

# **Spectroscopy of Asphalt Surfaces at Traffic Speed**

Donald Burton

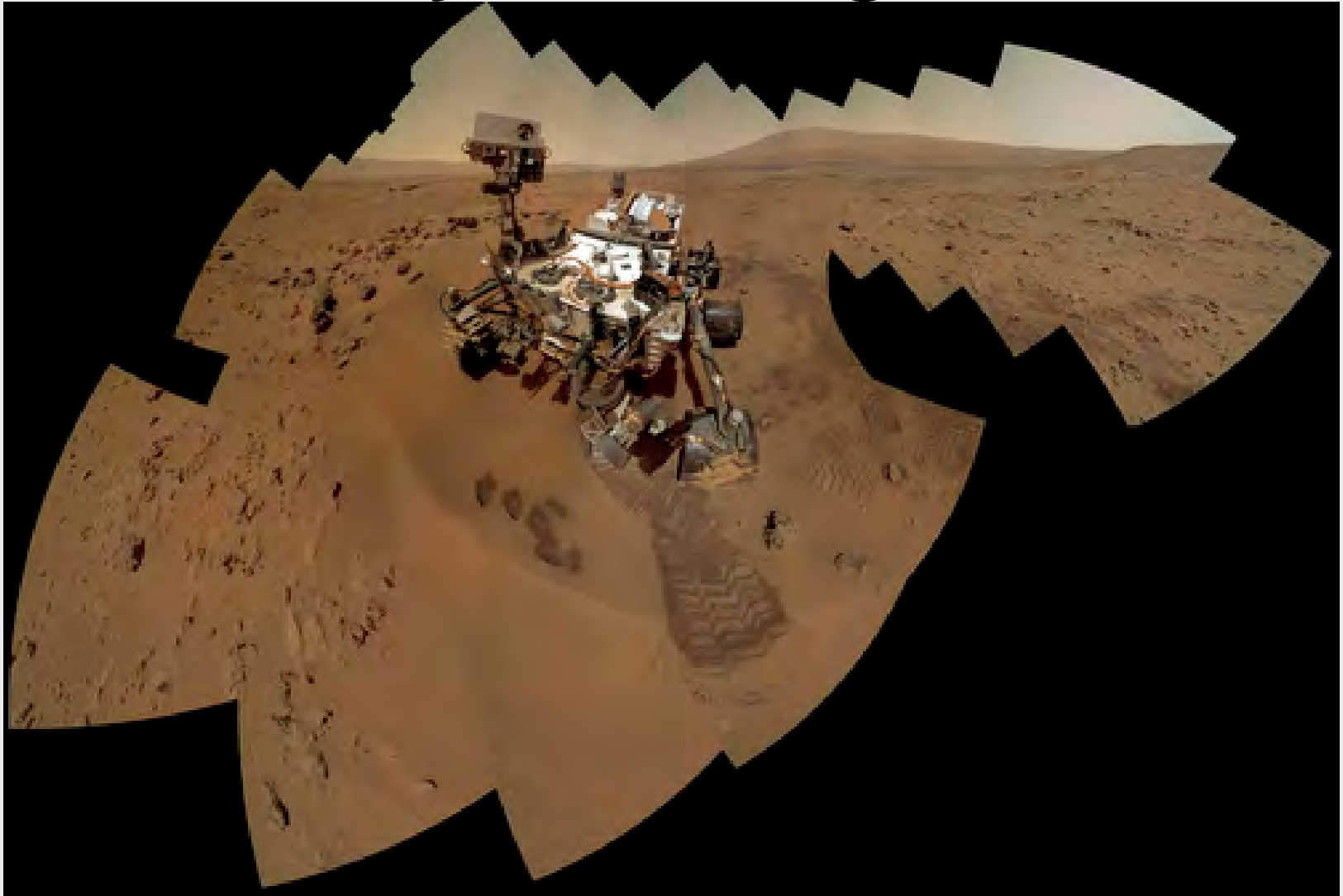
# The Problem

- Modern Road Surfaces deteriorate rapidly towards the end of their serviceable life
- The time between noticeable visible deterioration and unserviceability can be 1 to 2 years
- TSCS rely on binder to maintain integrity of mat rather than binder and aggregate/fines interlock in HRA

# The Concept

- Binders become harder and oxidise when exposed to air/water/sunlight
- Binders eventually lose adhesion to aggregate
- A chemical change in the binder must have occurred over time
- Measurement of the change in chemical properties will indicate point at which binder loses adhesion and pavement surface loses integrity

# The 'Red Sky' Thinking



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- If a rover named Curiosity travelling over the surface of Mars can determine the chemical composition of rocks by performing spectroscopic analysis then surely we can measure the chemical composition of a road pavement surface on earth.

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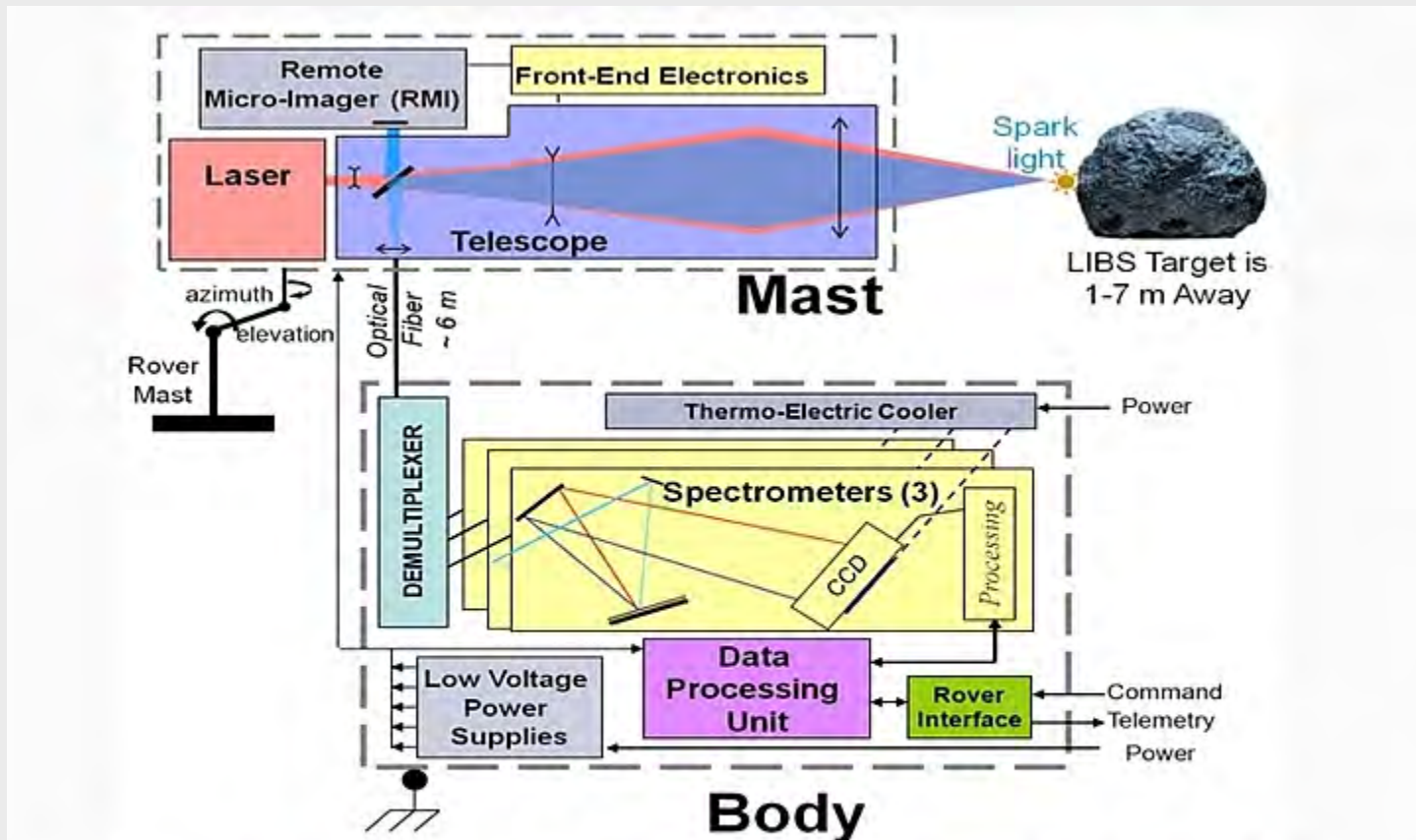
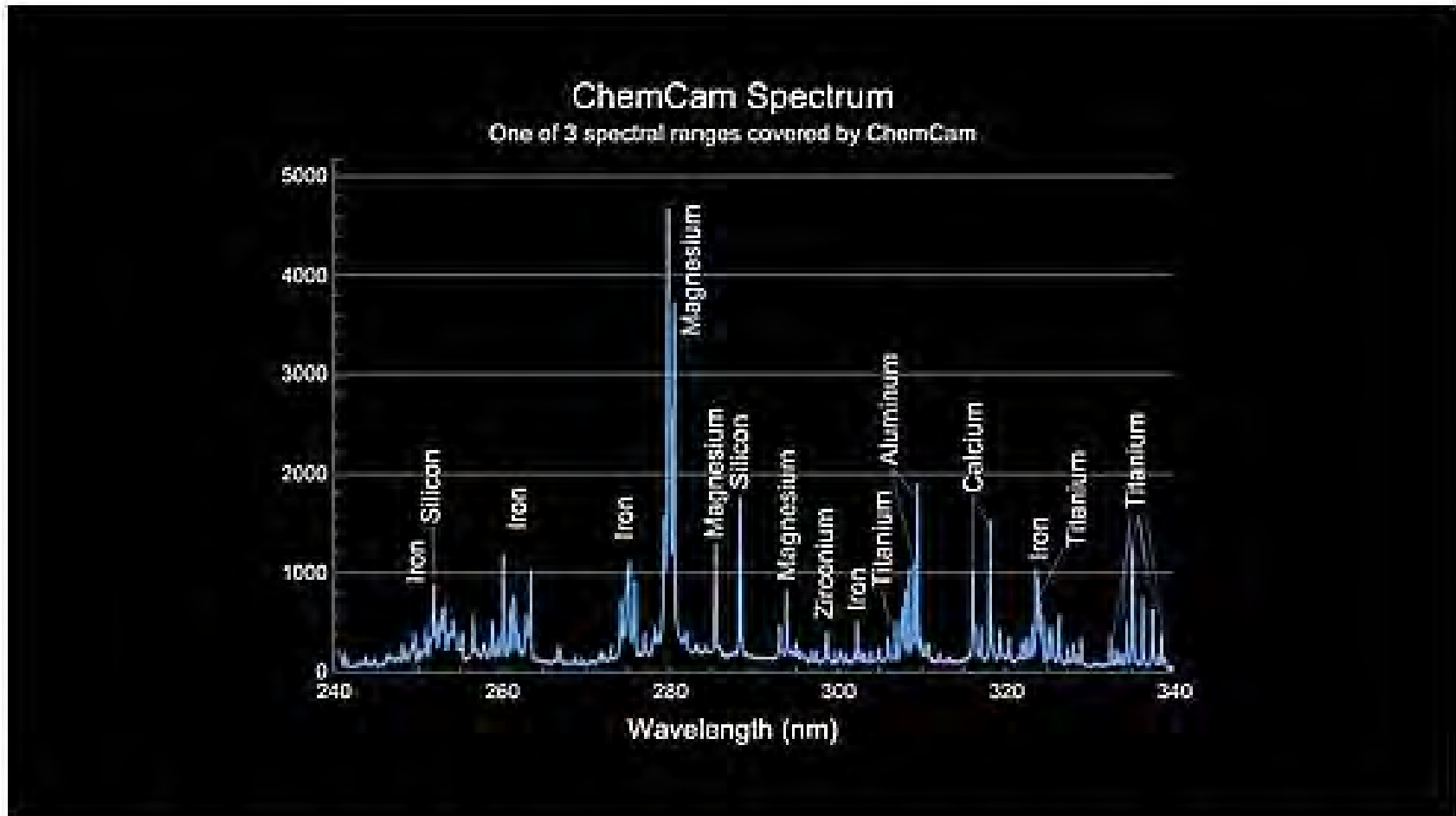


Figure 1: The ChemCam instrument has two parts: a mast package and a body unit. On the mast is a telescope to focus the laser and the camera, a laser for vaporizing surfaces, and a remote micro-imager. The mast package can be tilted or rotated as needed for optimum viewing of the rock. (Courtesy NASA/JPL)

# The 'Red Sky' Thinking



**Figure 3: Example of a Spectrum from Curiosity's ChemCam Instrument**

# The Feasibility Study

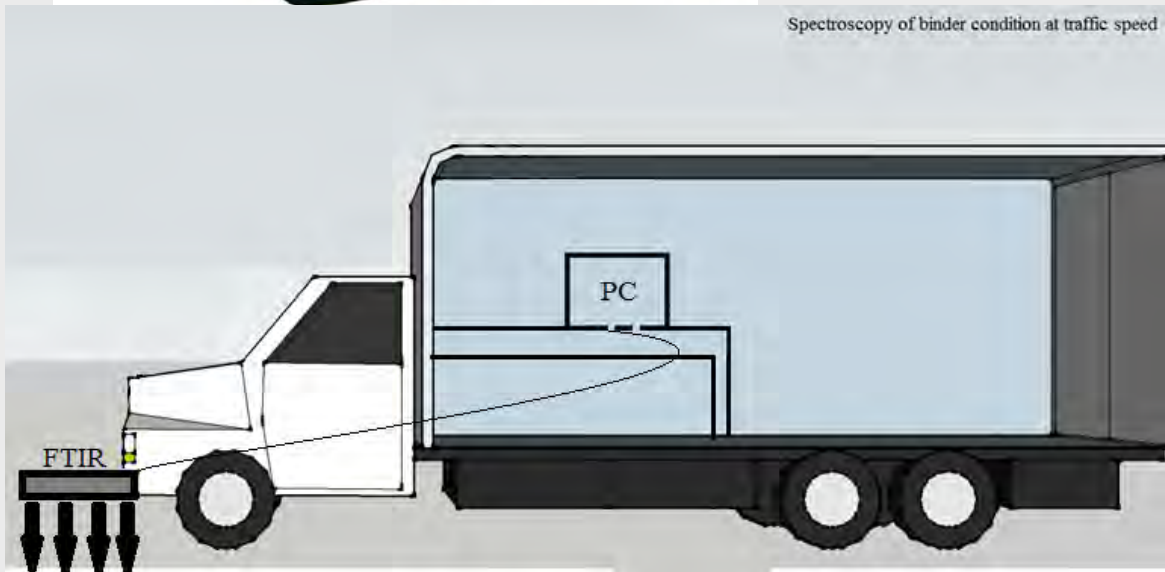
- 6 month desk study
- Review of literature
- Review data acquisition techniques
- Review binder chemical changes over time
- Review changes in asphalt mixtures over time



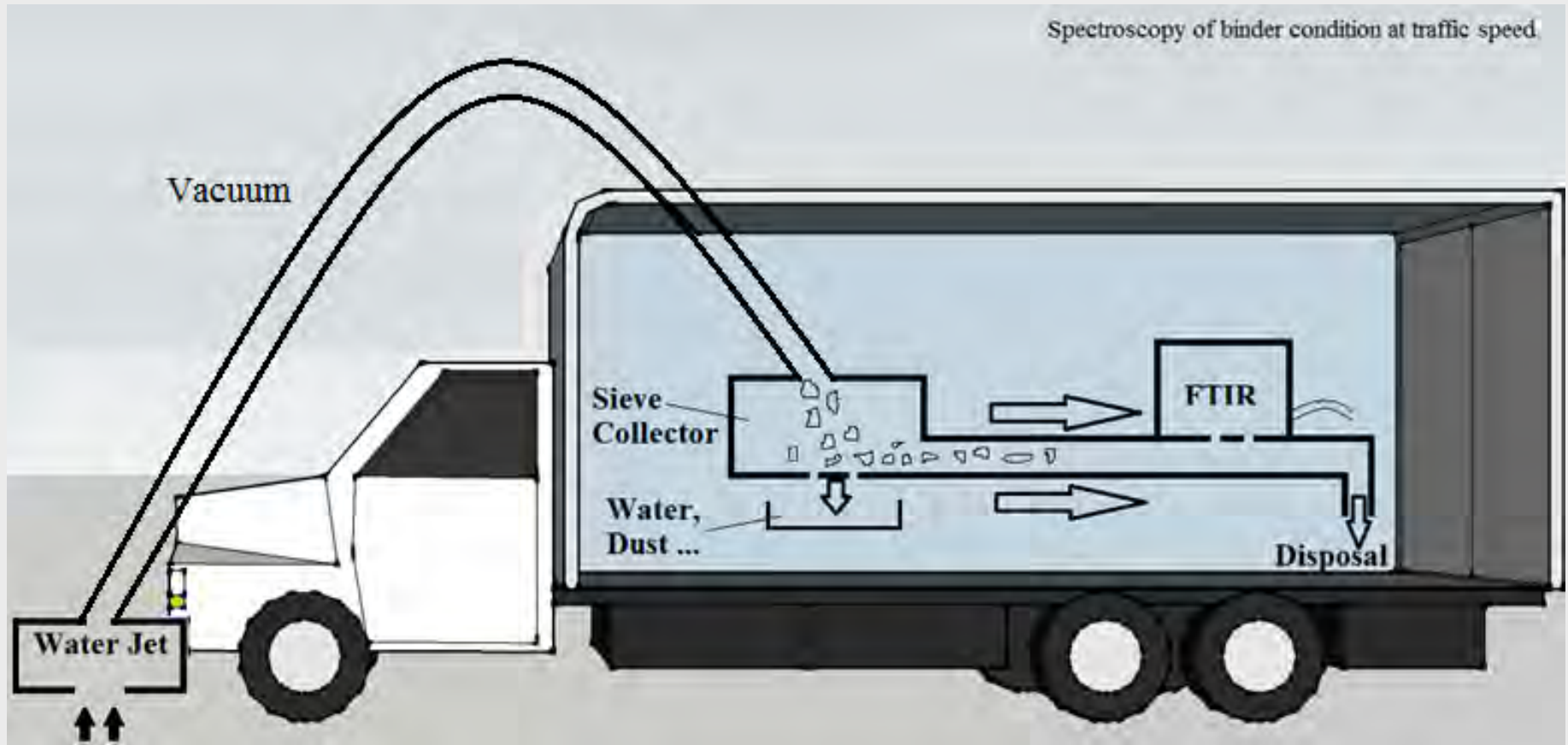
# Option1: Direct measurement



Spectroscopy of binder condition at traffic speed

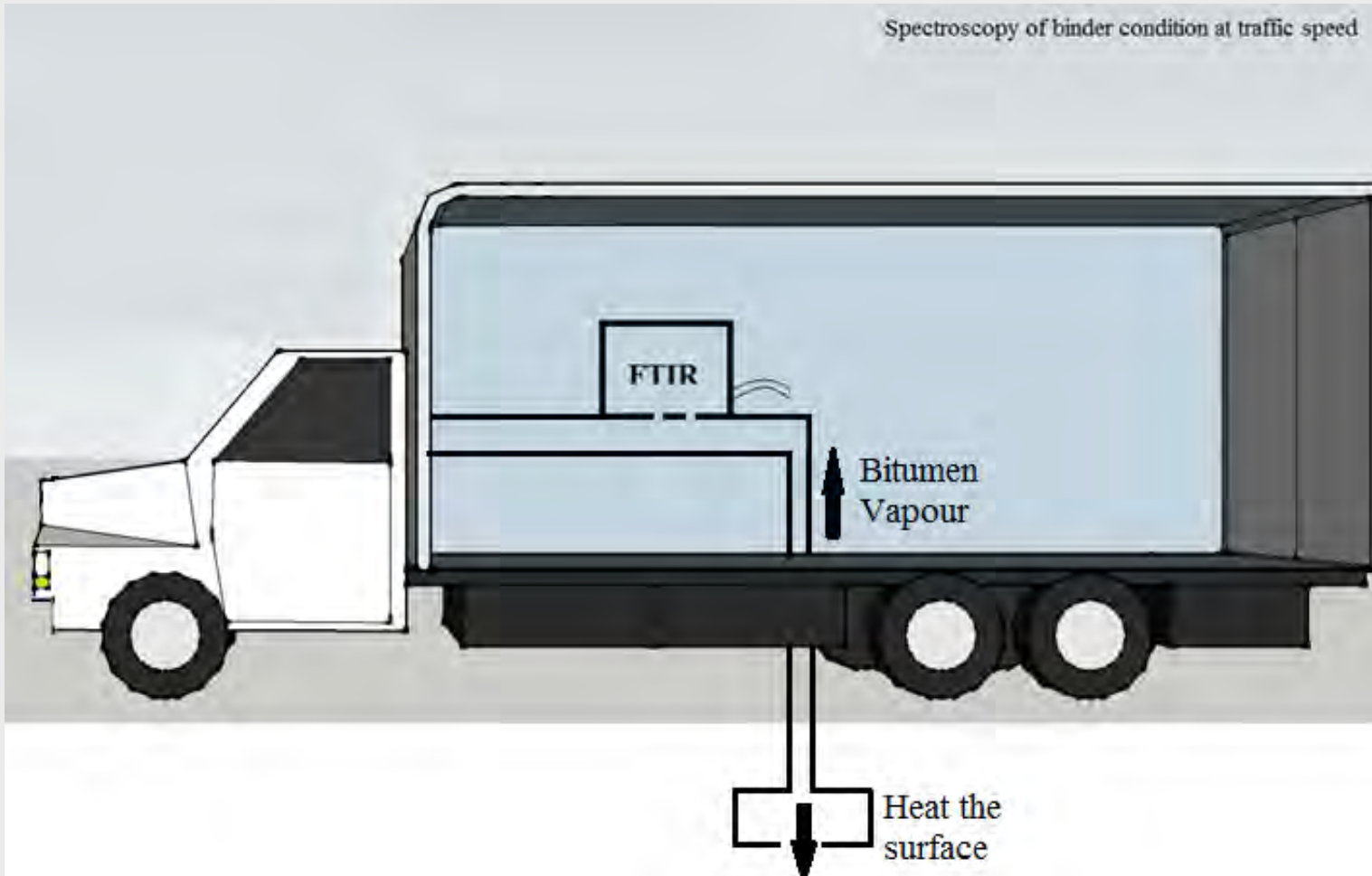


# Option 2: Sample collection by water jet



# Option 3: Sample collection by heat application

Spectroscopy of binder condition at traffic speed



# Option1: Factors to be considered



- Sampling rate and time required to scan the surface,
- Whether the technique is able to analyse asphalt mixture (e.g. not just bitumen),
- Sensitivity against contamination, moisture, temperature variance,
- Whether the technique is able to collect data in motion,
- Considerations for vehicle mounting


# Option2: Factors to be considered

- Water jet modification to recover sample at traffic speed (>50 mph),
- Whether FTIR technique is able to analyse the recovered asphalt mixtures,
- There is a possibility to collect the samples at high speed and bring them back to laboratory for audit or further testing.

# Option 3: Factors to be considered

- Safe application of heat,
- Bitumen oxidation,
- Possible surface damage,
- How to capture the binder vapour,
- How to test the binder vapour in FTIR,

Option	Advantage	Challenges
<p>Option 1 (Direct measurements, e.g. )</p>	<ul style="list-style-type: none"> <li>Initially can be assessed in lab</li> <li>Quick</li> <li>Available in market</li> <li>Non destructive</li> <li>Testing and research at low cost</li> </ul>	<ul style="list-style-type: none"> <li>No previous information, Research needed to assess the performance in static and dynamic mode,</li> <li>Currently contact is necessary research to move to contactless</li> </ul>
<p>Option 2 (water jet plus static )</p>	<ul style="list-style-type: none"> <li>Sample collection method being developed (previous experience)</li> <li>Static/contactless</li> </ul>	<ul style="list-style-type: none"> <li>Research needed to investigate/validate the capability of the FTIR on mixture testing (effect of</li> </ul>

Option	Advantage	Challenges
<p data-bbox="112 719 625 899">Option 3 (heat application plus static spectroscopy)</p> 	<ul data-bbox="683 374 1205 859" style="list-style-type: none"> <li>• Laser may be used to vaporise binder from surfacing</li> <li>• Static/contactless FTIR testing more likely to succeed-proven in the literature</li> </ul>	<ul data-bbox="1278 374 1823 1245" style="list-style-type: none"> <li>• Can laser beam (heat) vaporise binder at very short time? This may require discreet sampling.</li> <li>• Research needed to investigate/validate the capability of the FTIR on mixture testing (effect of aggregate content, bitumen content, moisture etc. )</li> </ul>



# Binder & Asphalt Changes

- Extensive history of Research
- Basic binder ageing processes well understood
- Less information on cortical ageing characteristics

# Future Research Programme

- Confirm changes in chemical composition of binder that indicate ‘critical’ state of surface material reached
- Choose most promising sampling/scanning technology
- Develop traffic speed measurement techniques
- Develop equipment specifications
- Build a prototype machine
- Trial on road network

# New Survey

- Goal
  - Start routine surveys in 5 to 7 years
  - If all goes well!