Tyre/Road Noise Research

New Zealand CPX Monitoring

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New Zealand Government

Tyre/road noise research

- Historically research has involved “uncoordinated” SPB measurements

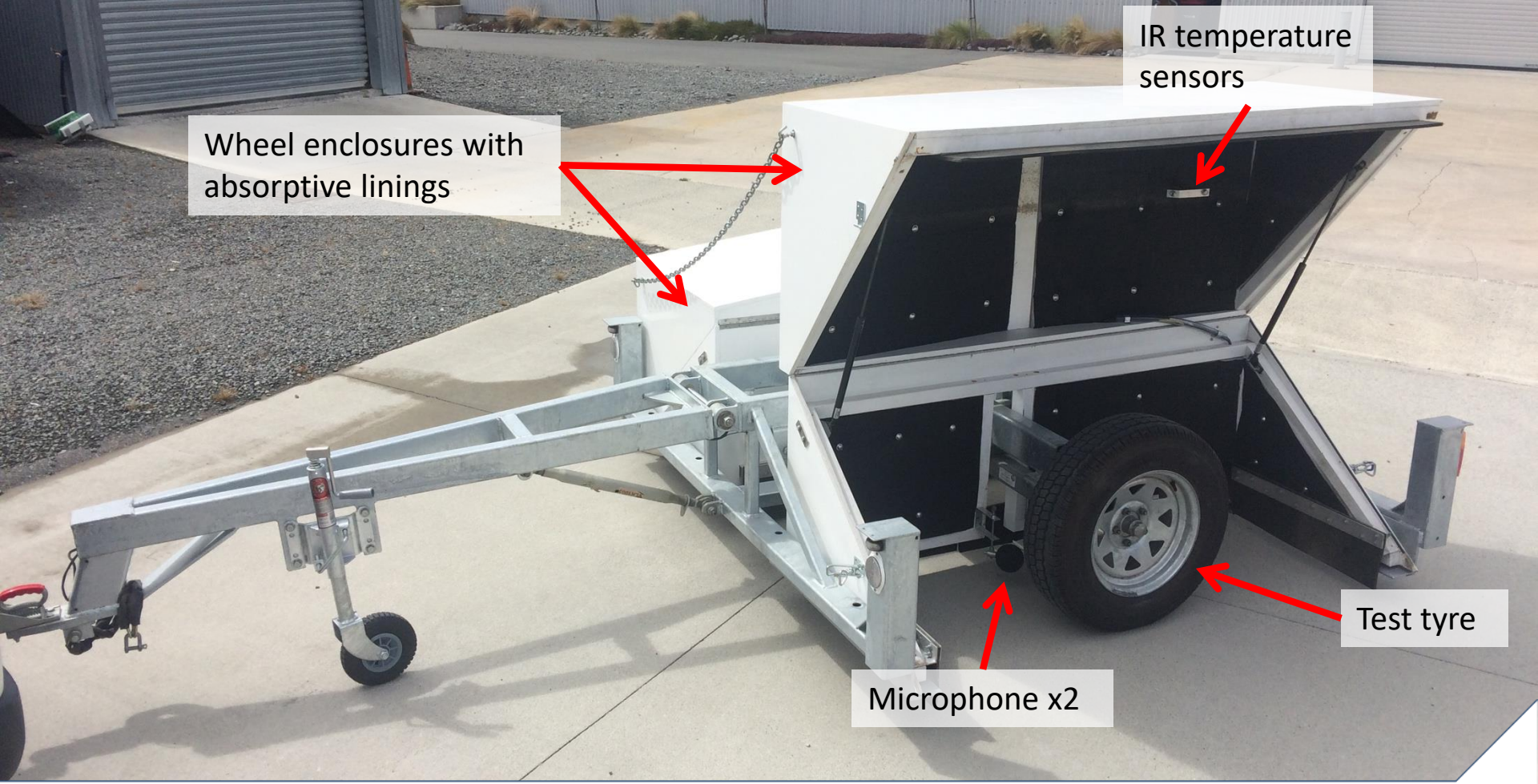
- NZTA began investigating CPX method in 2012 with University of Canterbury.

  - 2012 – Undergrad final year project to investigate options, key-design decisions, mechanical design.
  - 2013 – Detailed design and construction by UoC staff
  - 2017 – (unfinished) CPX trailer delivered to NZTA
  - 2017-2019 – Active investigation into asphalt surface noise

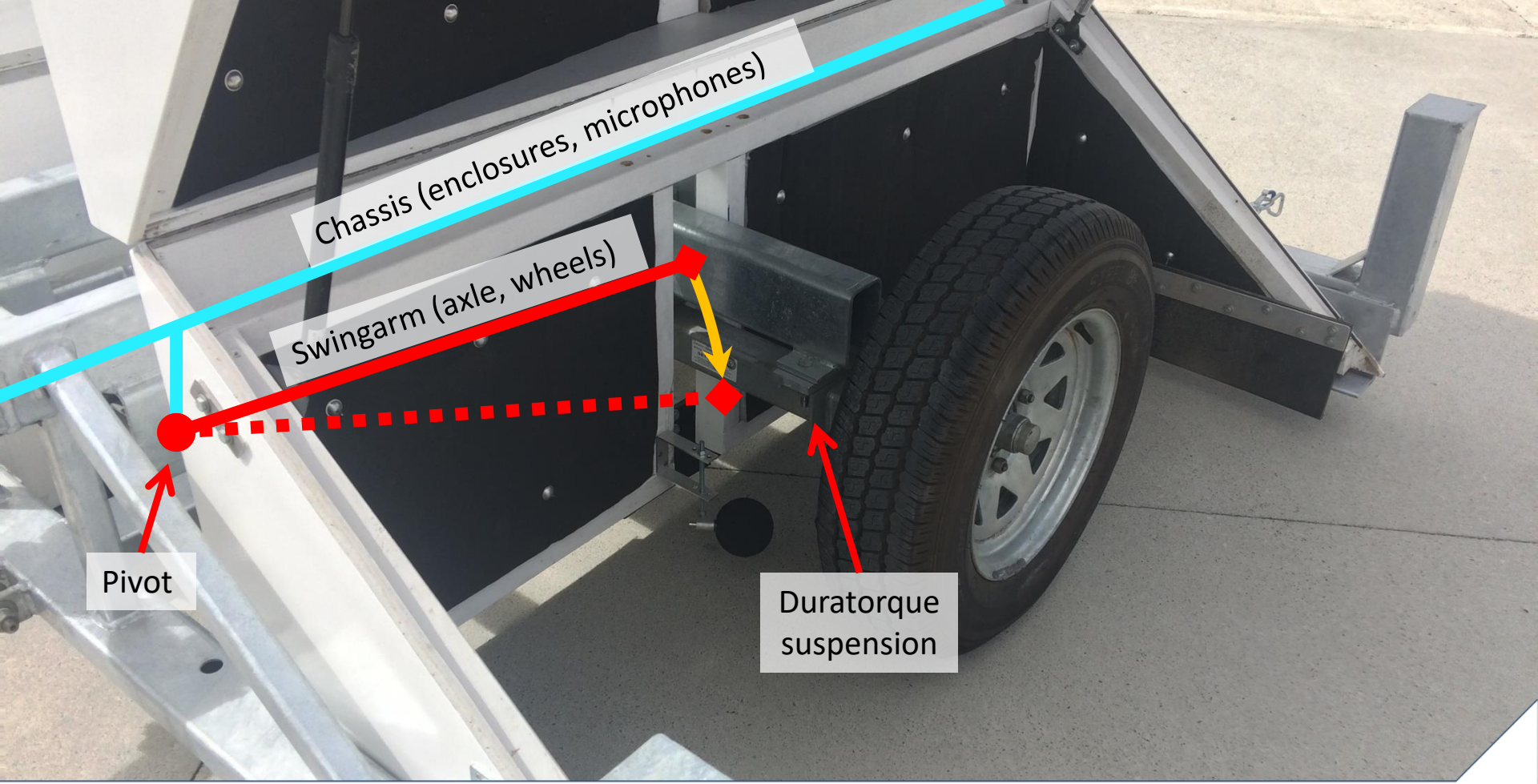
NZTA CPX Trailer

Key design parameters

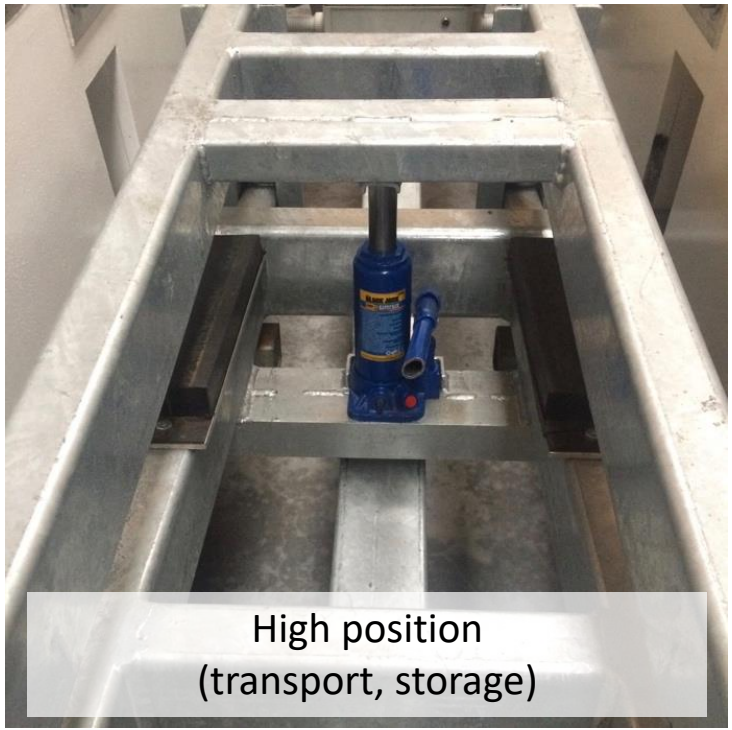
Parameter	Value
Vehicle type	Trailer
Open/closed	Closed
Measurement bays	2 (in the wheel paths)
Total width	2.05 metres
Wheel track width	1.6 metres
Microphones	2 mandatory positions (inside wheels)
Height	Adjustable


IR temperature sensors
Wheel enclosures with absorptive linings
Test tyre
Microphone x2

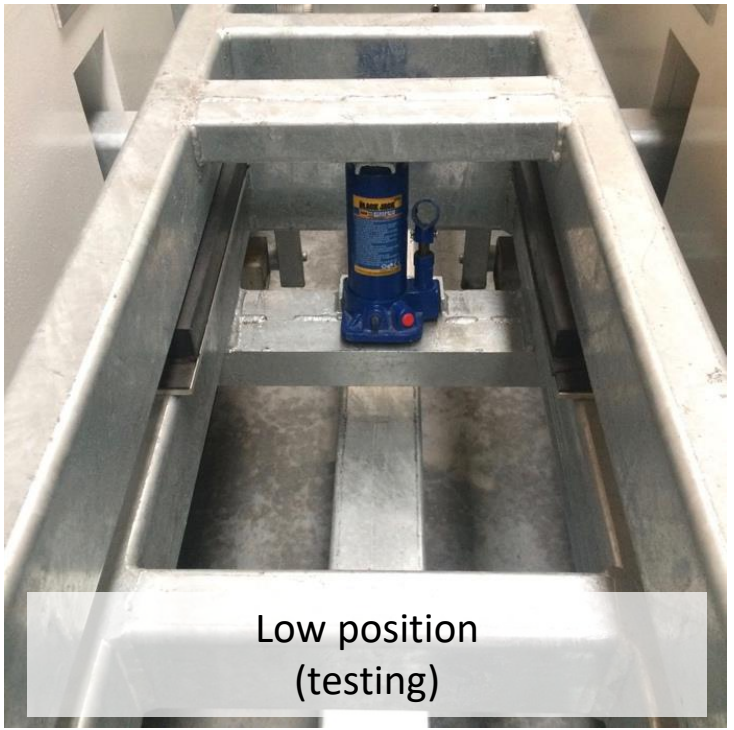

Adjustable height
Measurement system
DJK869
1D621


Chassis (enclosures, microphones)
Swingarm (axle, wheels)
Pivot
Duratorque suspension

Height adjustment mechanism

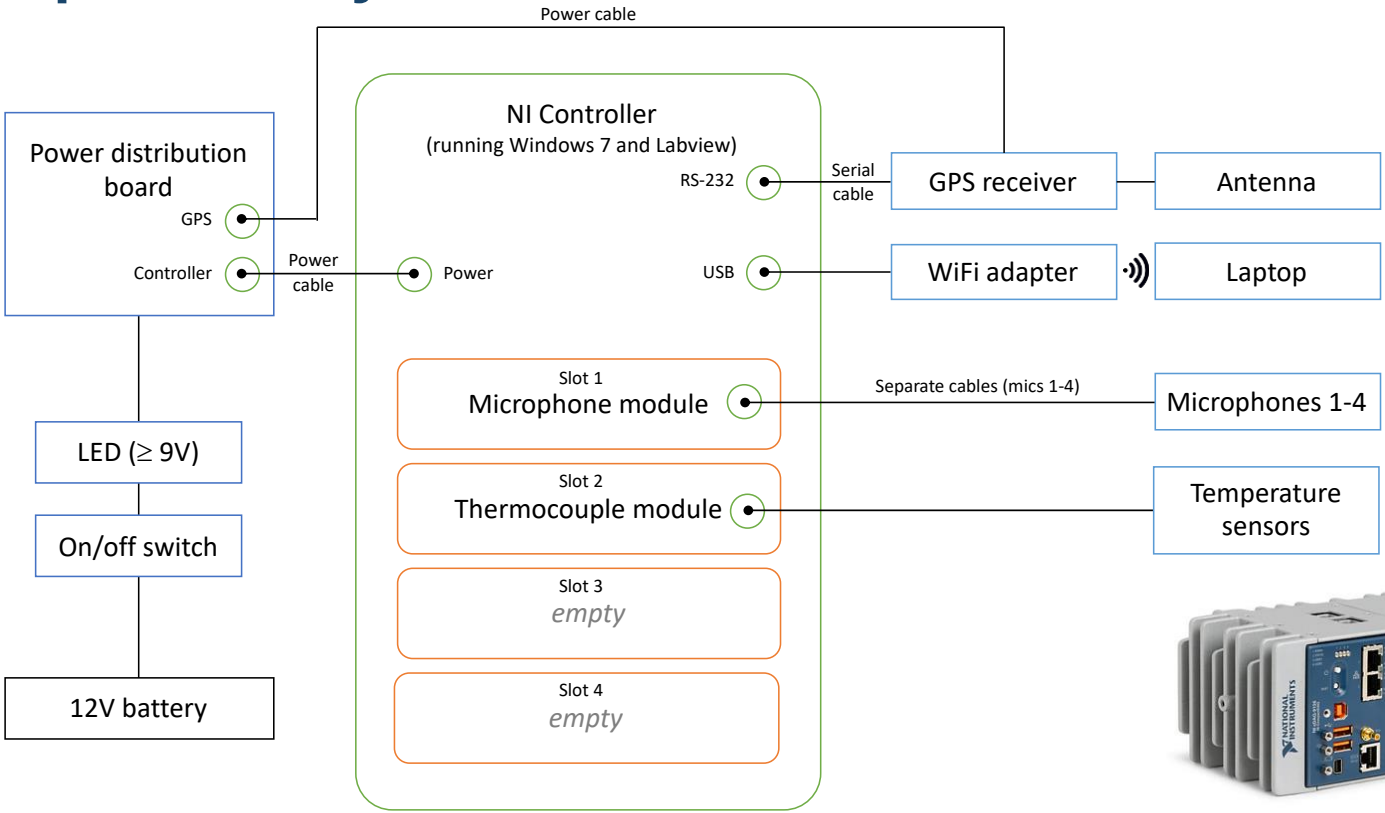


High position
(transport, storage)



Low position
(testing)

Data acquisition system



CPX Trailer Commissioning

Enclosure calibration (Test A.2)

- Initial tests failed:

	1/3-OCTAVE BAND CENTRE FREQUENCY											
	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Correction, C_d (dB)	1.8	0.1	4.9	-0.4	-2.1	-2.2	-2.6	-1.5	-3.7	-3.5	-3.6	-2.5	-2.2

- 500 Hz getting quieter with enclosure
  - Cancellation reflection from the inner rubber skirt.
- 2–3.15 kHz getting louder with enclosure
  - Insufficient sound absorption.

Enclosure calibration (Test A.2)

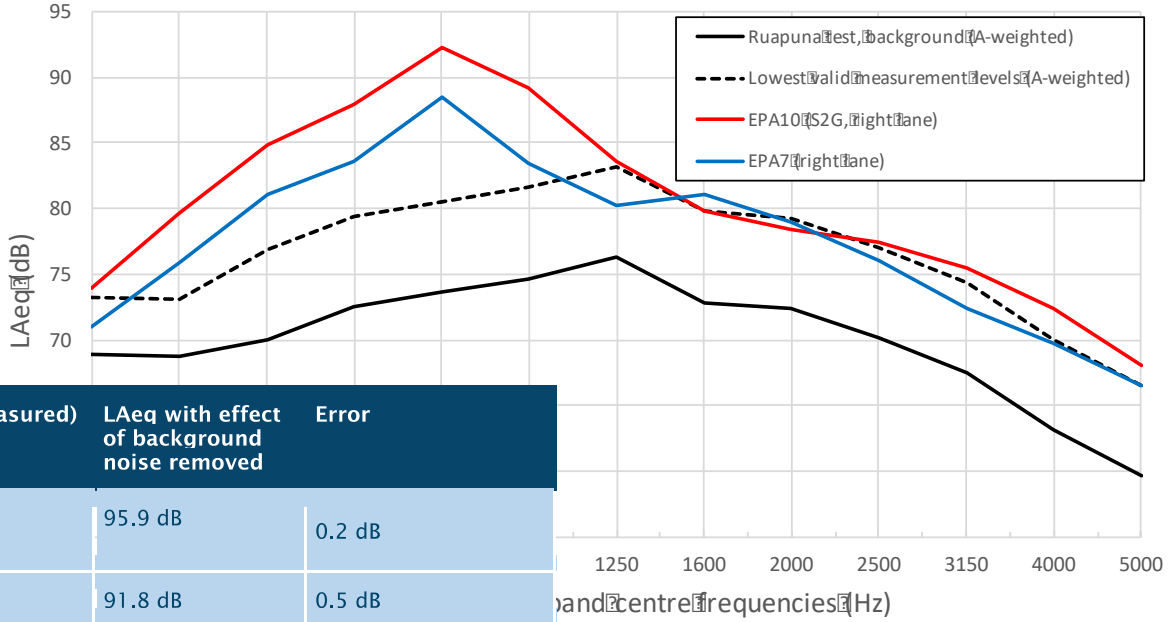
- 500 Hz corrected by removing inner skirt and covering timber member with felt.
- 2–3.15 kHz corrected by adjusting front and rear skirt angles to eliminate direct reflection.

Test and tow vehicle noise (Test A.3 and A.4)

- Trailer supported by outrigger wheels.
  - Increased vertical load on tow ball limits choice of tow vehicle.
  - Require alternative support so that any tow vehicle can be verified.
- Tests performed at closed raceway.
- Currently unable to verify all tow vehicles used with the CPX trailer.

Test and tow vehicle noise (Test A.3 and A.4)

- Quietest NZ surfaces may be affected by background noise:
  - Up to 0.5 dB error on quietest surfaces measured to date.



	LAeq (measured)	LAeq with effect of background noise removed	Error
EPA10 (S2G, right lane)	96.1 dB	95.9 dB	0.2 dB
EPA7 (right lane)	92.3 dB	91.8 dB	0.5 dB

External noise (Test A.5)

- Tests performed on Grade 2/4 chipseal.
  - Passing car and truck spectra corrected for speed and compared to background noise spectrum from Test A.3/A.4.
- Test fails for both cars and trucks in both lanes.
- Approach during CPX testing is to flag all road segments with:
  - a passing vehicle nearby,
  - surface damage, and
  - a visible surface joint.

Logistics


MFTU0010730
2EB0
87
33 TONNE
STEELBRO
CANTERBURY
PORT OPERATIONS

Transporting

- Generally stored in Christchurch, South Island.
- Transported around NZ in dedicated shipping container.

Traffic management

- Minimal requirements in most centres (15,000 AADT):
  - Sign and flashing beacon (on tow vehicle).
  - Operate at night for busier roads.

- Busy centres (100,000 AADT) or 110km/h roads:
  - Sign and flashing beacon (on tow vehicle).
  - Require truck mounted attenuators and advanced warning vehicles.
  - Operate at night for busier roads.

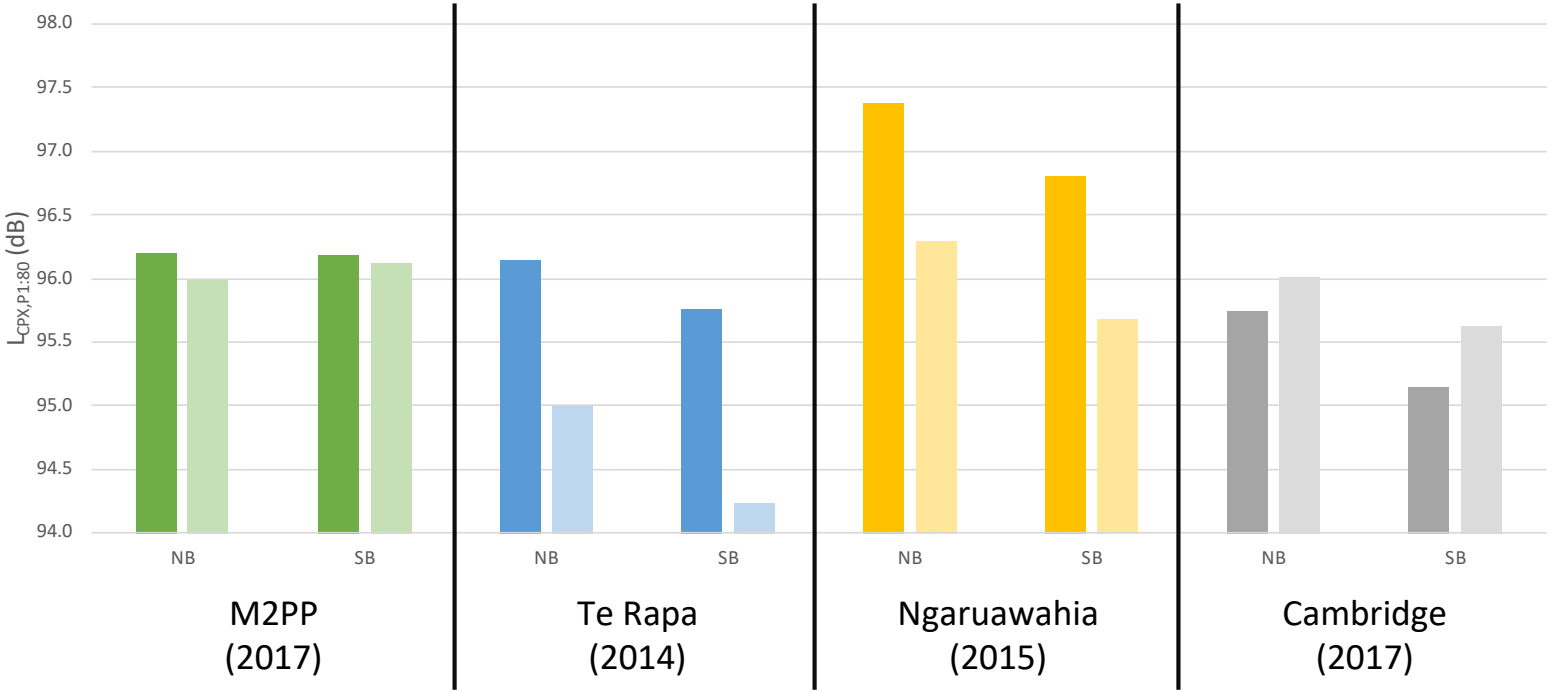
Research

Porous asphalt research

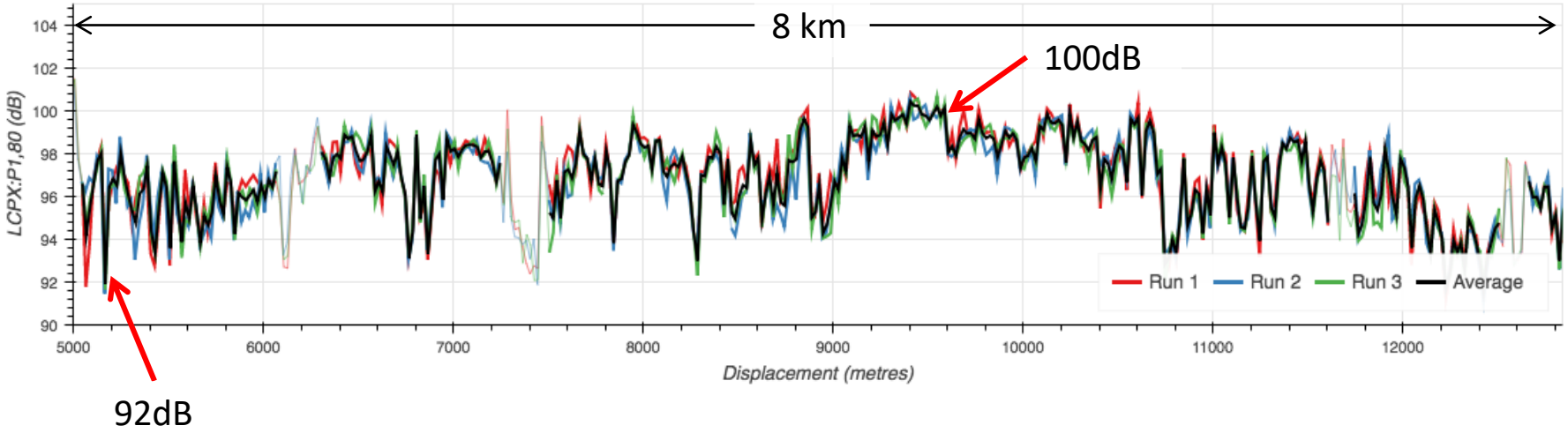
- CPX method verification
  - SPB vs CPX method comparisons
  - Effect of CPX test tyres on surface ranking
- Benchmarking surveys on new asphalt surfaces in the North Island.
- Focused trials around Christchurch looking at:
  - Macrotexture
  - Porosity (void content)
  - Thickness
  - Sources of longitudinal variability

Benchmarking

Dark shade = left lane
Light shade = right lane



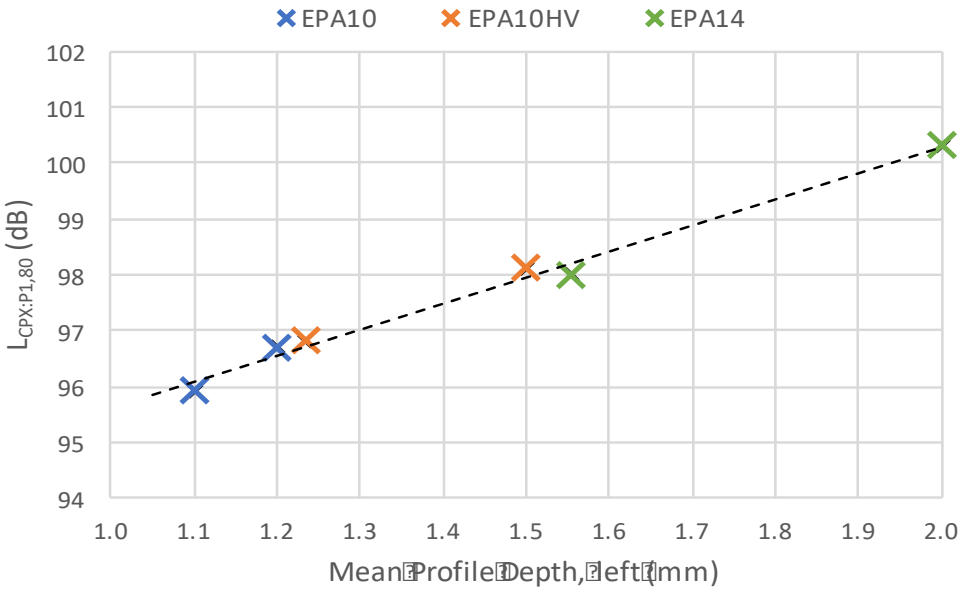
Benchmarking



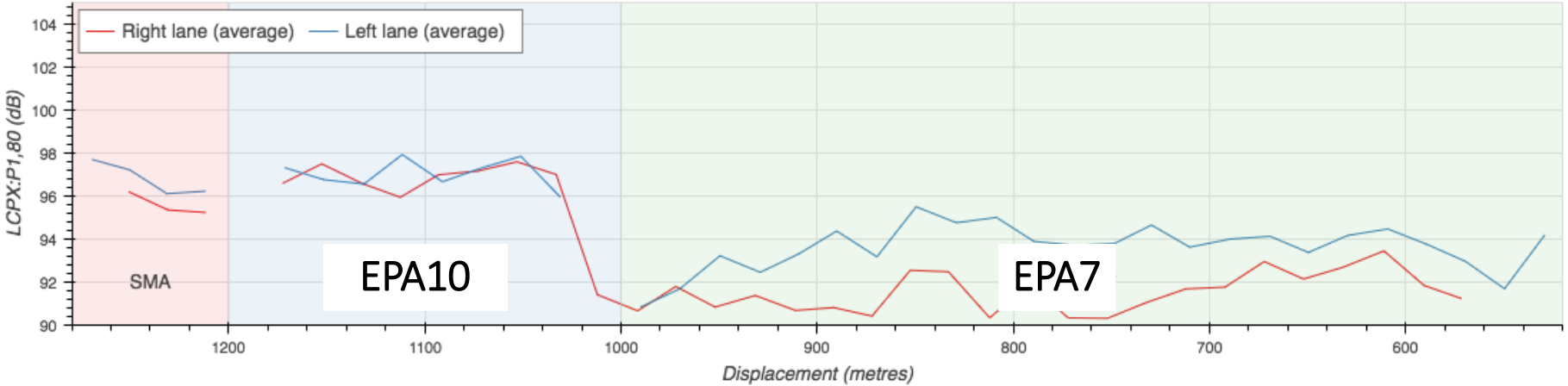
- Significant variations along the same surface within the same project.

High-void trial

- Initial focus was on void content (porosity):
  - EPA10, EPA10HV, EPA14
  - EPA14HV – failed lay down trial
- CPX showed no (or insufficient) high-void benefit.
- Results showed relationship between macrotexture (MPD) and tyre/road noise (CPX).
- Wayside measurements also showed no high-void benefit.

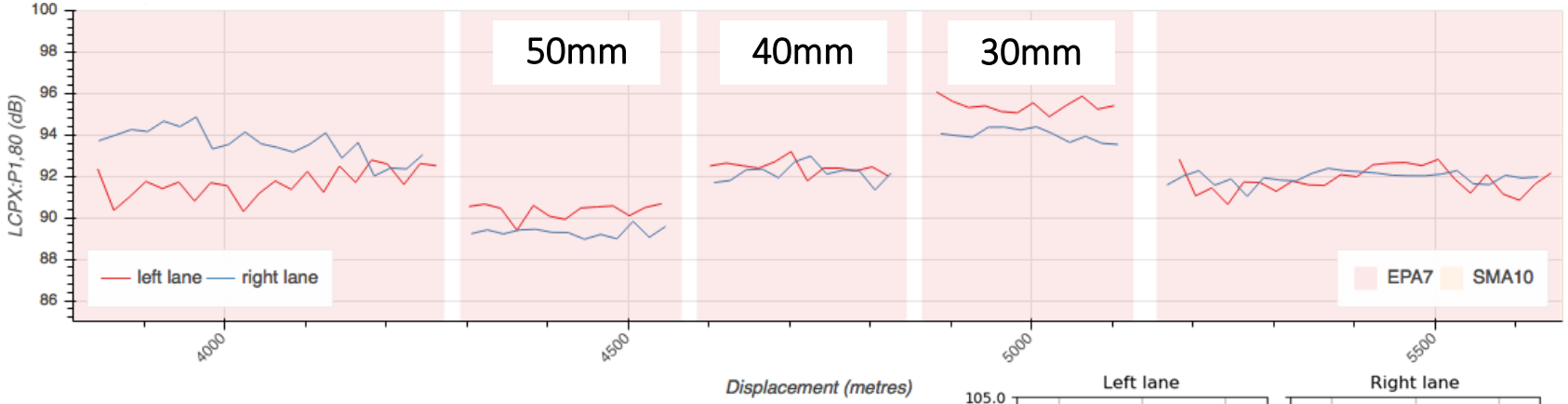


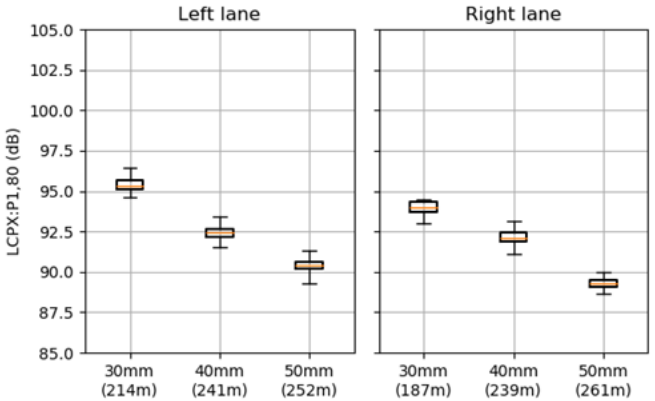
Small chip trial



- EPA10 (30 mm) vs EPA7 (40 mm)
- 4–5dB improvement going to 7mm chip
- Possible benefit from increased thickness

Thickness trial





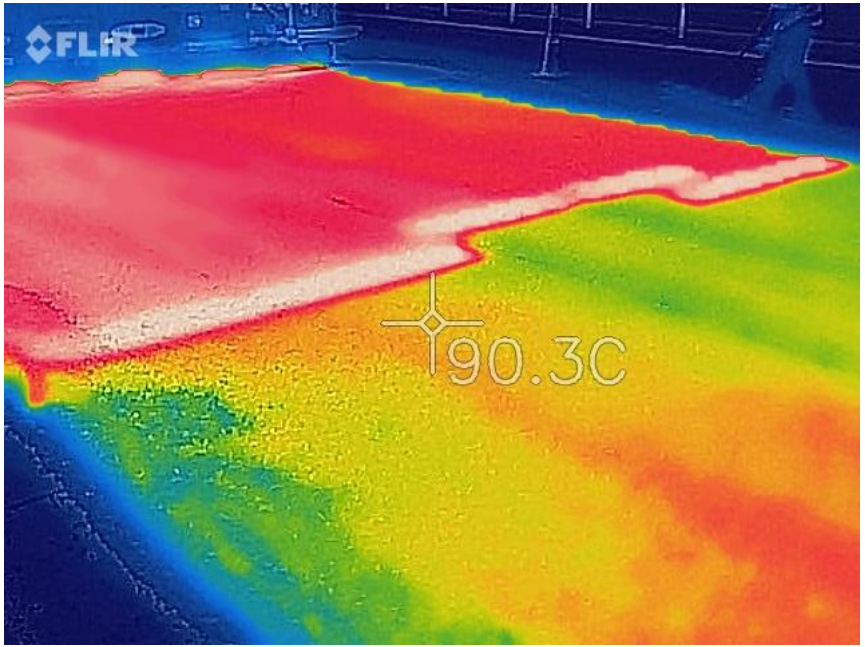
- All EPA7
- 2dB improvement for every 10mm extra thickness

Variability trial

- Construction monitoring at Western Belfast Bypass:
  - Asphalt temperatures during paving and rolling
  - Rolling and paving speeds
- Post-construction measurements:
  - Macrotexture
  - Porosity (void content)
  - Thickness
- Used material transfer vehicle (MTV) on all but one shift.

Variability trial – material transfer vehicle

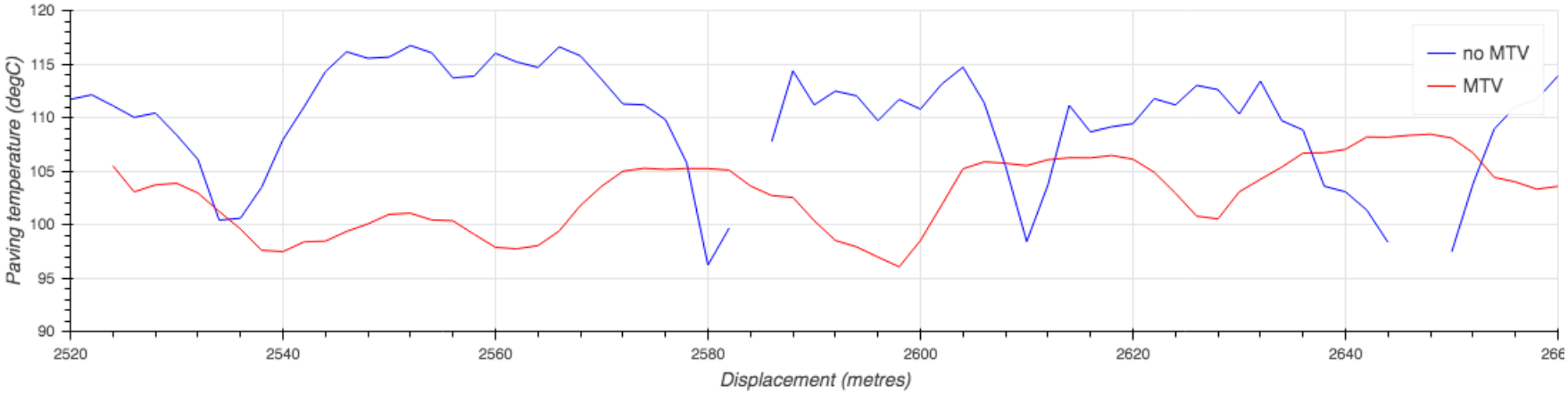
- Small asphalt trucks cause uneven cooling of asphalt during transport.
- Common practice in NZ is to halt paving to swap asphalt trucks.
- Minimise these effects by using material transfer vehicle (MTV)
- Mixing only (no heat)



Variability trial – temperature measurements

- Paving and rolling temperatures / speeds:
- Bespoke instrumentation – GPS, infrared temperature probes.

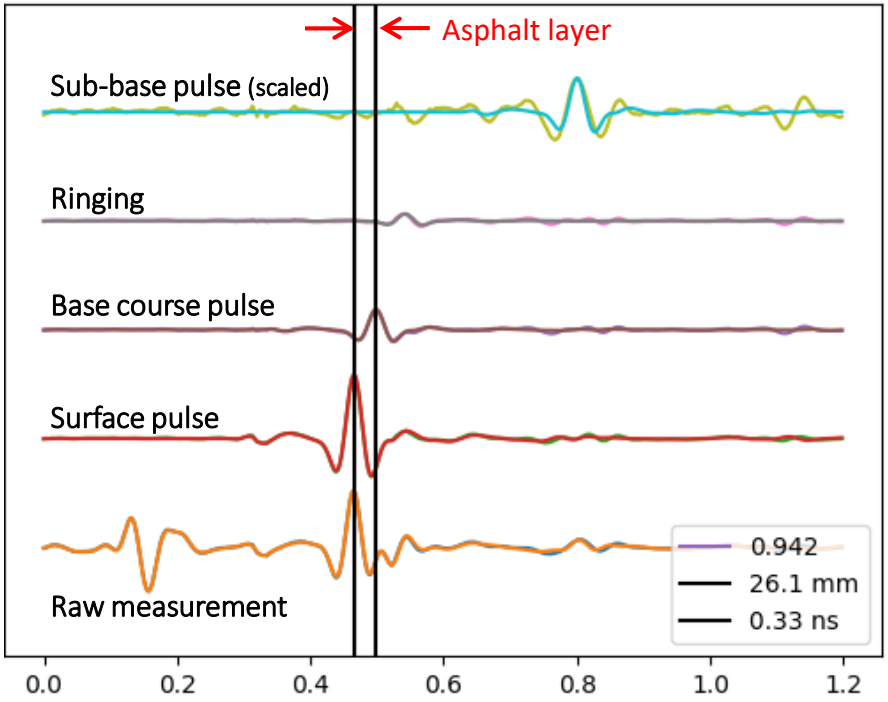
Variability trial – temperature measurements



- Cyclic paving temperature due to asphalt trucks.
  - 15-20ºC variation without MTV
  - ~10ºC variation with MTV

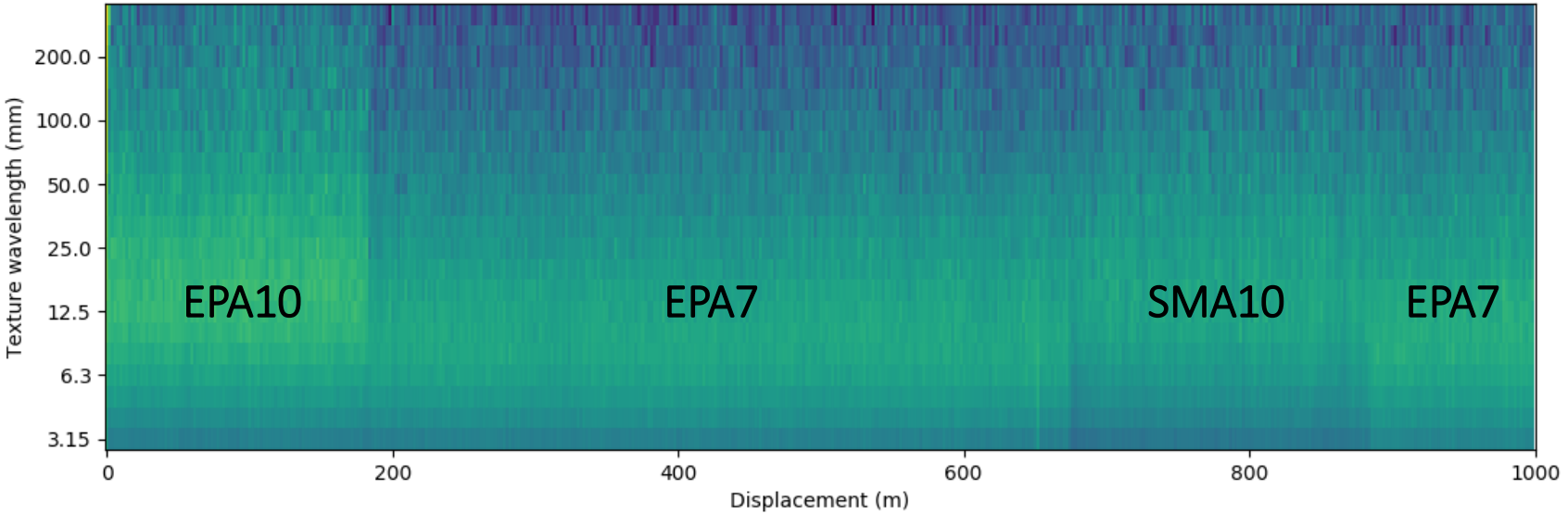
Variability trial – surface thickness and porosity

- Measured by:
  - Lidar scan over thickness trial area (~900 metres x2 lanes)
  - Ground penetrating radar (GPR) over full project area
- Ground penetrating radar (2.4 GHz antenna, air launched):
  - Bottom surface reflection generally masked by much stronger top surface reflection.
  - Required additional processing to reveal bottom surface – not always reliably detected.
- GPR also provides the surface dielectric constant, which is a proxy for void content (porosity).



Variability trial – surface macrotexture

- Measured during annual high speed data survey (10 weeks after construction).
- Mean profile depth (1 metre segments)
- Raw texture profile (1 mm spacing) – for calculation of texture wavelengths



Variability trial – other datasets / information

- Trace sheets – truck load sizes, wait times
- Asphalt lab test reports
- Hand-held infrared photographs
- Paver-mounted infrared camera
- With / without material transfer vehicle
- Left / right lane
- On-site observations

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