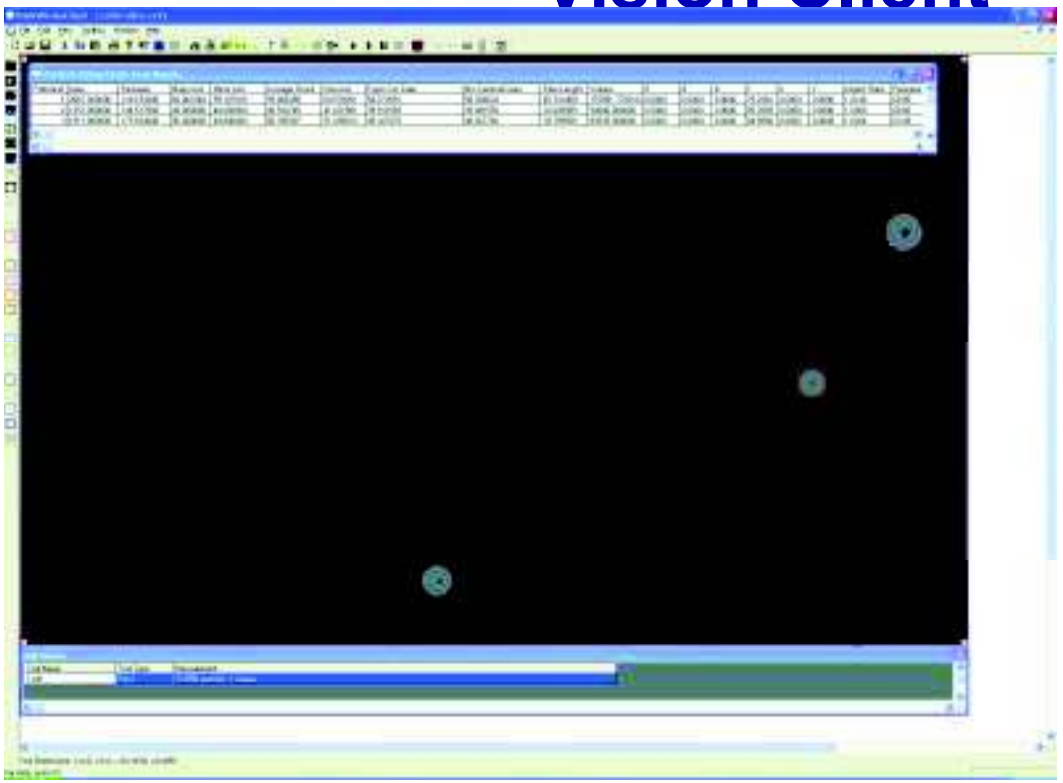


Gap adjustment



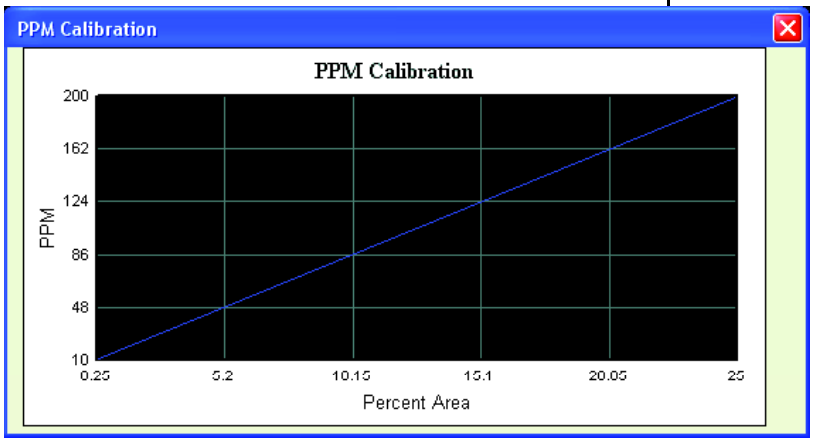
Oil in Water Detection using Canty Vision Client

- Visual verification of particles truly sets Canty apart from all other systems.
- Each particle analyzed is clearly displayed on the screen.
- There is no guessing with a Canty Particle Sizing System



Data Analysis and Graphs

- Calibrated PPM and PPB outputs
- Replaces and correlates to screen analysis
- Particle distribution by major, minor diameter
- Particle area
- Particle perimeter

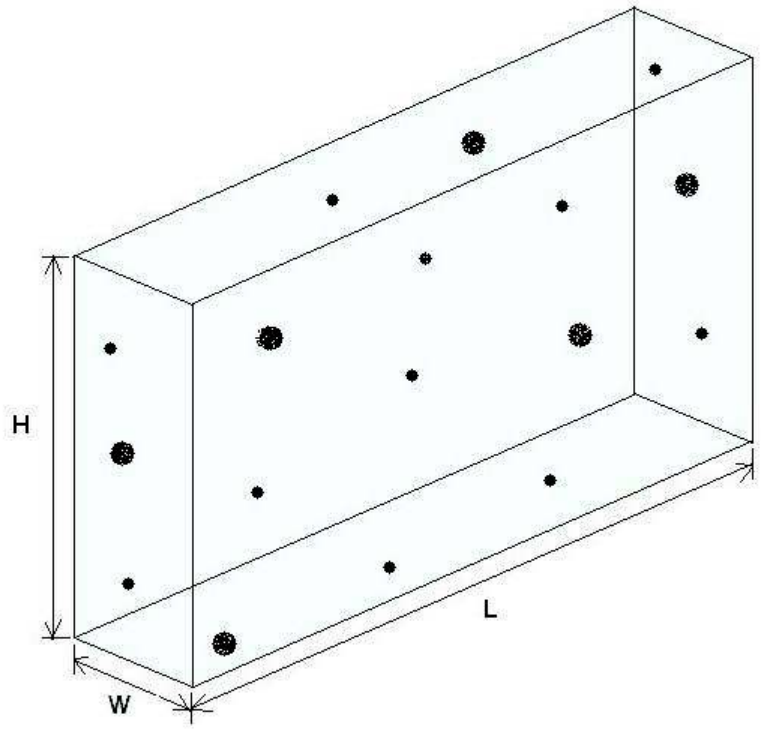


- Several Plot Types: Differential, Cumulative Retained & Passing
- Plot Data By: Minor Axis or a major, Average Cord, Area, Perimeter, Aspect Ratio many more

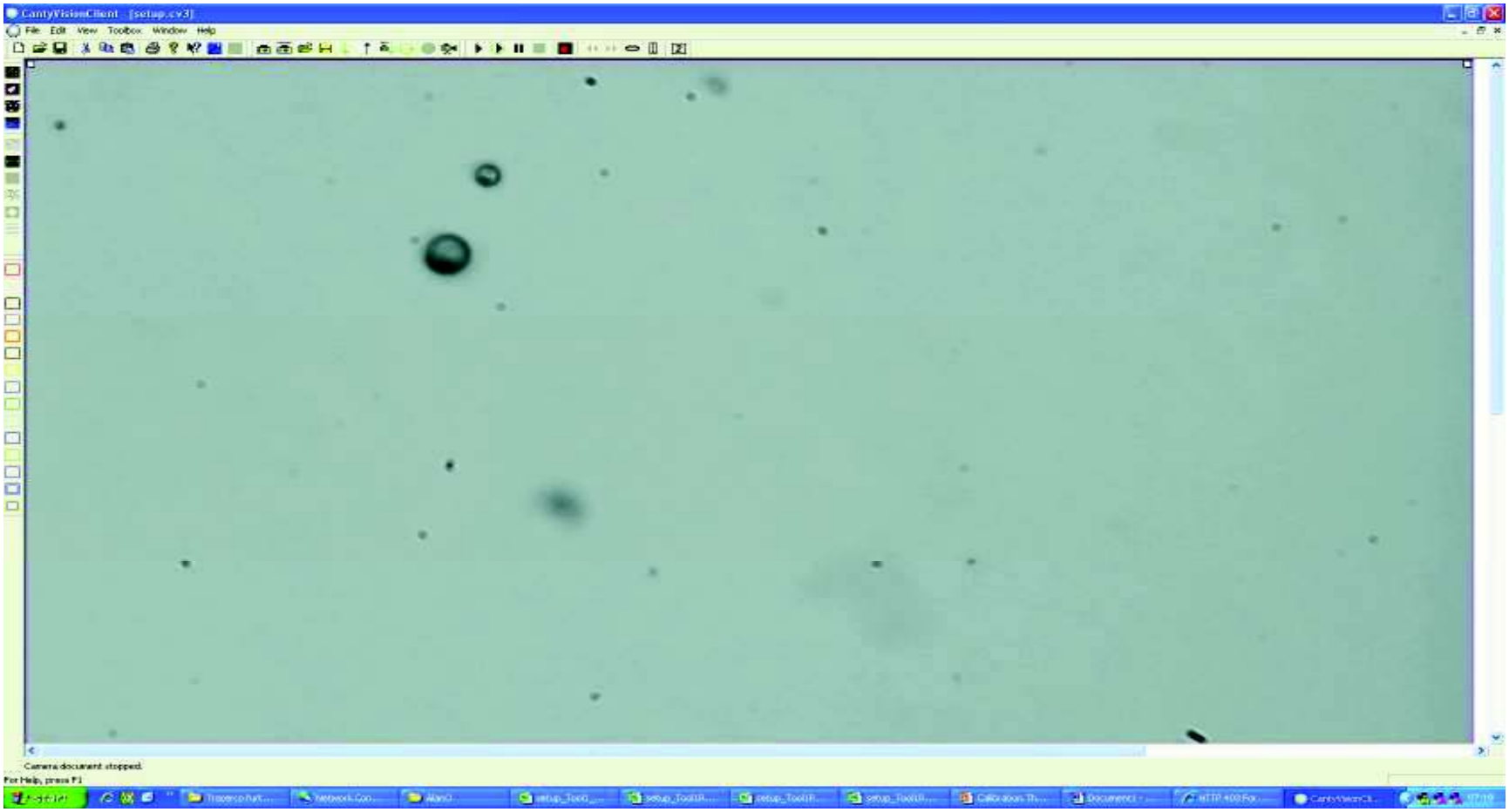
Calibration Theory

The percent oil in water can be calculated using the formula below:

% Oil in Water = (Volume of oil in water / Volume of water) x 100



Live Image


File Edit View Toolbox Window Help
Camera document stopped.
For Help, press F1

From the image shown on the pervious slide we can calculate the volume of the oil droplets using the formula:

$4 / 3*\pi*r^3$

Therefore using the formula;

N = Number of oil particles

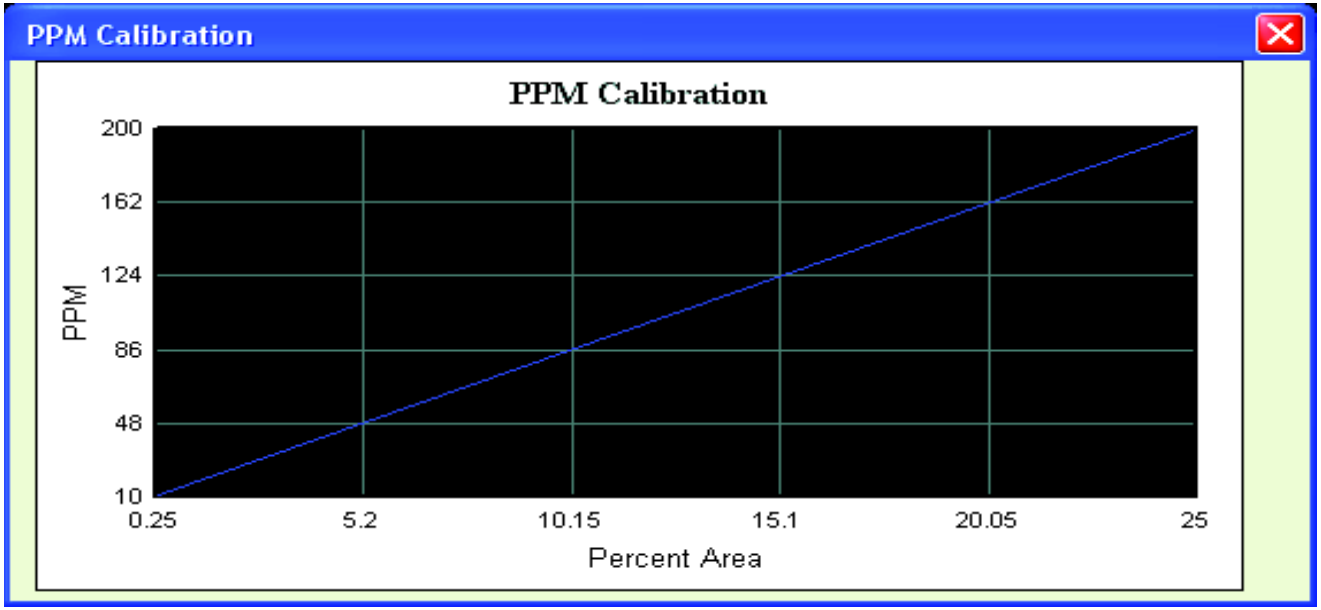
Oil volume = Σ volume of oil particles

Volume of water = W * L * H

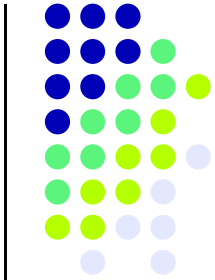
oil in water = Σ (volume of oil particles) / ((W * L * H)* number of images)) *100% = Percent oil in water.

Calibration Implementation

- Firstly insert a known calibration lens into the Canty particle sizing unit.
- Set up a particle sizing zone in the Cantyvision software on the area one which to detect.
- Using the software draw a calibration line and this gives a pixel scale factor.
- Run a sample of Known concentration through the unit.
- Set threshold value.
- Set the appropriate filters.
- Scan the sample through the unit using the Cantyvision software.
- Calibrate the output PPM value using the total area percent value and the known PPM value in the PPM calibration tool in the Cantyvision software.

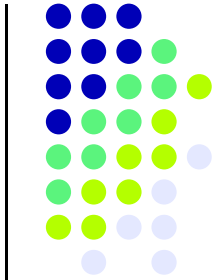


All units Optically identical



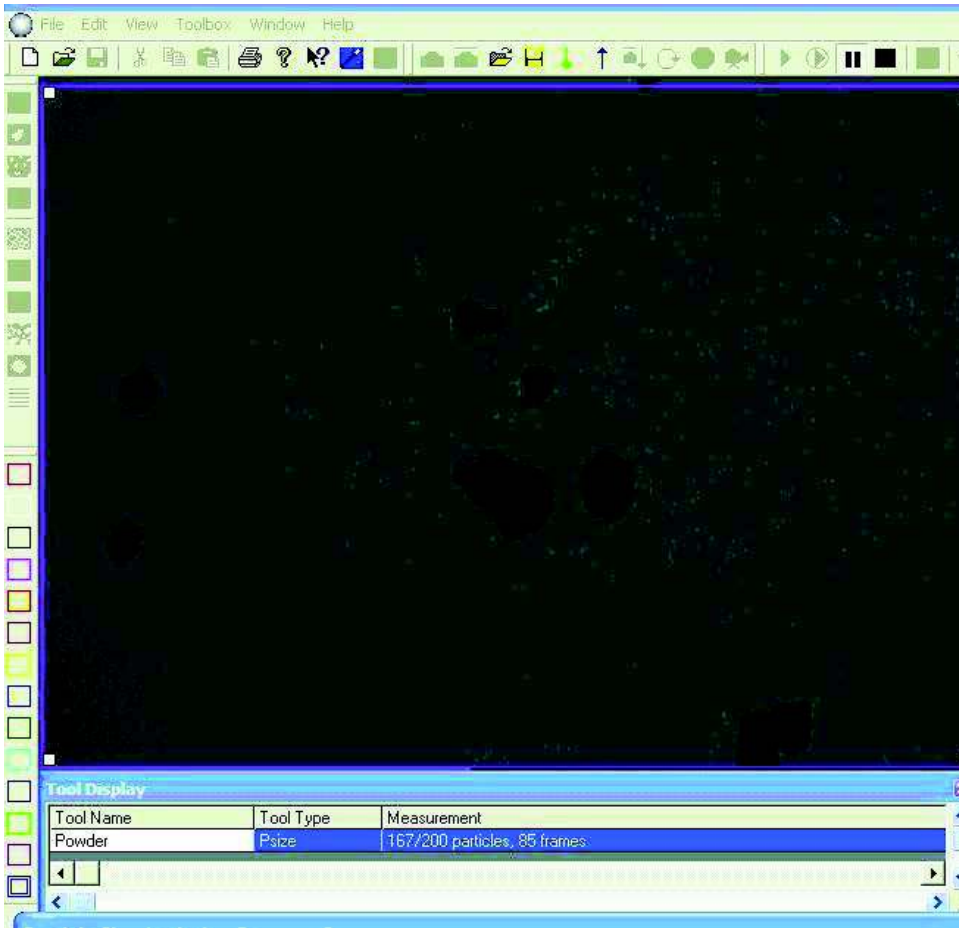
- Lab MicroFlow
- Inline high pressure flow unit
- Insertion probe

Software

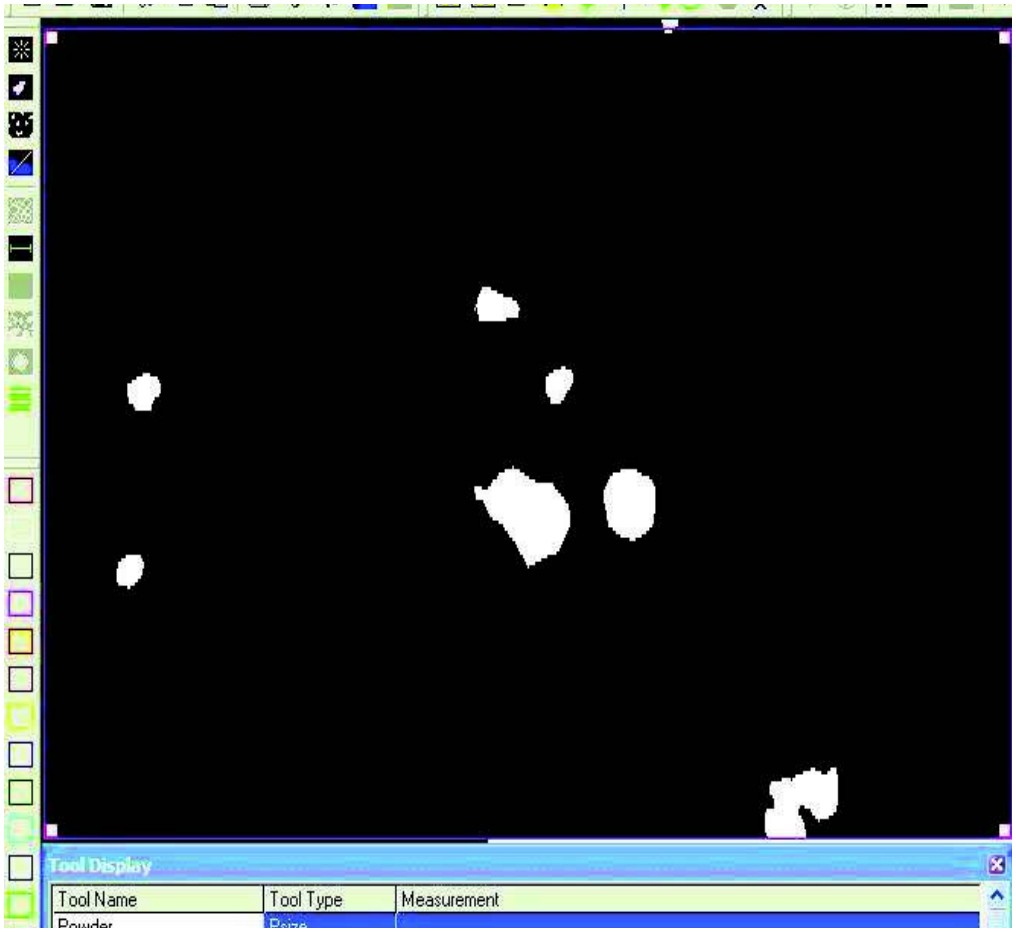


- Image Analysis software provides size ,shape and color
- The imaging software is married to the hardware
- Detection on and residual items is eliminated from data
- Focus reject is key tool for accuracy

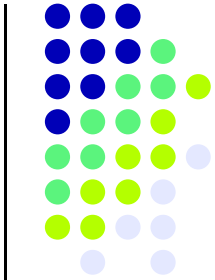
Digital Image



Digitized image



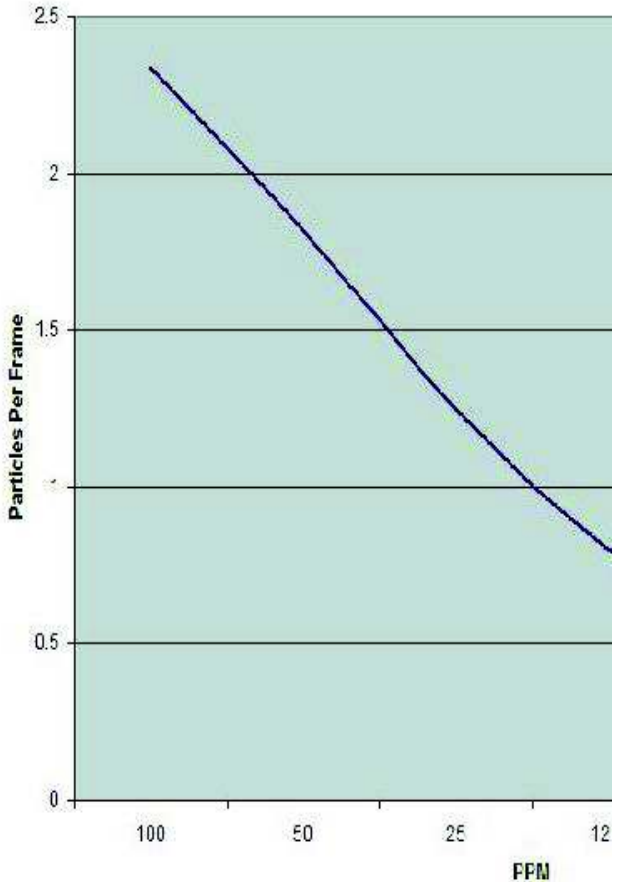
Water Quality Analysis

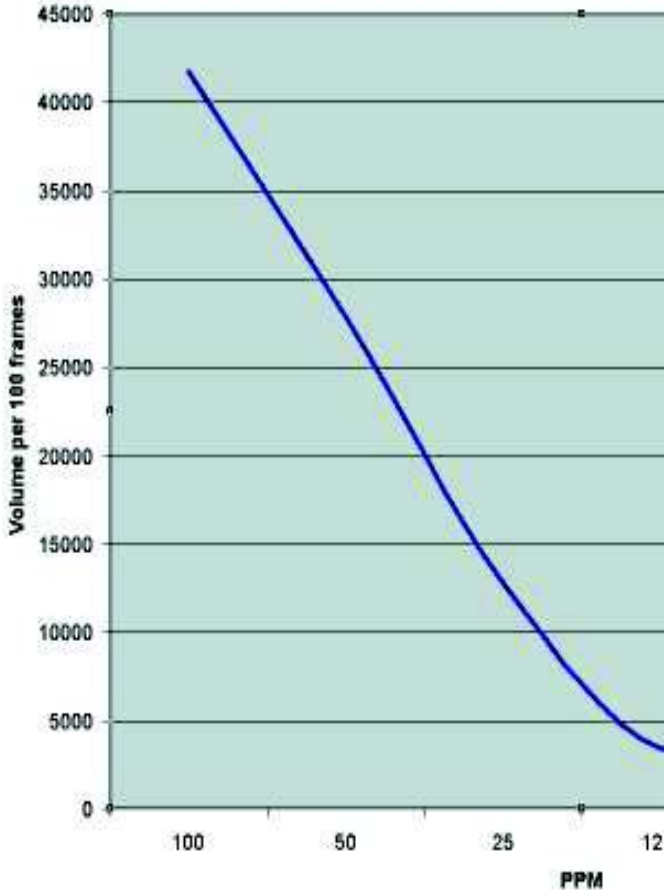


The following data results from analysis of 6 different oil contaminated water samples ranging from 1.56 ppm to 100 ppm.

Sample 1	100 ppm
Sample 2	50 ppm
Sample 3	25 ppm
Sample 4	12.5 ppm
Sample 5	6.25 ppm
Sample 6	1. 56 ppm

Output Comparison
Particle Count vs. Volume output



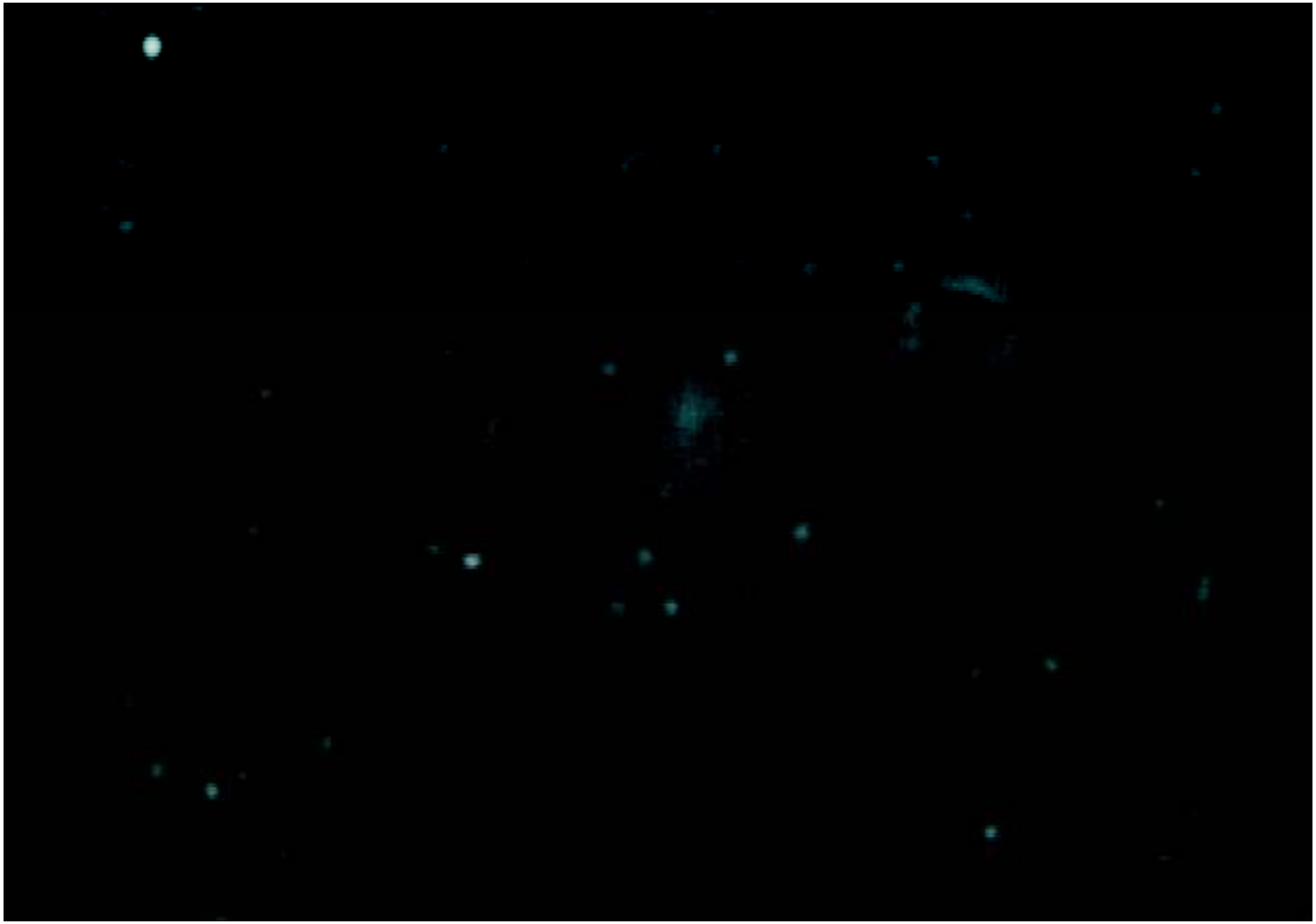


The system used for this analysis was the Canty MicroFlow.

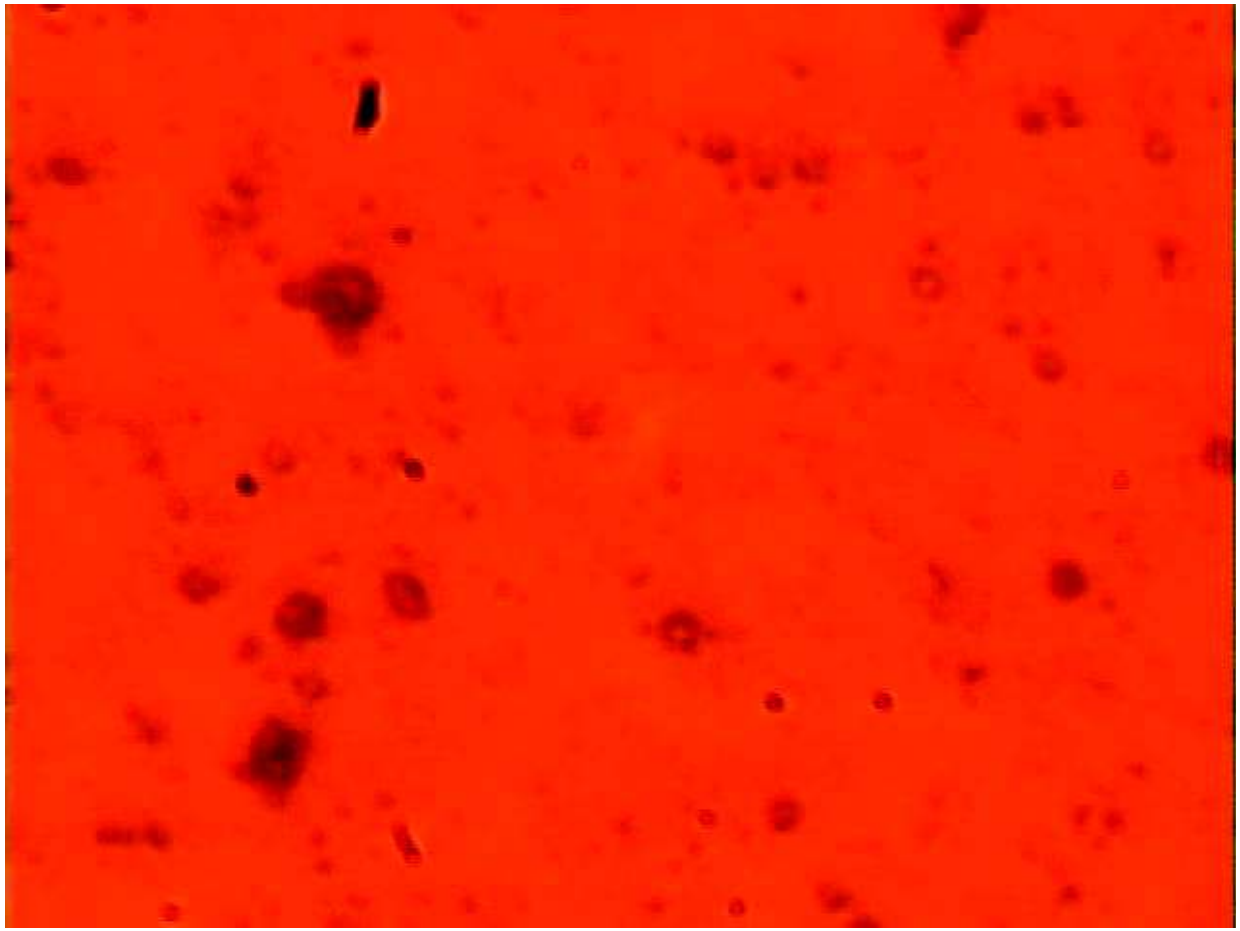
The sample volume flowed through the analysis chamber where the camera recorded the image detections and the software recorded the particle size and counts. Typical images from the measurement chamber are included for reference. The droplet size ranges from approximately 1 to 20 microns in diameter.

A typical image of oil droplets in the flow is included on the next slide.

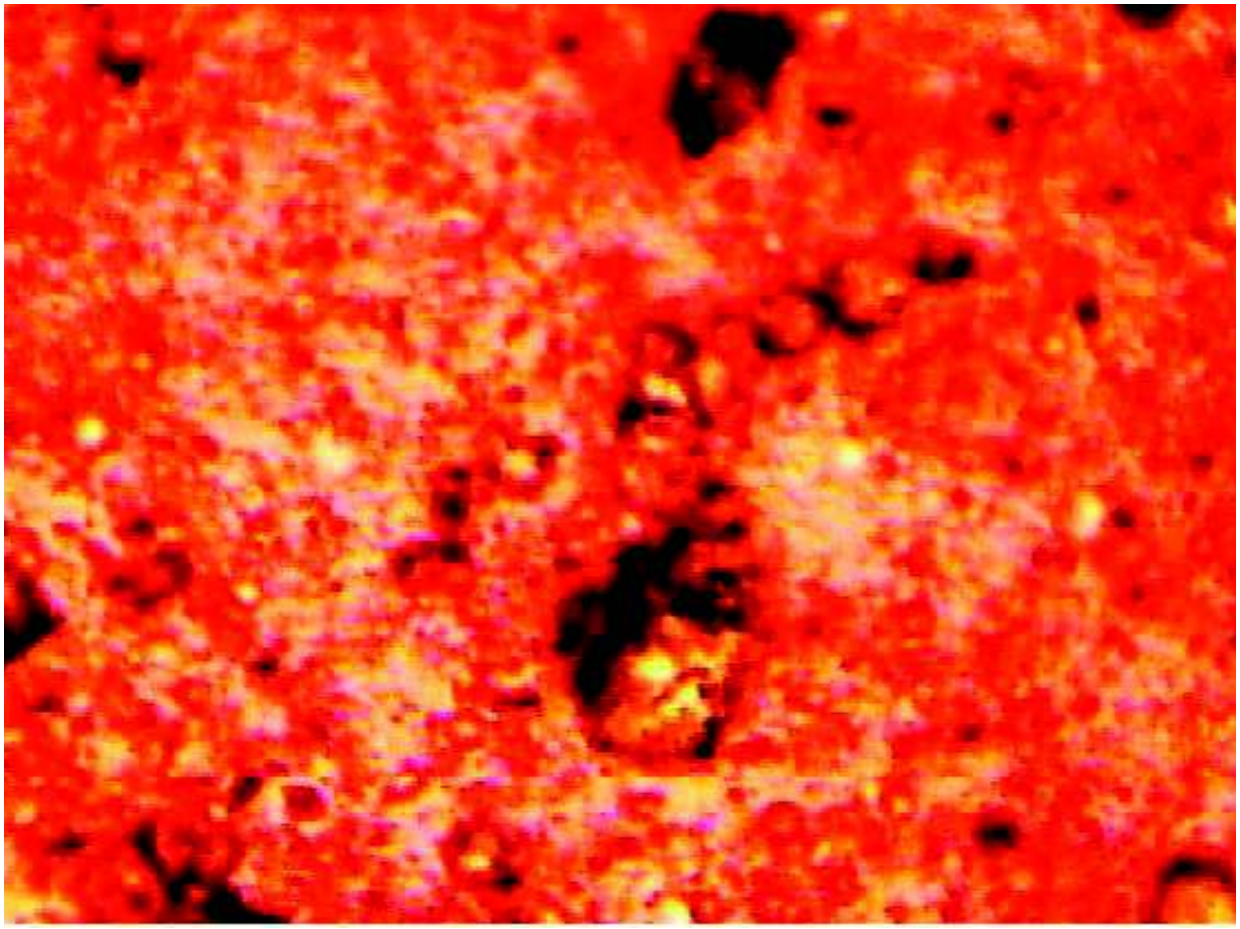
Complex Multiphase Image

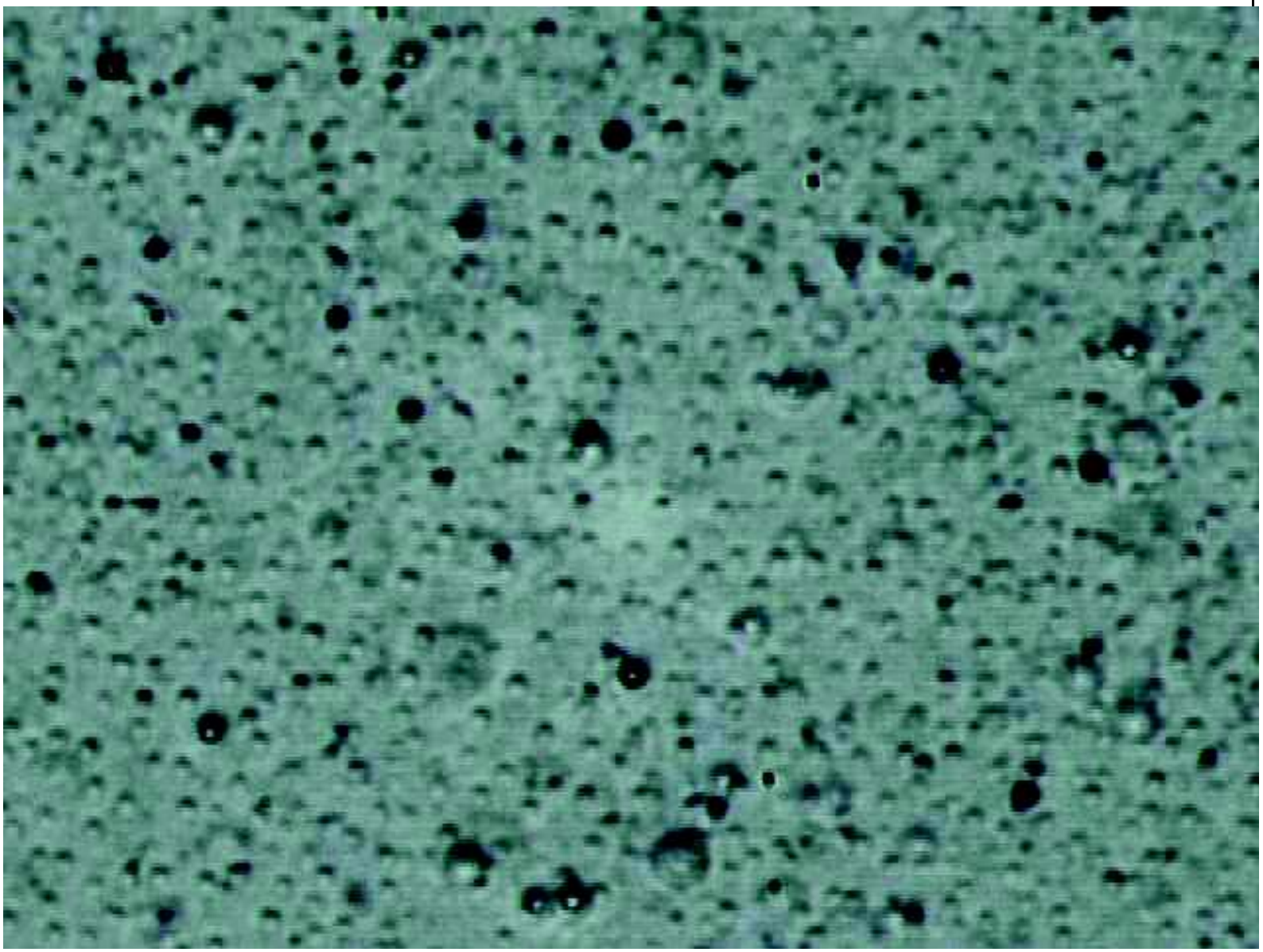


Color based image

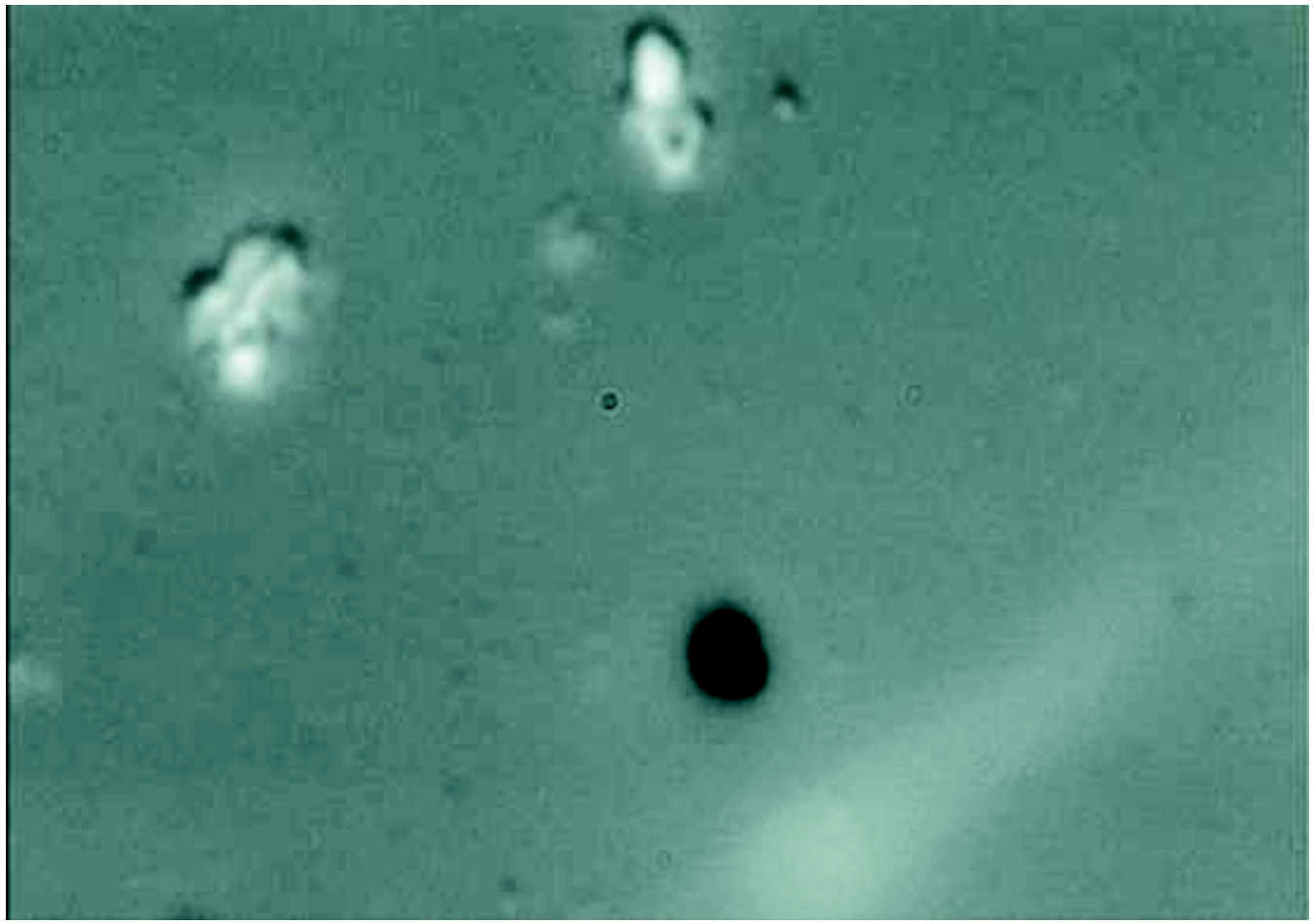


Crude Oil

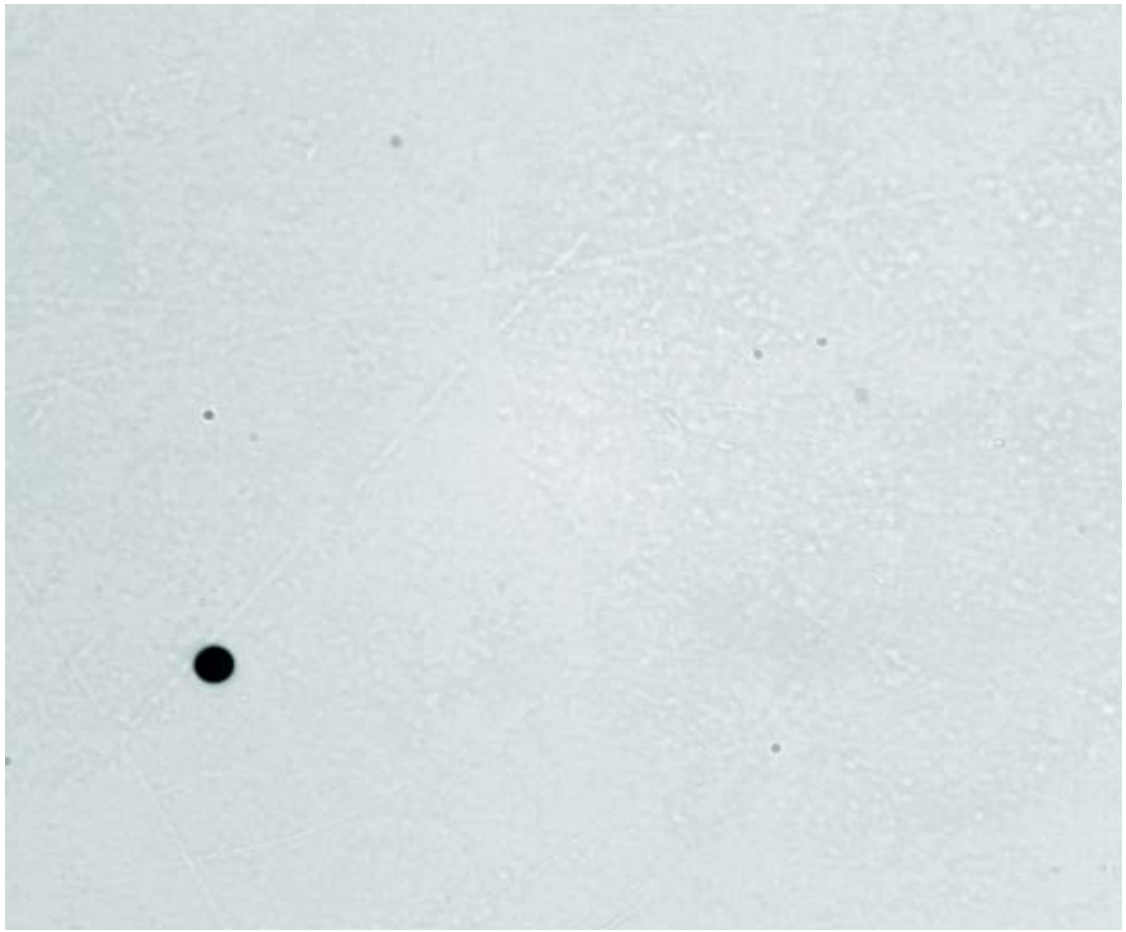


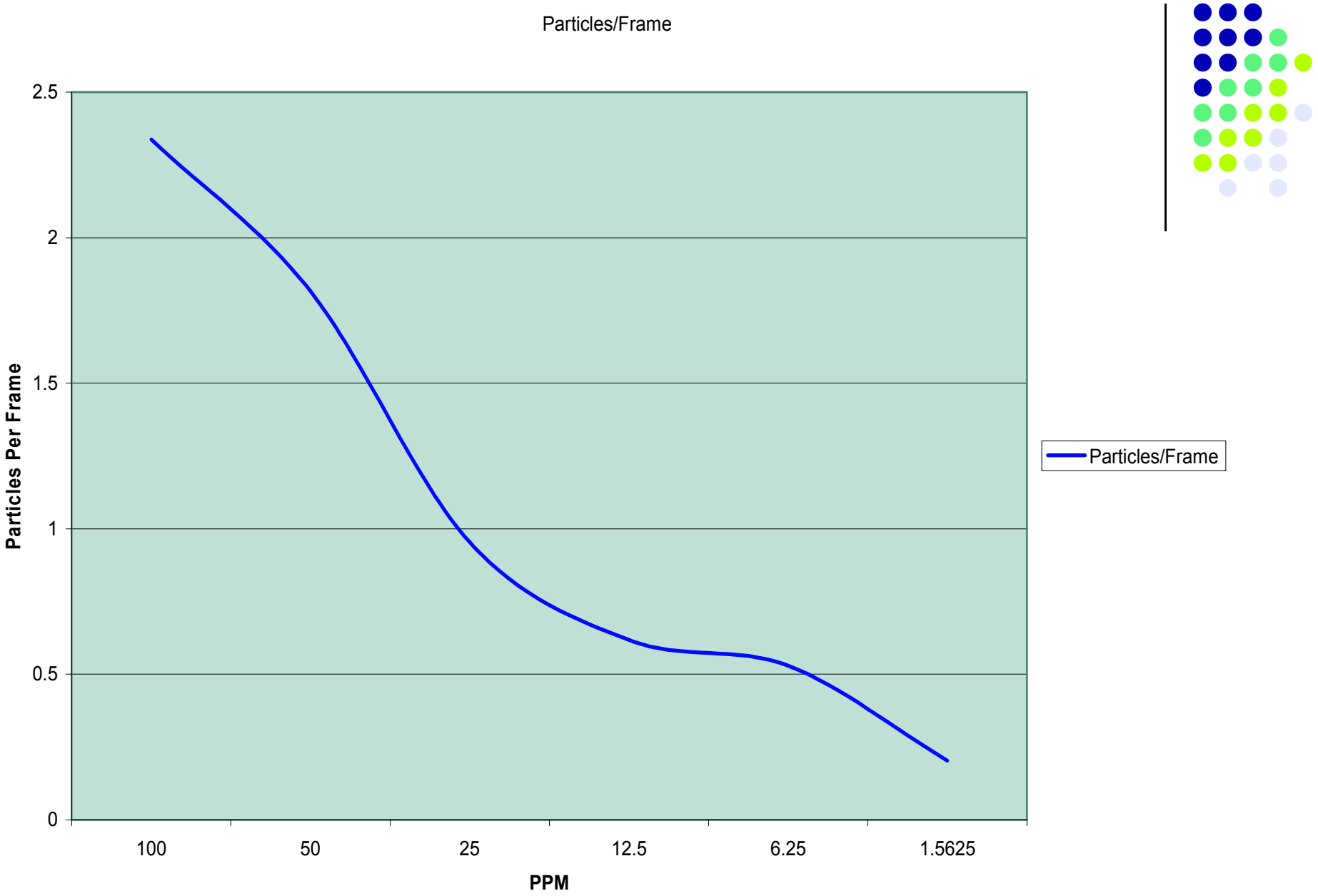


Inline Polarization for Clear Crystals



Simply image low concentration

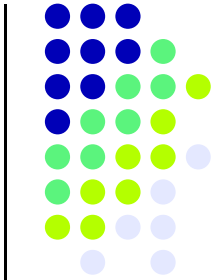



Particles/Frame
Particles Per Frame
2.5
2
1.5
1
0.5
0
100
50
25
12.5
6.25
1.5625
PPM
Particles/Frame

System Features and Benefits:

The question naturally arises, ’How do you know the system is detecting ?’.

The image that follows illustrates this dilemma. The particle on the right of the screen is obviously not an oil droplet. Droplets are spherical or near spherical depending on flow forces acting on them at the time, however they are not long and thin with sharp edges as this particle in question is. To explain how the vision system handles this we need to examine how the software works and how other systems detect particle presence in the flow. As mentioned briefly before this, the software detects changes in how light reflects off different surfaces to allow objects to be distinguished from their surroundings. The measured light intensities are then constructed into a single image in much the same way your brain does it



Other situations:

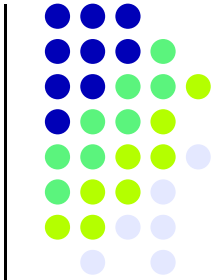
How can air bubbles be detected and eliminated?

Air bubbles can be filtered by light transmission through the particle.

What happens if a particle gets stuck in the view?

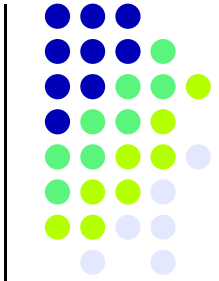
Software identifies the same particle in the same location and does not make multiple counts.

Visual Advantages



- Vision captures multiple particle features:
  Major Dia, Minor Dia, Area, Perimeter, Color
- From these parameters additional features can be calculated:
  Shape (cube, prism, rod etc…), opacity
- Other instruments measure one or none of the direct particle parameters leaving a large margin of doubt in the result.

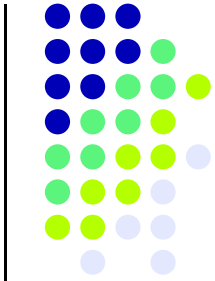
Calibration



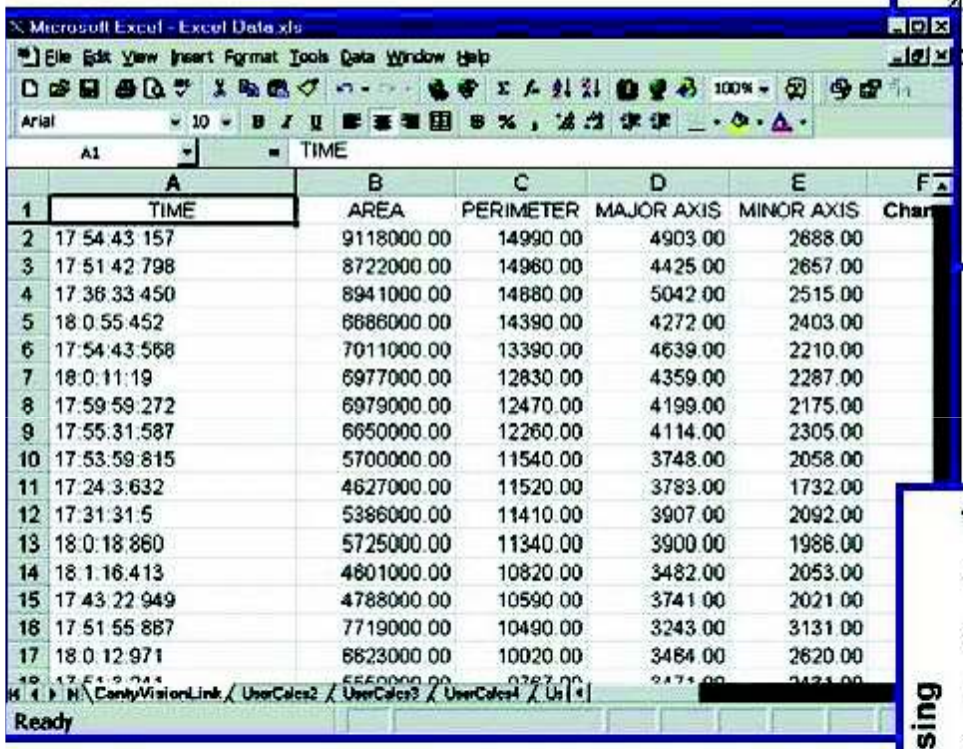
- Calibration remains unchanged-Digital

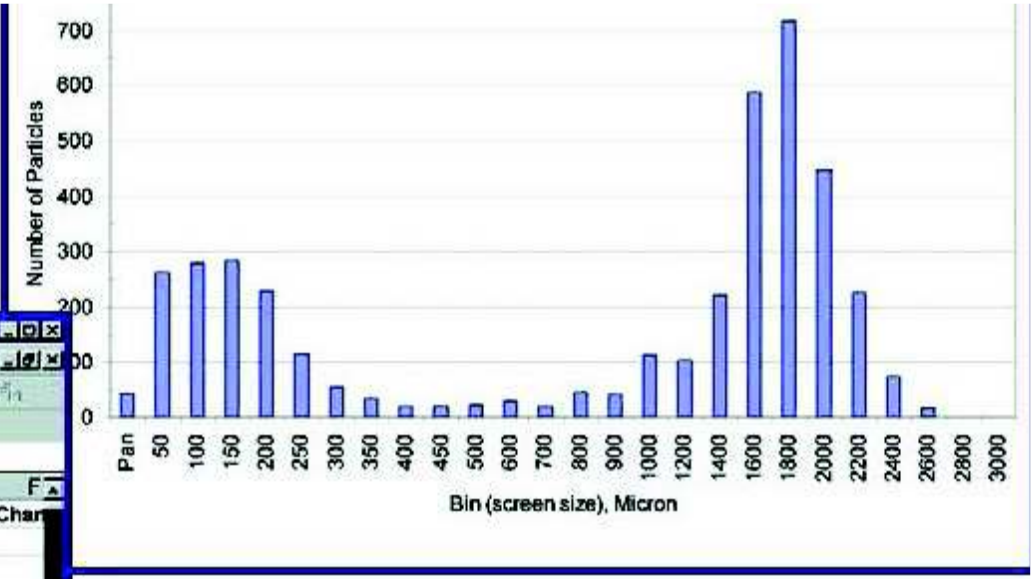
- Method is straightforward:
  Prepare known samples as in example.
  Run through system and capture data.
  Input calibration

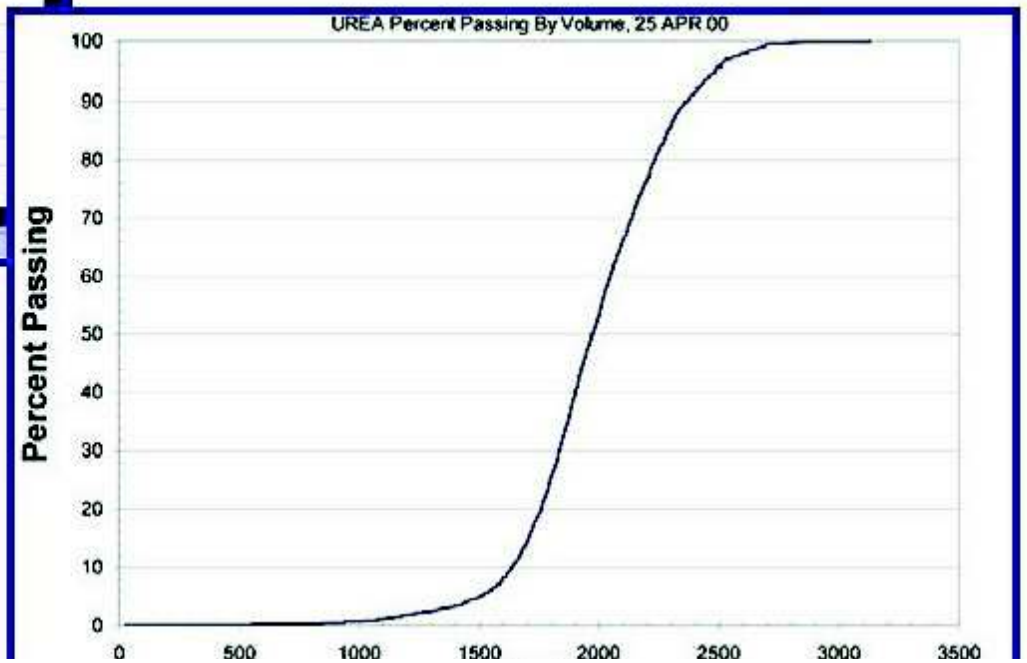
Interfacing and Support



- 4-20ma
- Excel (research tool)
- OPC (Ethernet data interface to PLC,DCS,Scada)
- Remote support via internet /broadband
- Wireless or wired Ethernet connection


Microsoft Excel - Excel Data.xls
File Edit View Insert Format Tools Data Window Help
Arial 10
A1
TIME
A B C D E F
1 TIME AREA PERIMETER MAJOR AXIS MINOR AXIS Char
2 17:54:43.157 9118000.00 14990.00 4903.00 2688.00
3 17:51:42.798 8722000.00 14960.00 4425.00 2657.00
4 17:36:33.450 8941000.00 14880.00 5042.00 2515.00
5 18:0:55.452 6686000.00 14390.00 4272.00 2403.00
6 17:54:43.568 7011000.00 13390.00 4639.00 2210.00
7 18:0:11:19 6977000.00 12830.00 4359.00 2287.00
8 17:59:59.272 6979000.00 12470.00 4199.00 2175.00
9 17:55:31.587 6650000.00 12260.00 4114.00 2305.00
10 17:53:59.815 5700000.00 11540.00 3748.00 2058.00
11 17:24:3.632 4627000.00 11520.00 3783.00 1732.00
12 17:31:31.5 5386000.00 11410.00 3907.00 2092.00
13 18:0:18.860 5725000.00 11340.00 3900.00 1986.00
14 18:1:16.413 4601000.00 10820.00 3482.00 2053.00
15 17:43:22.949 4788000.00 10590.00 3741.00 2021.00
16 17:51:55.887 7719000.00 10490.00 3243.00 3131.00
17 18:0:12.971 6823000.00 10020.00 3464.00 2620.00
N \ CognivisionLink / UserCalcs2 / UserCalcs3 / UserCalcs4 / Us
Ready

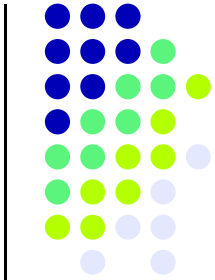

Number of Particles
0
100
200
300
400
500
600
700
Pan
50
100
150
200
250
300
350
400
450
500
600
700
800
900
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Bin (screen size), Micron


UREA Percent Passing By Volume, 25 APR 00
Percent Passing
0
10
20
30
40
50
60
70
80
90
100
0
500
1000
1500
2000
2500
3000
3500

Product Comparison

Canty Feature	Laser Feature
Visual verification both of set-up and measurement run, allows particle shape to be identified	No visual verification at any time
Direct measure of Particle Area – a two dimensional measurement	No Area measurement, only 'characteristic diameter' -- a one dimensional measurement provided
Direct measure of Particle Perimeter – a two dimensional measurement	No Perimeter measurement, only 'characteristic diameter' -- a one dimensional measurement provided
Direct measure of Major axis and Minor axis – a two dimensional measurement	No, only 'characteristic diameter' -- a one dimensional measurement provided
Able to thin measurement data using: •Minimum particle size •Maximum particle size •Particle aspect ratio	No, only 'characteristic diameter' -- a one dimensional measurement provided
Direct measure of Particle color	No color measurement
No plan to add laser measurement capability	Many laser manufacturers are adding vision measurement to product line

Summary of System Features and Benefits:



- Visual verification, remote Support
- System adjustment based on actual view
- Filtering of non droplet for more accurate data gathering
- Elimination of air bubbles and stuck particles (or analysis of multiple particles)
- Detections based on count and/or volume
- One time calibration. Operator recalibrate
- Ethernet image/data distribution
- Particle distribution and Turbidity reading in One probe

Thank You for your time

www.jmcanty.com

Buffalo New York

Dublin Ireland