

The Value of InfraRed Spectroscopy

Paul Wilks

Wilks Enterprise, Inc.

www.WilksIR.com

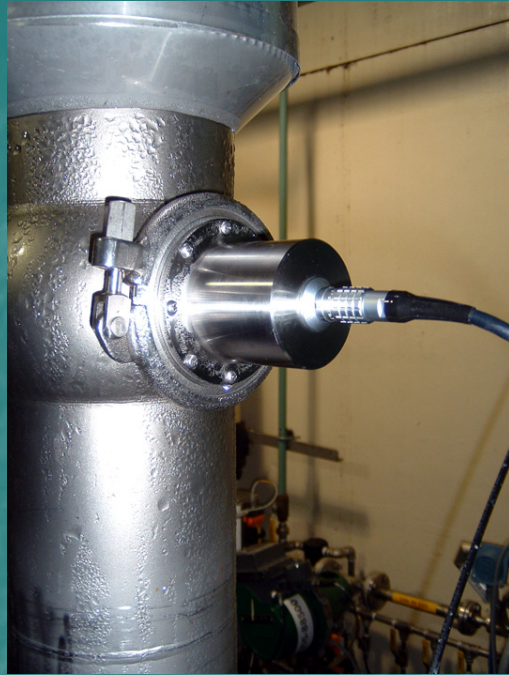
Current Trend For Measurement Technologies:

move process and environmental analysis
out of the laboratory to onsite

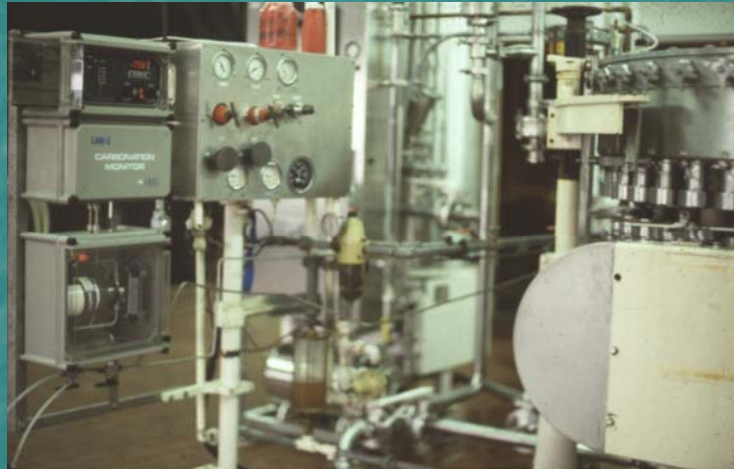
InfraRed Analysis Ideal for Process and Environmental Monitoring

- Molecules have characteristic IR spectra
- Spectra are additive
- IR Analysis is non destructive

In-line



Slip Stream



At-line

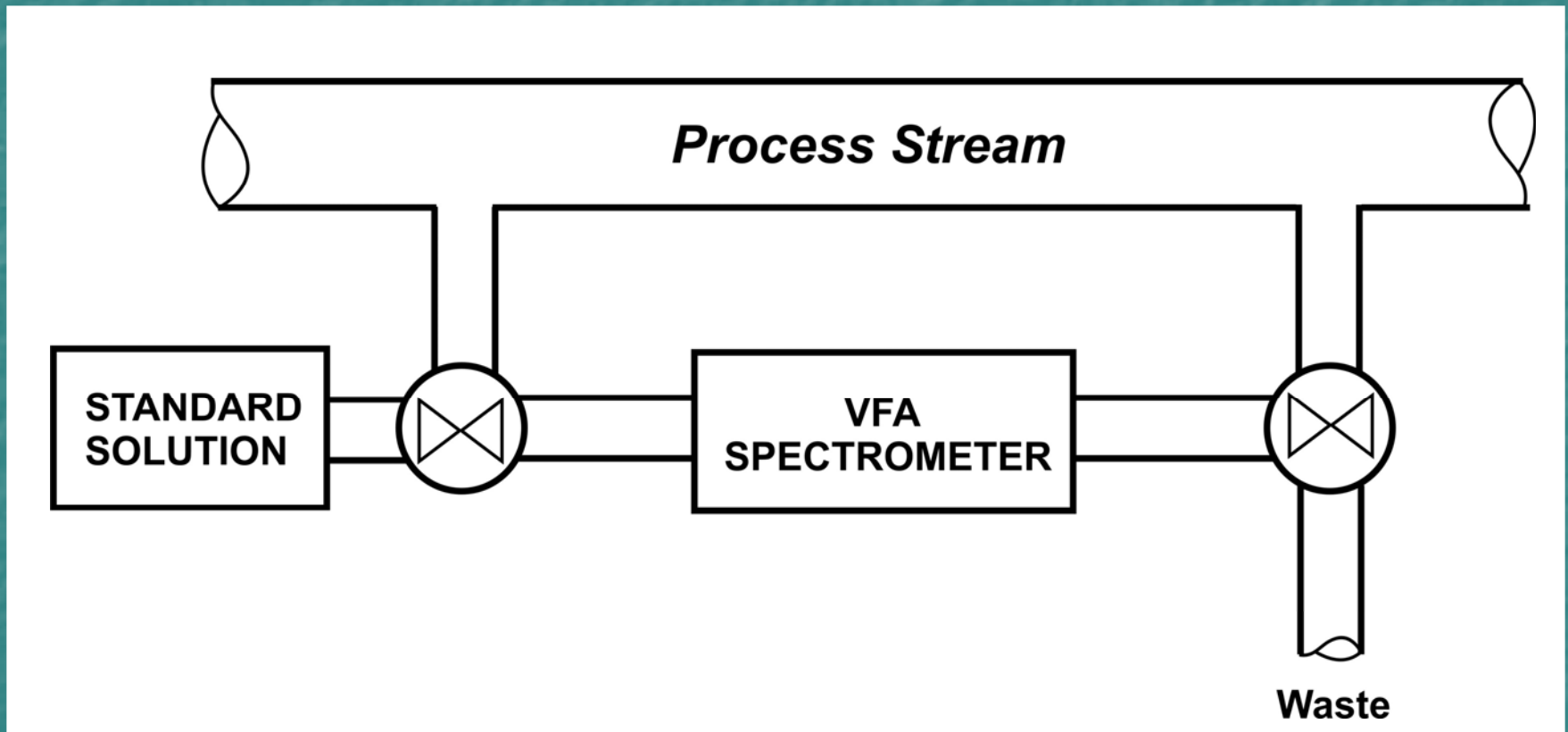


In-line IR Sensors



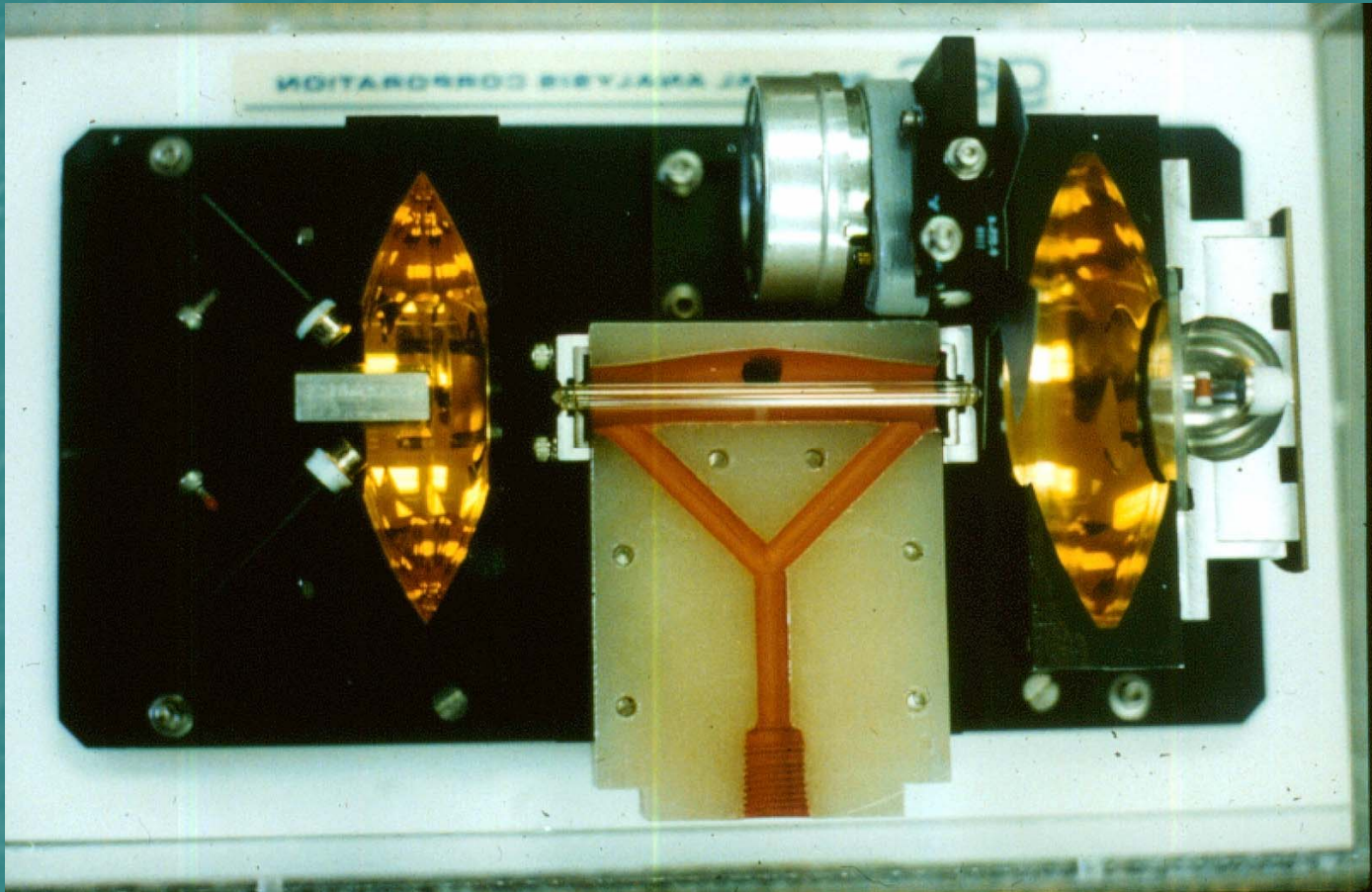
For Beverage Lines and in
Chemical Processing Environments

Diagram of Slip-stream



Slip-stream permits either an off shoot from the main process stream or standard solutions for calibration purposes

Process CATR Schematic



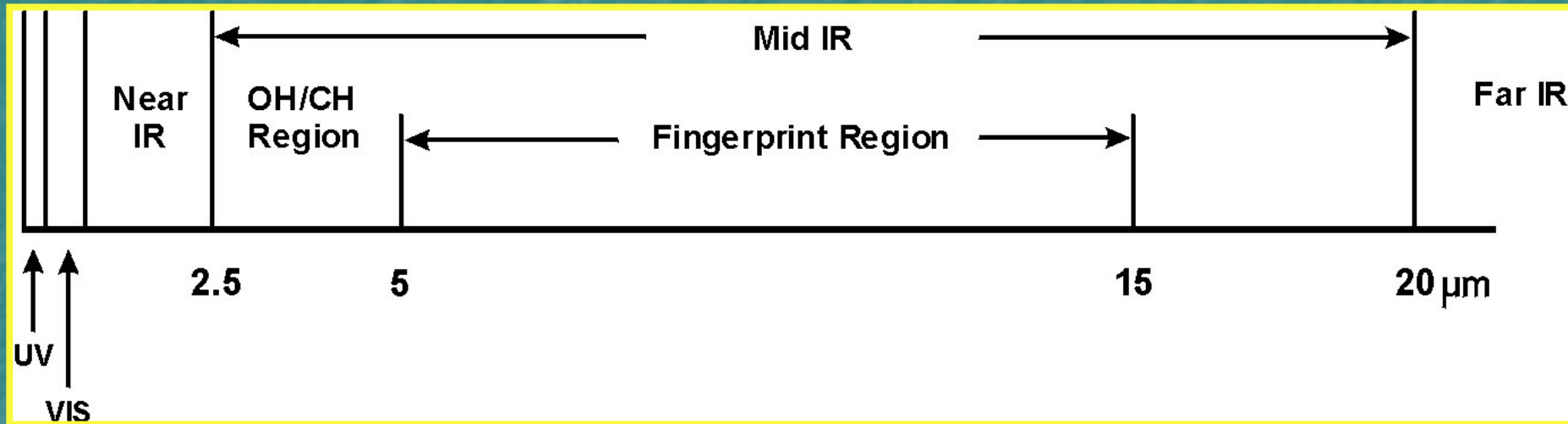
Process Monitoring with Slip-Stream

On Site Analysis



With Portable Infrared Analyzer

Infrared portion of the Electro Magnetic Spectrum



NIR and Mid-IR Strengths and Weaknesses

NIR Strengths:

- Higher energy levels--black body emitters peak at shorter wavelengths

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- High sensitivity photo conductive detectors
- Water transparent in NIR region
- Low cost cell materials—ie: glass, quartz

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- Quantitative calculations complex
- Can not transfer calibrations from one instrument to another

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- Organic functional groups have well delineated absorption bands

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Strengths and Weaknesses

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- Organic functional groups have well delineated absorption bands
- Molecules have different functional groups that can be used to identify them in Mid-IR
- Mid-IR spectra are additive

NIR and Mid-IR

Strengths and Weaknesses

Mid-IR Strengths:

- Organic functional groups have well delineated absorption bands
- Molecules have different functional groups that can be used to identify them in Mid-IR
- Mid-IR spectra are additive
- Calibration data more generic and more transferable between instruments

NIR and Mid-IR Strengths and Weaknesses

Mid-IR Weaknesses:

- Available energy decreases with wavelength due to black body radiation curve

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- Mid-IR optical fibers expensive and lose transmission with length

NIR and Mid-IR Strengths and Weaknesses

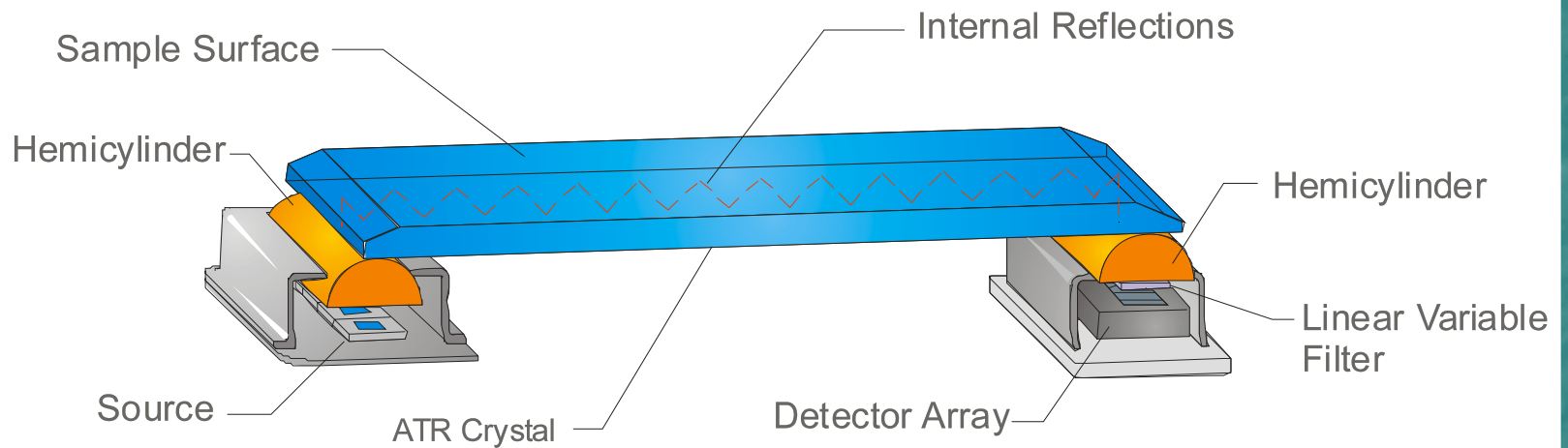
Mid-IR Weaknesses:

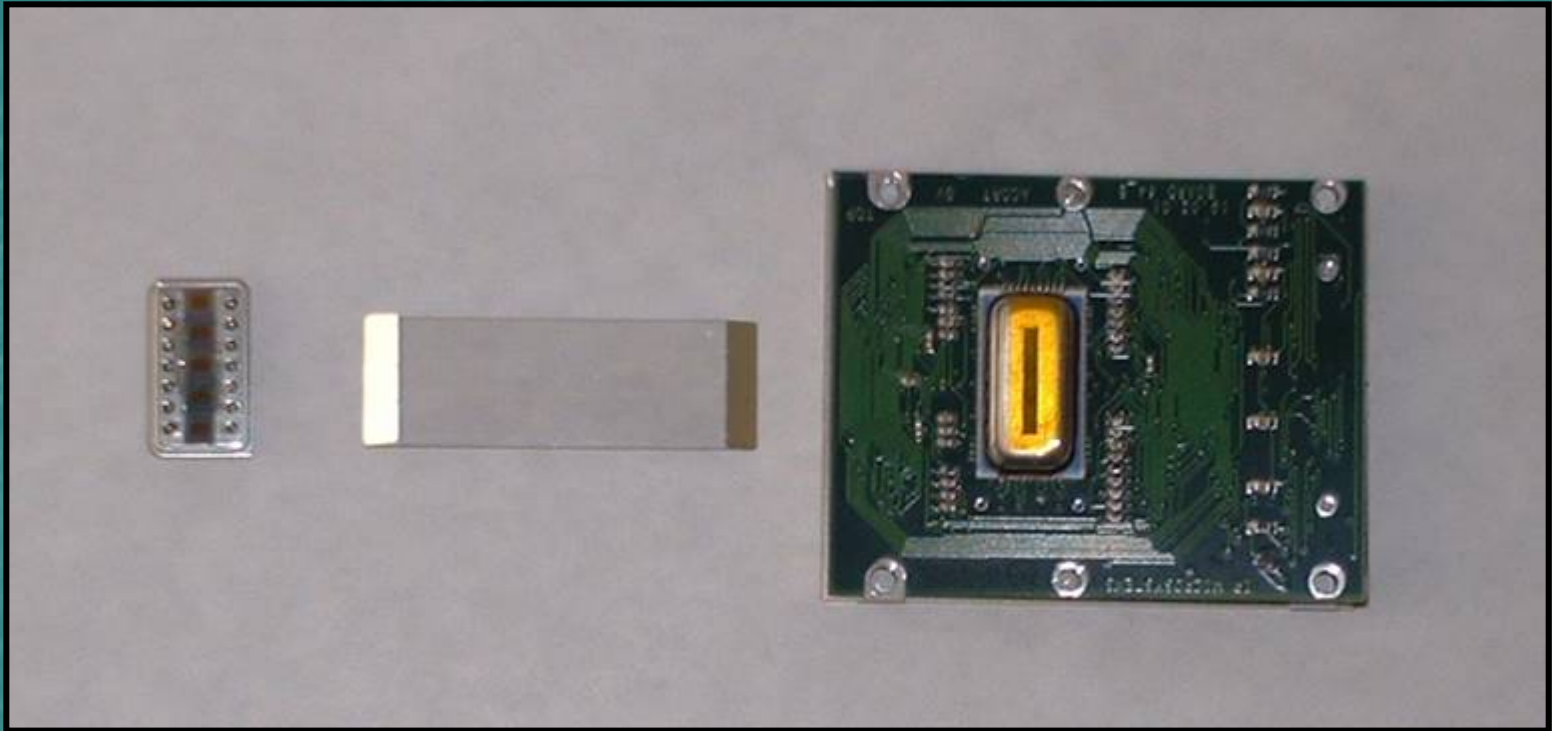
- Available energy decreases with wavelength due to black body radiation curve
- Mid-IR transmitting materials more expensive and often less chemically resistant
- Mid-IR optical fibers expensive and lose transmission with length
- Materials have strong absorbances and requires short pathlength cells-10-100um

NIR vs Mid-IR Applications

<i>Sample Type</i>	<i>Sampling Method</i>	<i>Spectral Region</i>
Protein in Grain	diffuse reflection	NIR
Moisture in Vegetable Matter	diffuse reflection	NIR
Trace Water in Solvents	trans ATR	mid-IR
Fat in Meat	transmission	NIR
Fat in Homogenized Milk	ATR	mid-IR
Trans Fat in Vegetable Oil	ATR	mid-IR
Pill Composition – known components	trans or diffuse reflection	NIR
Pill Composition – unknown components	ATR	mid-IR
Powder Identification	ATR	mid-IR
Coatings on Metal – thin	specular reflection	mid-IR
Coatings on Metal – thick	diffuse reflection	NIR
Reaction Monitoring – liquid	ATR	mid-IR
Reaction Monitoring – powders	diffuse reflection	NIR
Fluid in containers	transmission	NIR
Gas Analysis	transmission	mid-IR
Minerals	specular reflection or ATR	mid-IR

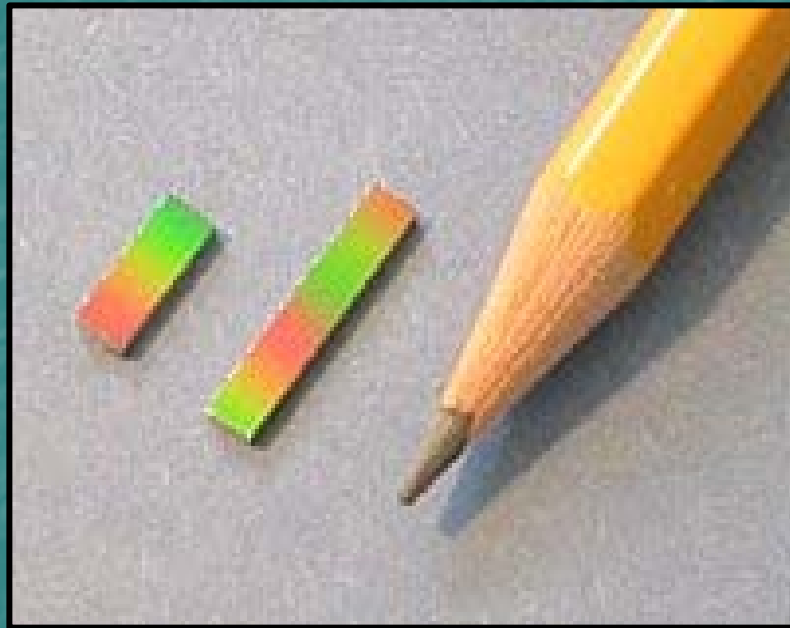
ATR Schematic of the VFA-IR Spectrometer





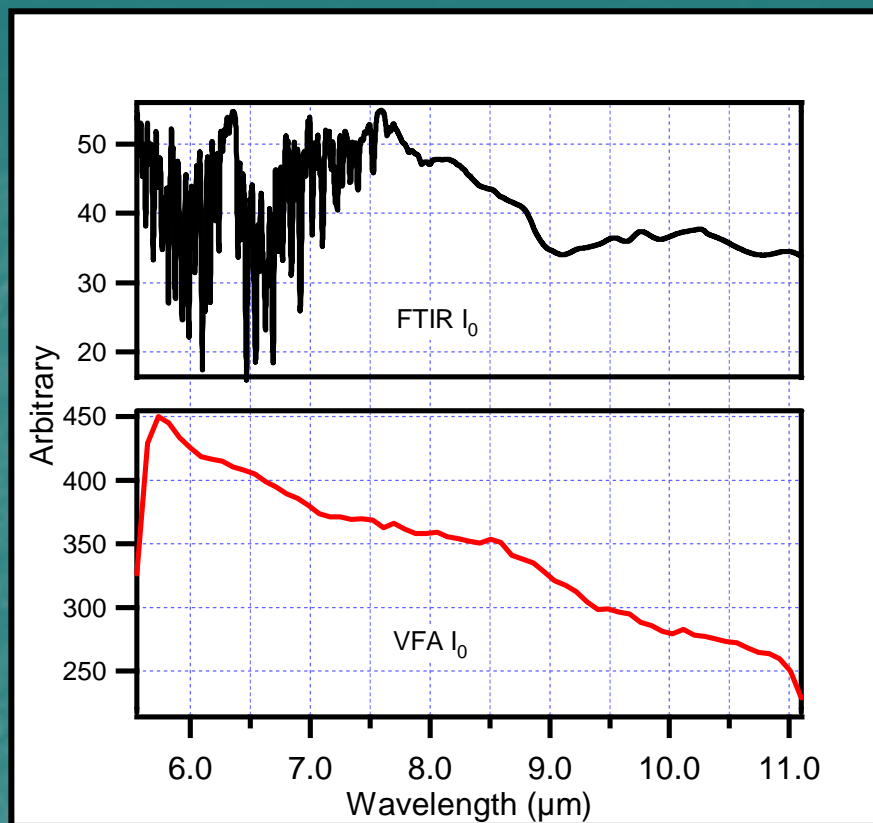
VFA Spectrometer – Optical Components

Linear Variable Filter (LVF)



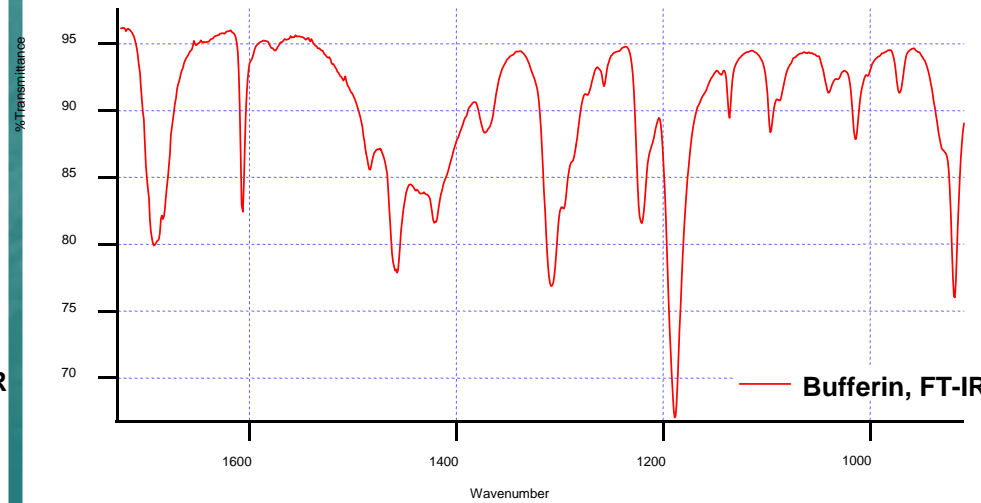
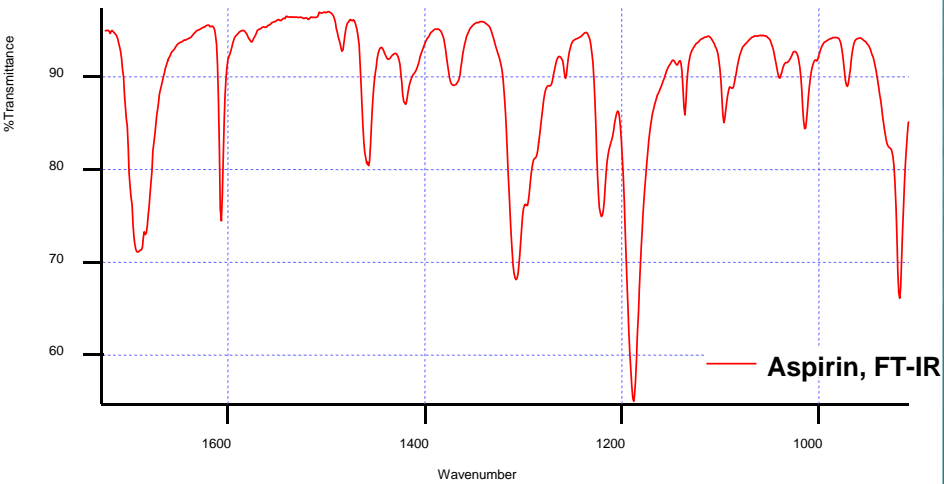
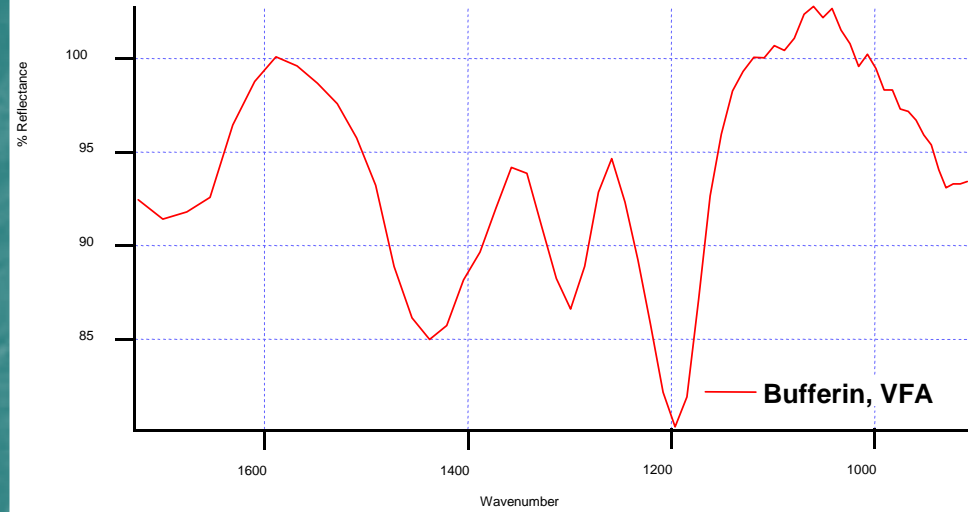
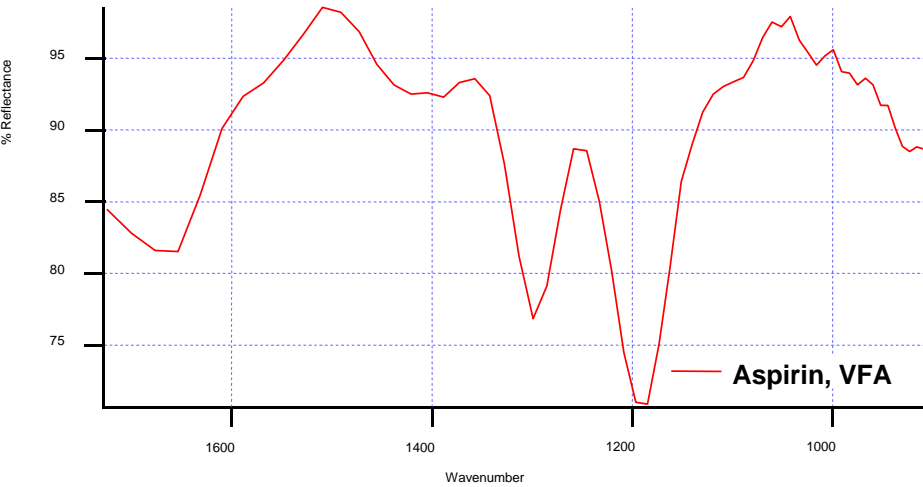


VFA Spectrometer



One meter + optical path (FT-IR) vs.
no air path (VFA)

Resolution Effect



ATR Trough Plate



ATR Flat Plate



Transmission Cuvette



Transmission Card or CellHolder



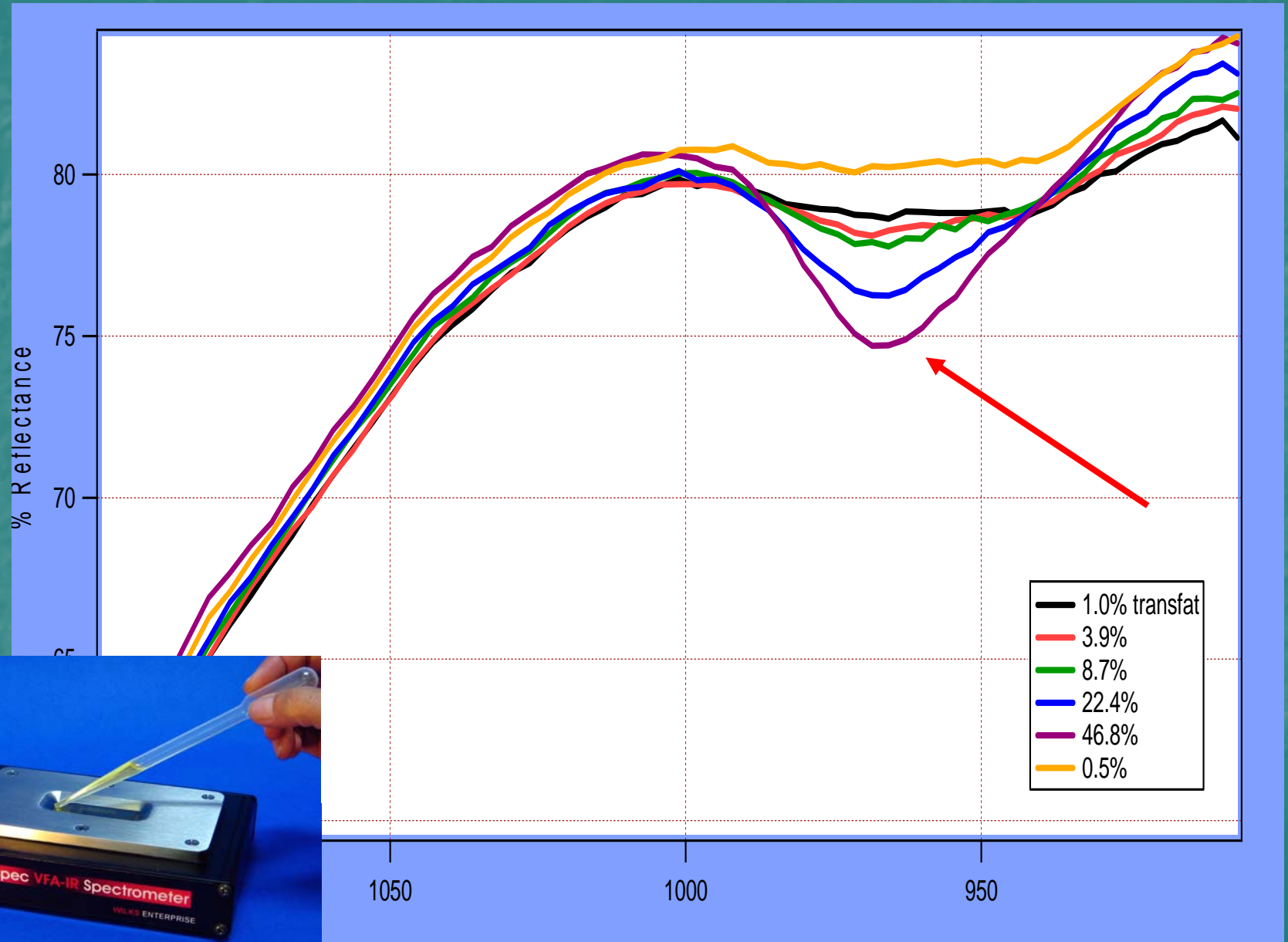
Ideal for:

- Materials Verification
- Quality Control
- Food Analysis
- Environmental Testing
- Reaction Monitoring
- Flexible Film Analysis
- Process Monitoring (PAT)

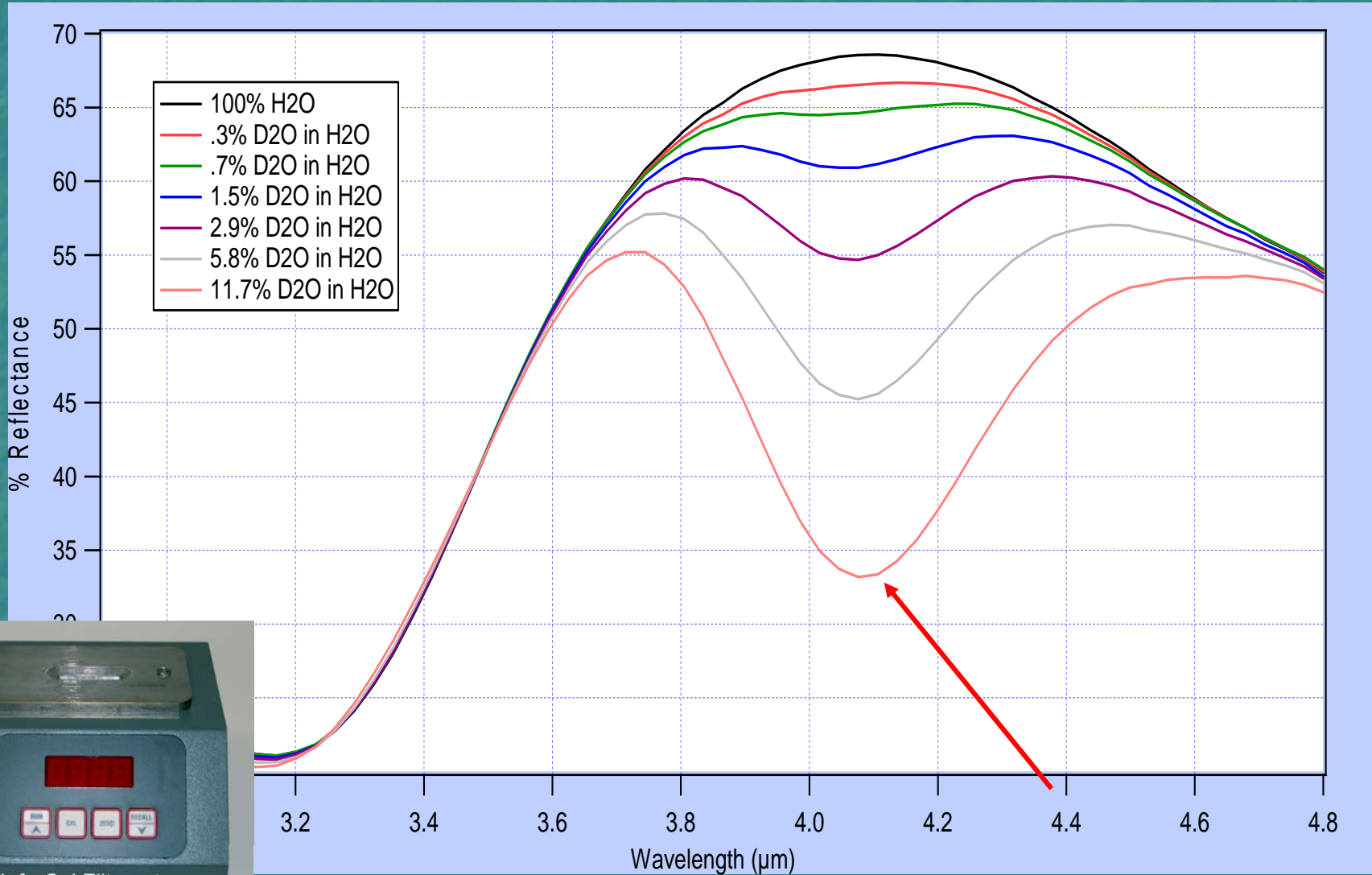
Typical Applications:

- Trans Fatty Acid Measurement
- D_2O in H_2O
- Biodiesel in Diesel Fuel
- Powdered Material Verification
- Liquid Material Verification

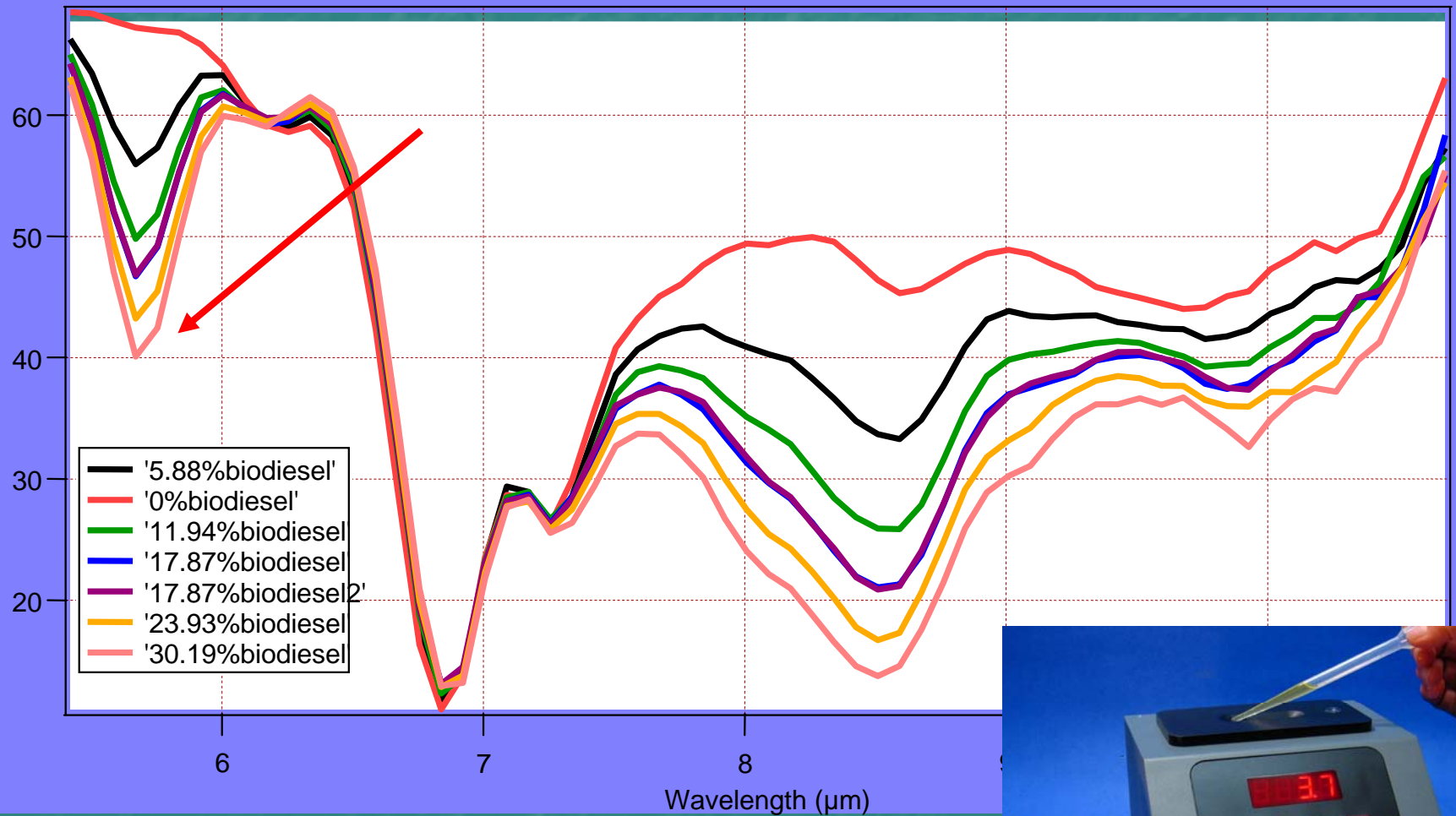
Trans-Fatty Acid in Edible Oils



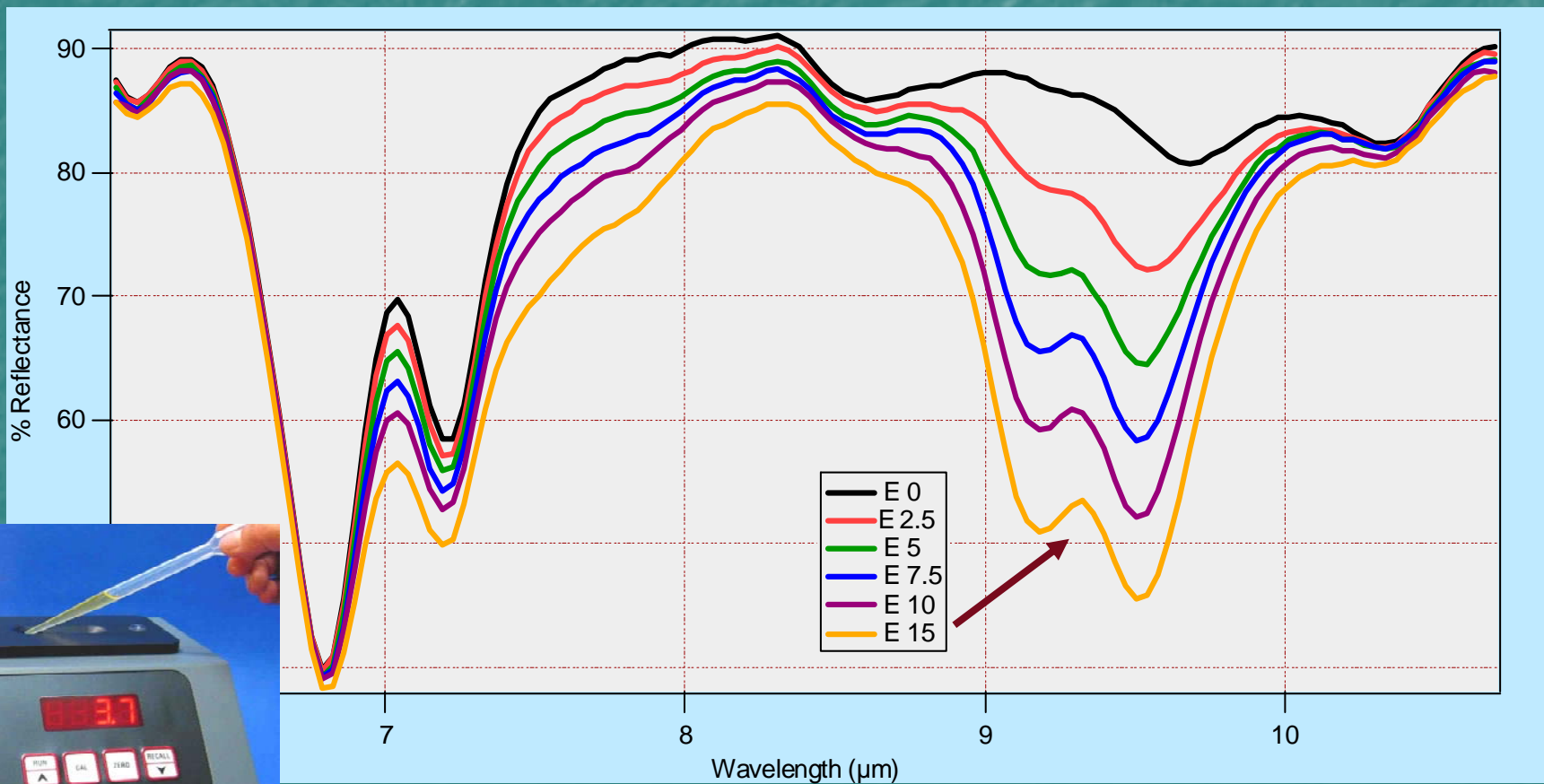
Deuterium Oxide (D2O) in Water



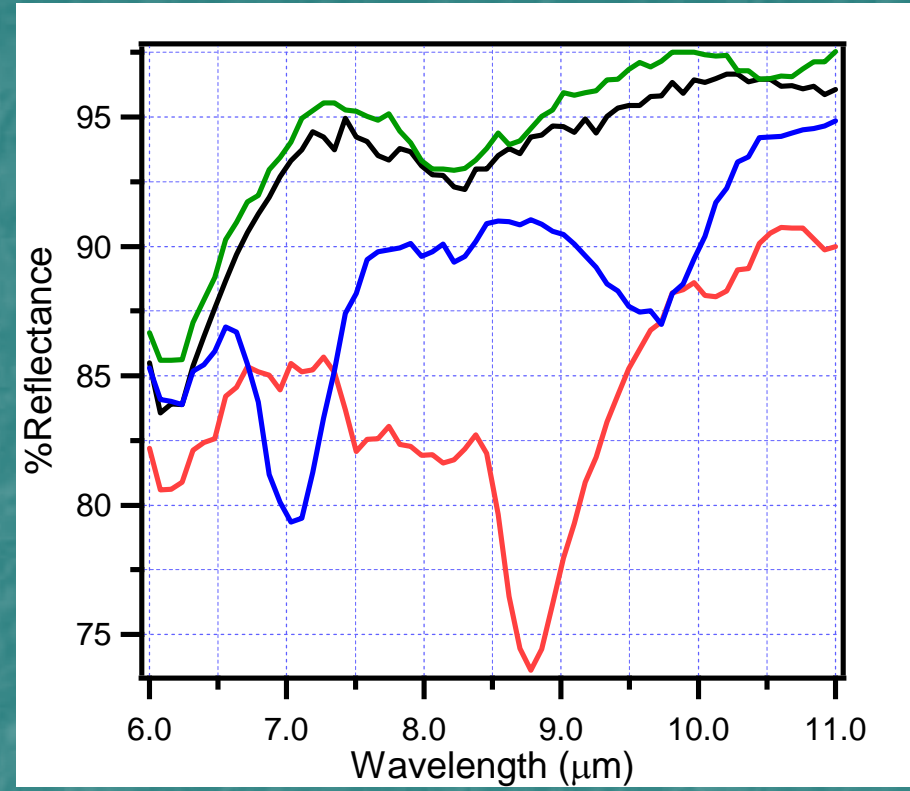
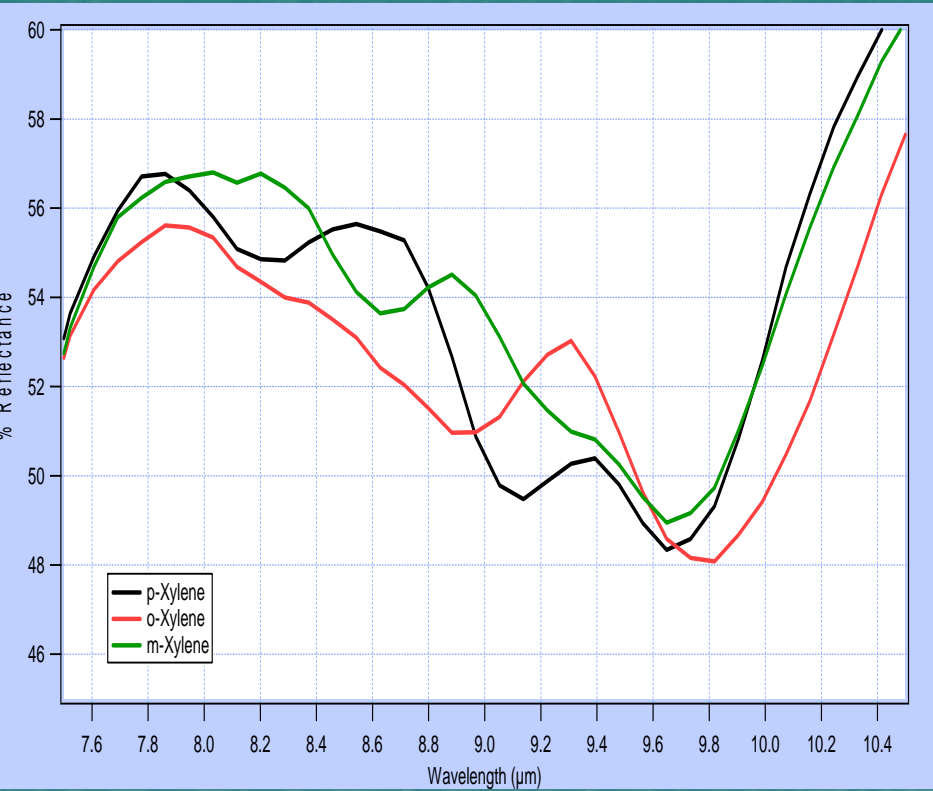
Biodiesel in Diesel Fuel



Ethanol in Gasoline



Material Verification

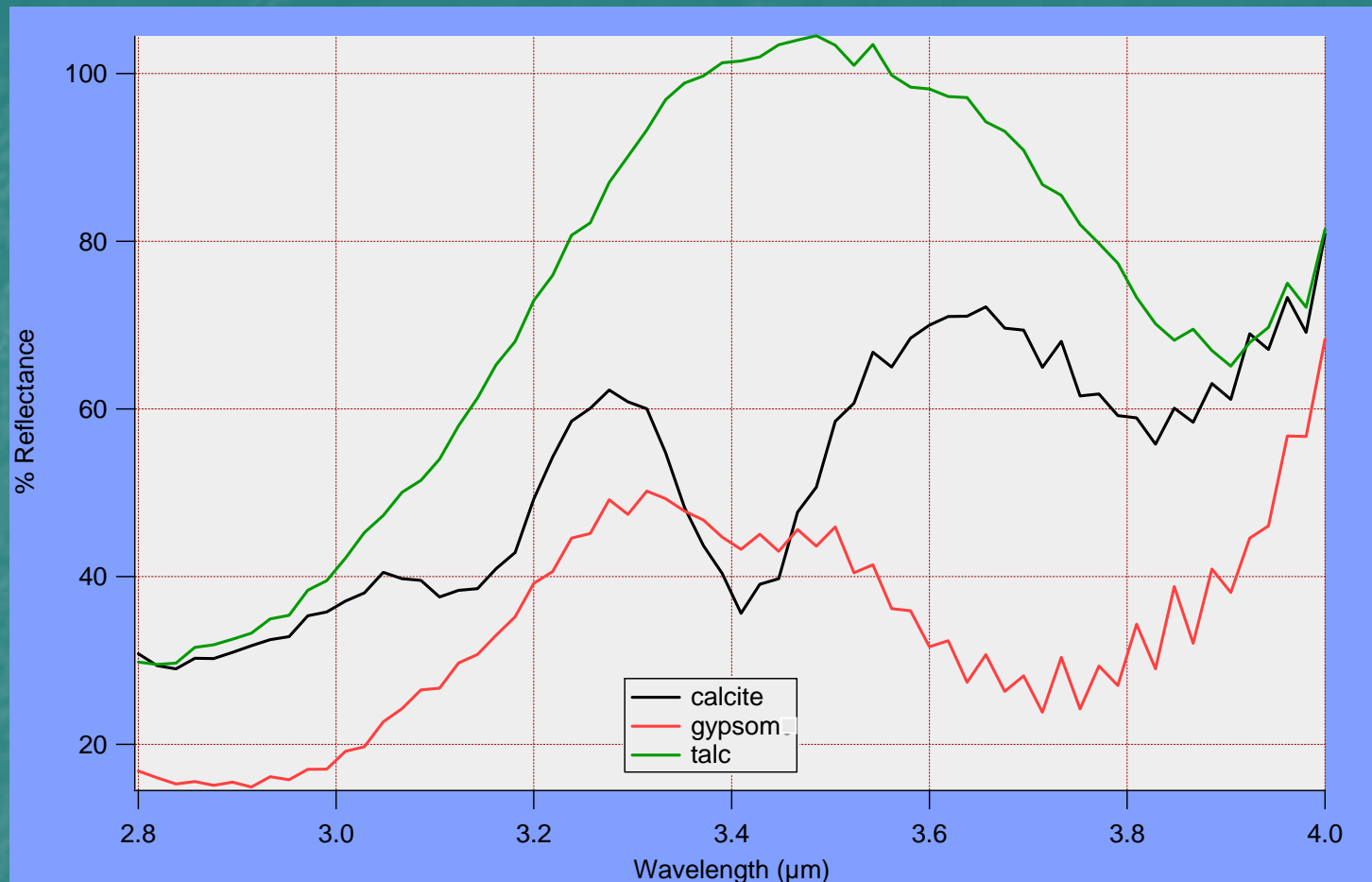


Liquid Material Verification

Common Pills and Capsules



Diffuse Reflection



Overtone spectra of various minerals by diffuse reflectance from a first prototype in cooperation with the University of Washington in St. Louis



A cure for obesity in the laboratory!