FDOT's Use of Fourier Transform Infrared Spectroscopy (FTIR)

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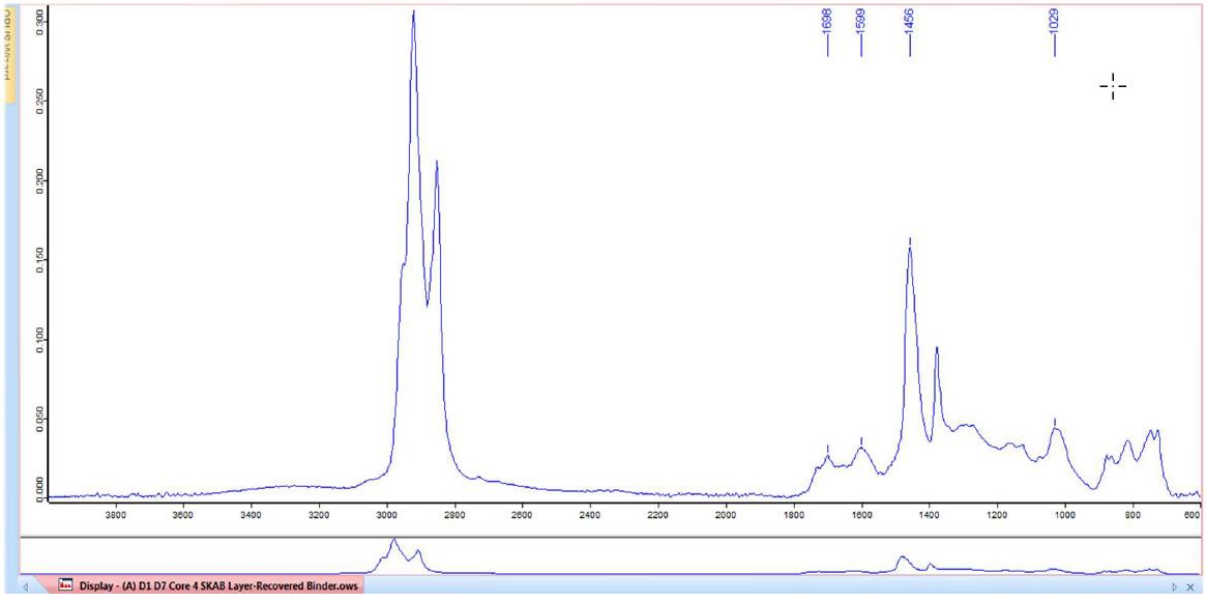


Purpose of Presentation

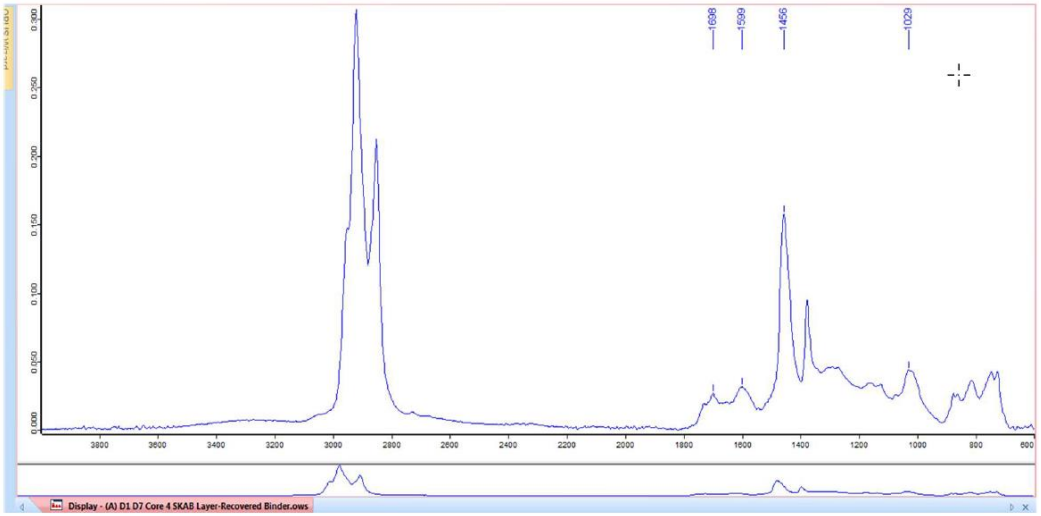
- **This presentation will cover the following topics:**
  - Background of issues leading to FTIR.
  - Initial FTIR testing/research and purchase of portable device.
  - Current work being conducted by FDOT.

Background

- At least four known projects discovered by inspection where it was determined Contractor was using non-PMA binder where contract required it.
- Required extensive coring and testing.
- Significant quantities of mix removed and replaced.

Background

- **FDOT binder specs require polymer modification with SBS or SB.**
- **Current binder mechanical tests not able to accurately determine the modification type. (Only provides an indication)**
- **An FTIR scan is more robust.**
  - Similar to a fingerprint.



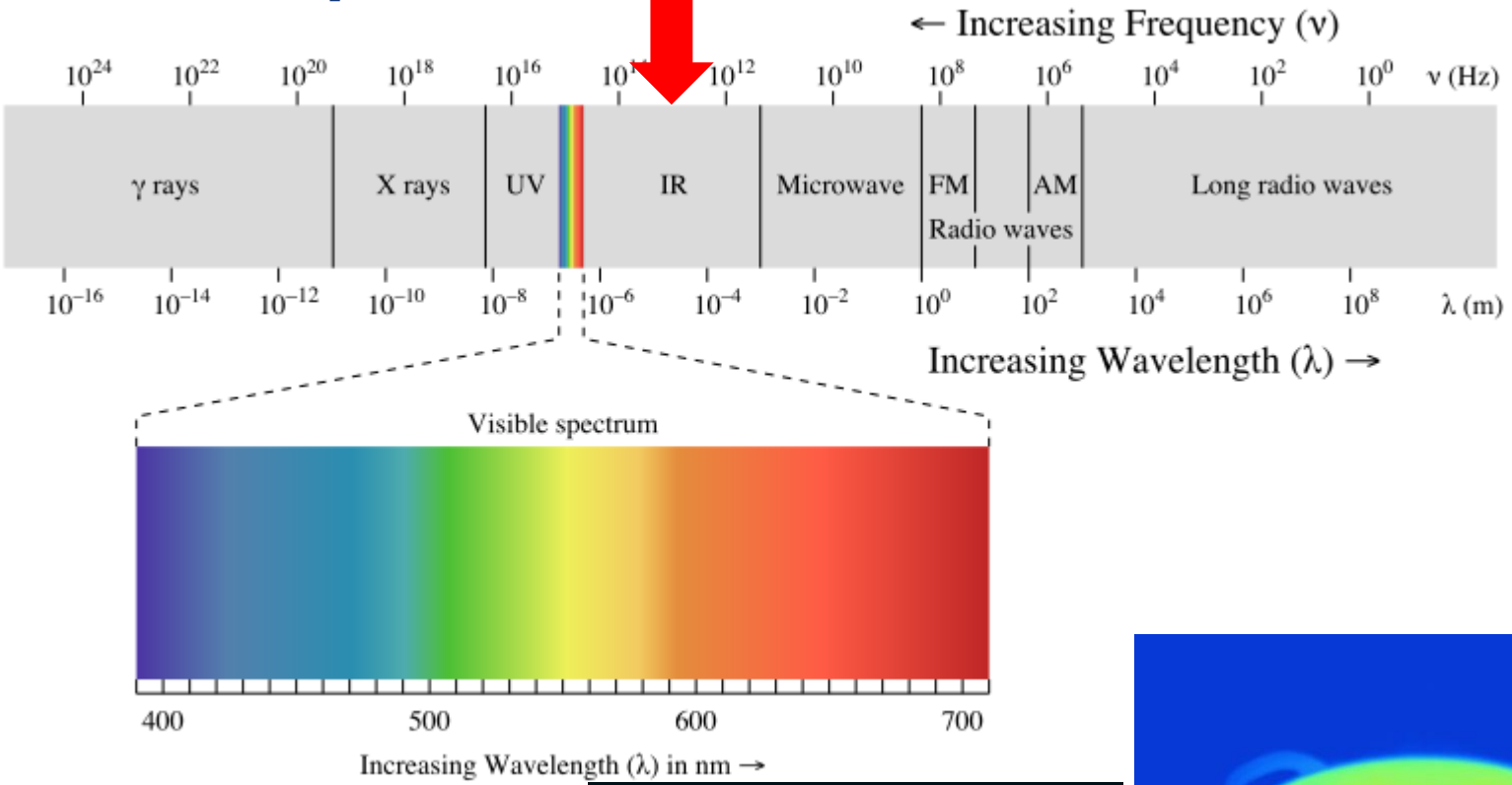
Wish List

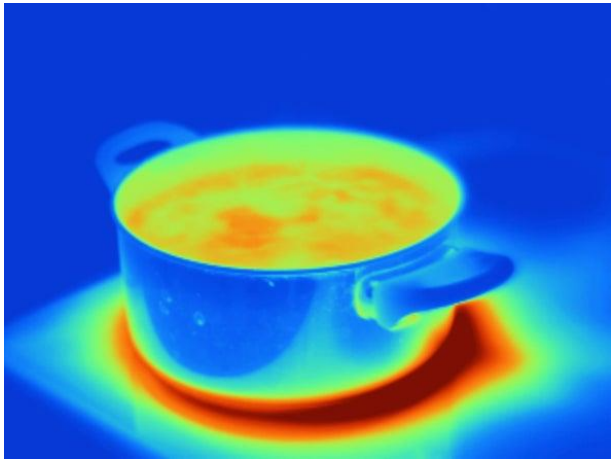
- Portable device that could be placed on pavement and would measure % polymer.
- Test hot mix and binder at the asphalt plant.
- Able to be used and interpreted by an asphalt technician instead of a chemist.
- Calibration curve independent of binder source and polymer source.

SHRP2 Solution Showcase (2016)

- **Attended Federal workshop "Techniques to Fingerprint Construction Materials" in Connecticut to learn abilities of FTIR.**
  - Learned that possibility existed to accomplish some of FDOT's needs and therefore decided to purchase a device.

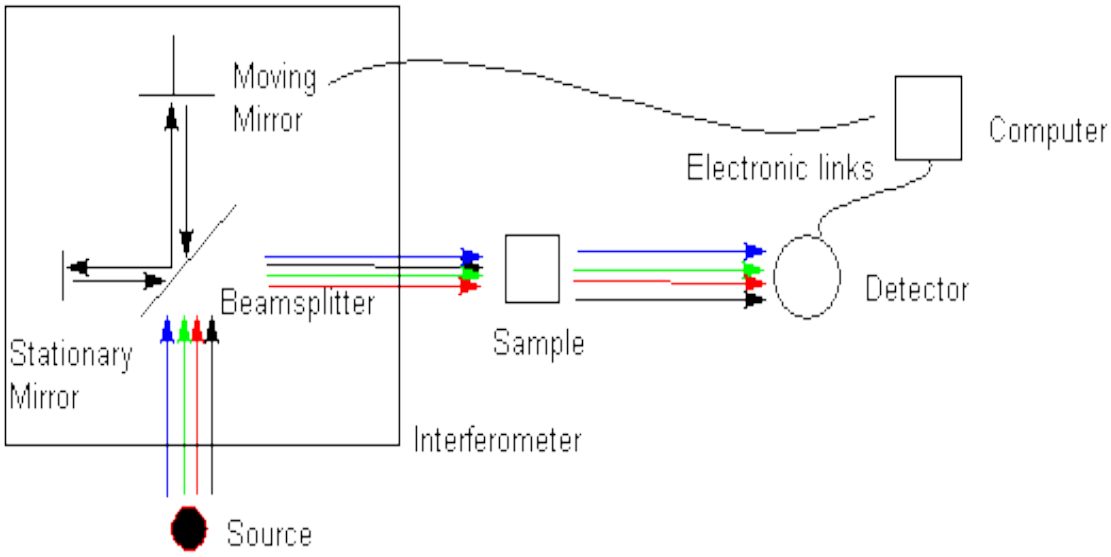
Infrared Spectrum





What is FTIR Spectroscopy?

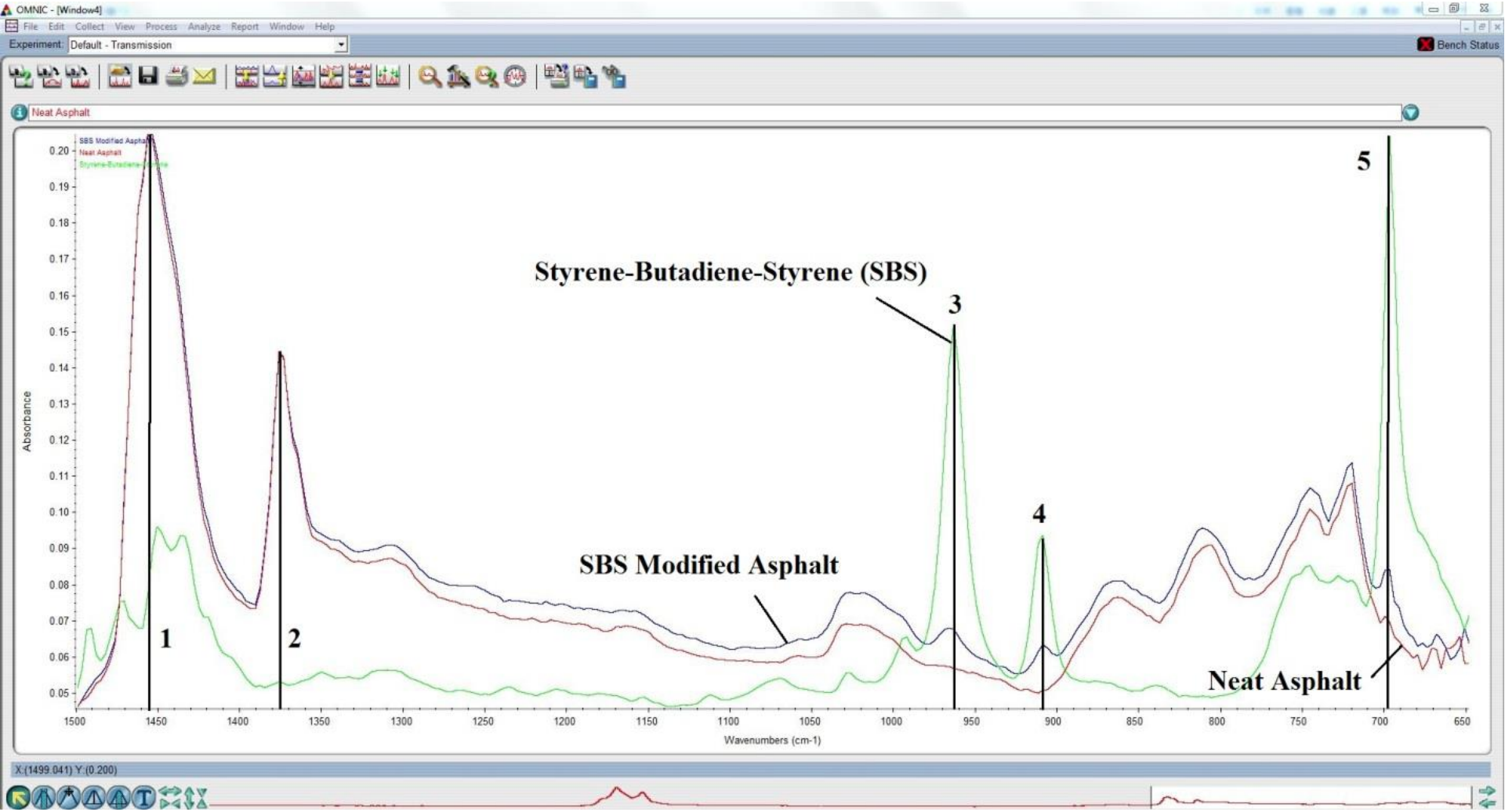
- **Fourier Transform Infrared Spectroscopy**
  - Spectroscopy - "Measurement of spectra produced when matter interacts with electromagnetic radiation."



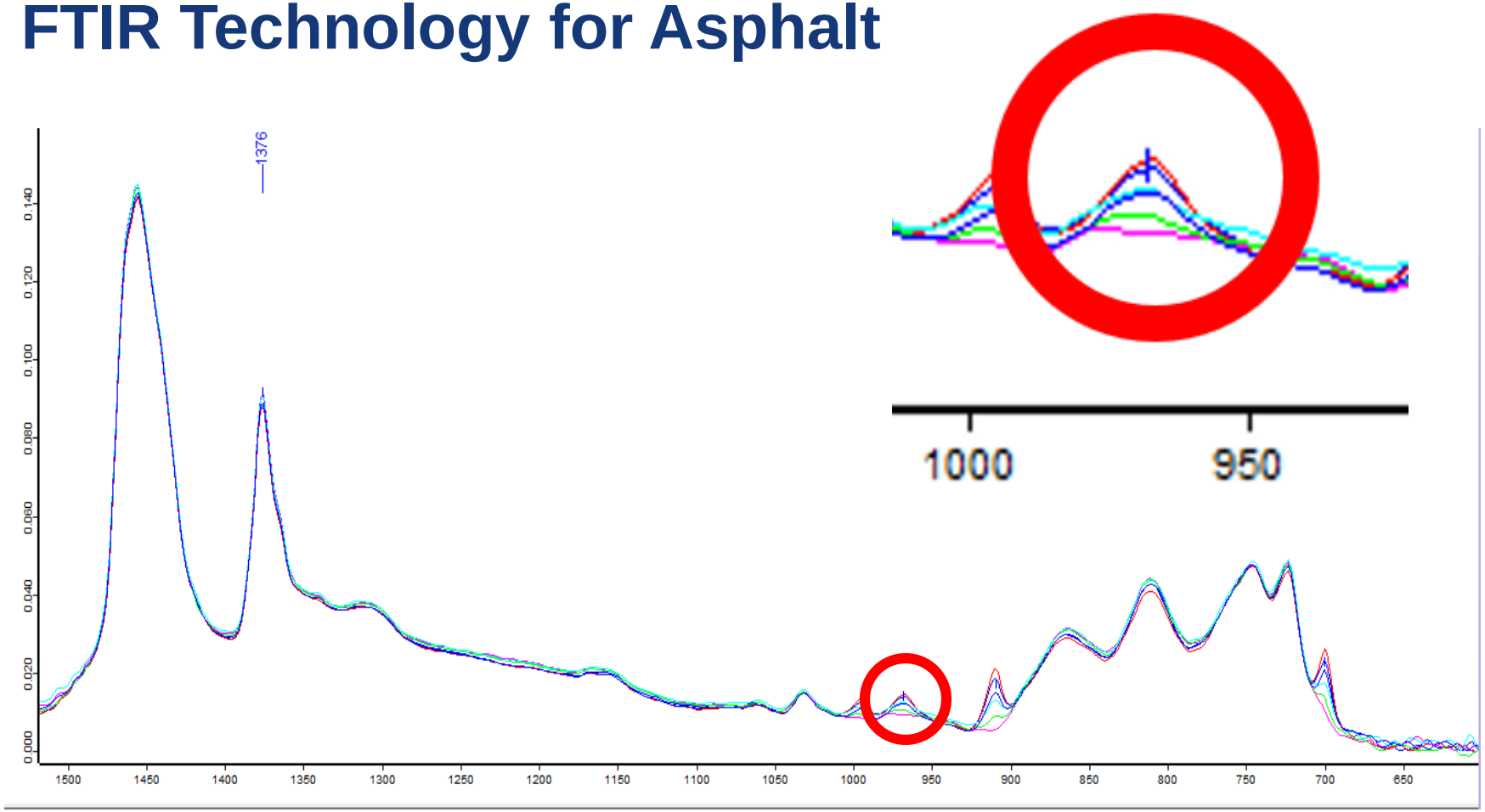
What is FTIR?

- Molecules of a particular material vibrate when bombarded with a particular frequency of infrared energy.
- Lower energy than XRF (X-rays).
- Infrared good for carbon based materials (asphalt), whereas XRF good for metals.

FTIR Technology for Asphalt



FTIR Technology for Asphalt



FTIR Scan Courtesy of FDOT State Materials Office

FTIR Technology for Asphalt

- **AASHTO T 302-15**
  - Peak height at wavenumbers 965 cm^{-1} and 1375 cm^{-1}

    (FYI, wave number is the inverse of wavelength)
  - Use the ratio
  - Compare with a calibration curve to determine polymer content

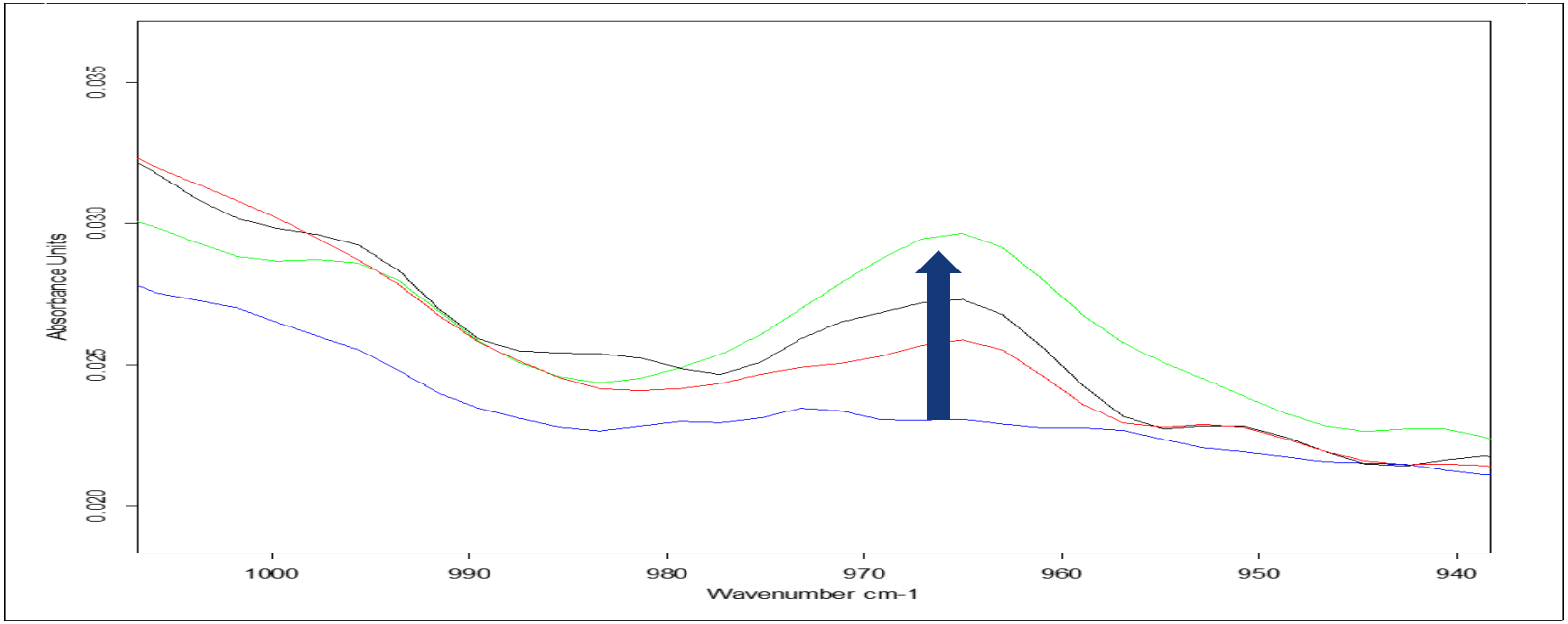
USF Contracted Research

- Four FTIR Instruments Utilized

Images Courtesy of FDOT State Materials Office, Thermo Scientific, and Bruker Optics, Inc.

USF Contracted Research

- 1375 cm^{-1} remained constant
- 965 cm^{-1} peak increased with known increasing SBS concentration



FTIR Spectrum Supplied by Bruker Optics

USF Contracted Research Conclusions

- FTIR suitable for polymer.
- FTIR not suitable for ground tire rubber. Different sources of GTR behave differently. No common characteristic peaks.
- Table-top and portable FTIR devices correlated very well.

FTIR Device Purchased by Bituminous Lab

- **Bruker Alpha**
  - Lightweight and portable
  - User Friendly
- **32 scans in 60 sec.**
- **Total test time is 5 minutes (prep, scan, clean, analyze).**

SMO Research Conducted

- **Original Binder**
  - Multiple Crude Sources
- **Various SBS Concentrations**
  - 0% to 10%
  - Various SBS Sources
- **Multiple Sample Measurements**
  - Less than 1g of Material Needed
- **Standard Curve(s) Generated**

Things Don’t Always Go As Desired

- **Cannot measure binders contained on pieces of pavement.**
- **Not able to test hot binder scraped off of mix due to contamination of fine material.**
- **Only able to test new or recovered binder.**
  - For recovered binder samples, the fines are removed in the recovery process.

Wish List Accomplished-Somewhat

- Portable device capable of measuring % polymer.
- Can test binder at the asphalt plant or in the lab.
- A technician can interpret the data with some guidance.

How Will FDOT Use FTIR?

- **Forensic investigations.**
- **APL samples.**
- **Project samples.**
- **Mix design verification binder samples.**
- **Research.**
  - New products.
  - Anti-strip interactions.
  - Aging of binders.
- **Not the best test for REOBs detection. ICP and XRF better due to metals in REOBs.**

Thank you.

Questions?