



3rd ICTG 2016

04-07 September 2016, Guimarães, Portugal



University of Minho
School of Engineering



Monitoring track defects in ballasted high speed railways

**David Milne¹, Louis Le Pen¹, David Thompson¹,
Willaim Powrie¹**

*1. Faculty of Engineering and the Environment,
University of Southampton*

UNIVERSITY OF
Southampton

EPSRC
Pioneering research
and skills



3rd ICTG 2016

04-07 September 2016, Guimarães, Portugal



University of Minho
School of Engineering



SIMSG ISSMGE



GEO-INSTITUTE



IGs

Track Defects





3rd ICTG 2016

04-07 September 2016, Guimarães, Portugal



University of Minho
School of Engineering

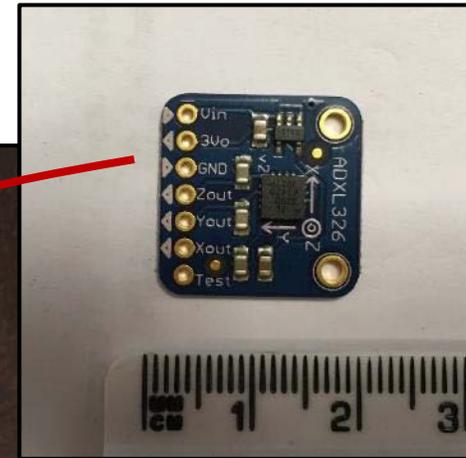
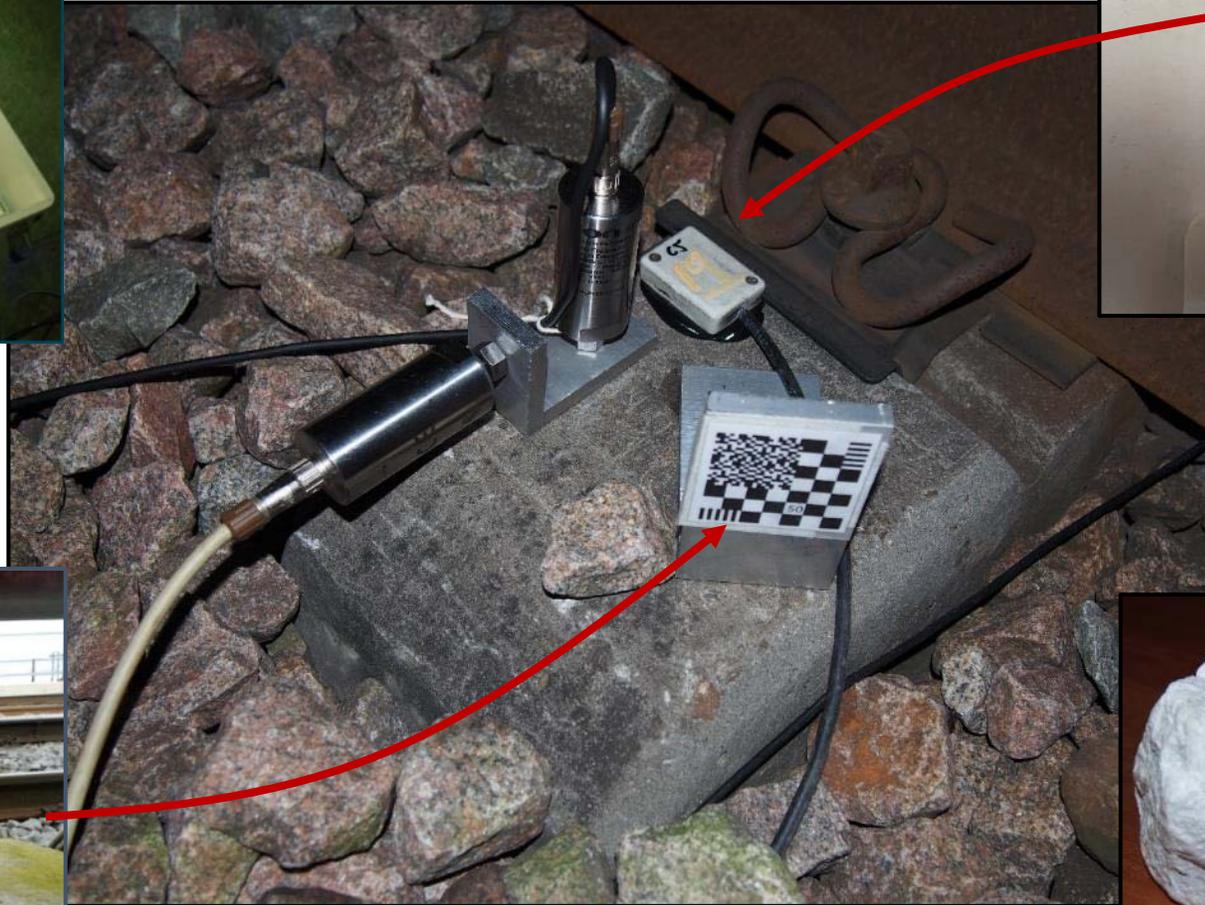


ORDEM DOS ENGENHEIROS



ORDEM DOS ENGENHEIROS

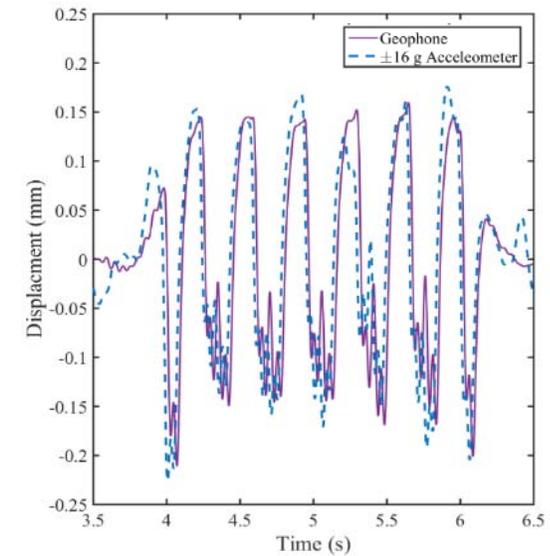
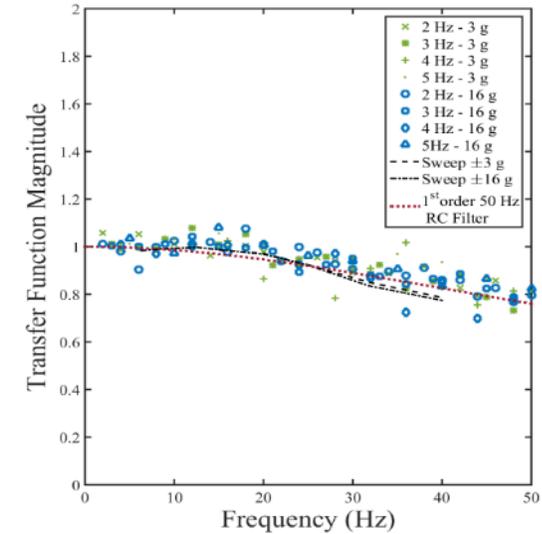
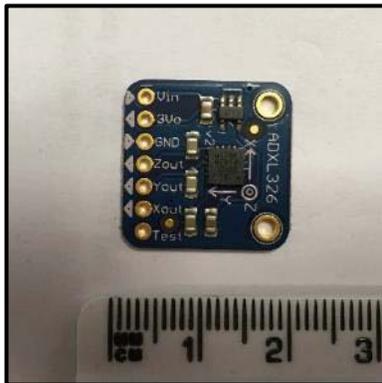
Monitoring Systems





MEMS Accelerometers

- Very low cost acceleration transducer
- Robust
- Data agrees with geophones
- Enables long term monitoring





3rd ICTG 2016

04-07 September 2016, Guimarães, Portugal



University of Minho
School of Engineering



GEO-INSTITUTE



RUTGERS
Center for Advanced Infrastructure
and Transportation

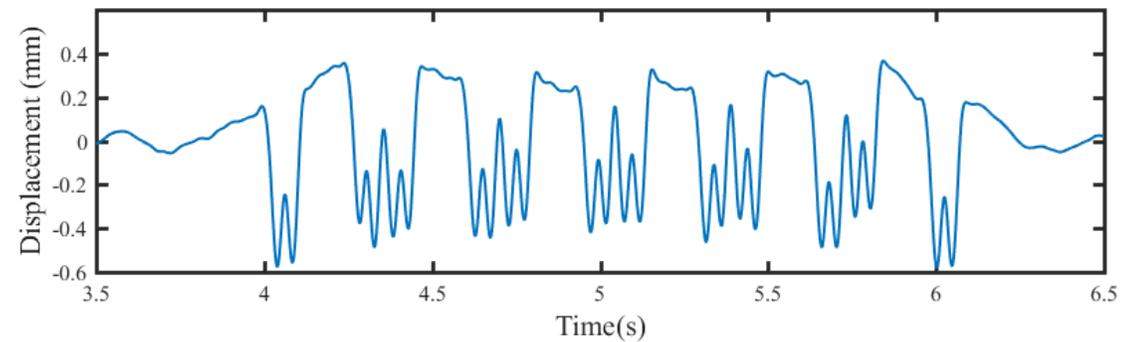
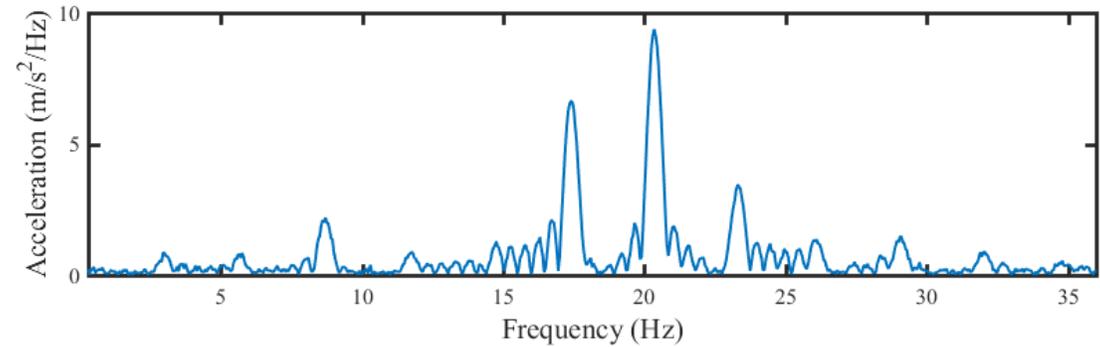
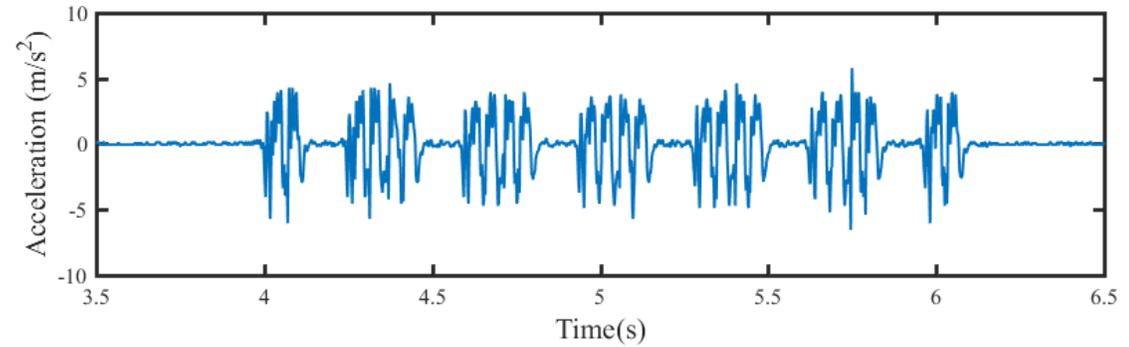


ORDEM
DOS
ENGENHEIROS



ORDEM
DOS
ENGENHEIROS
REGIÃO NORTE

Example data





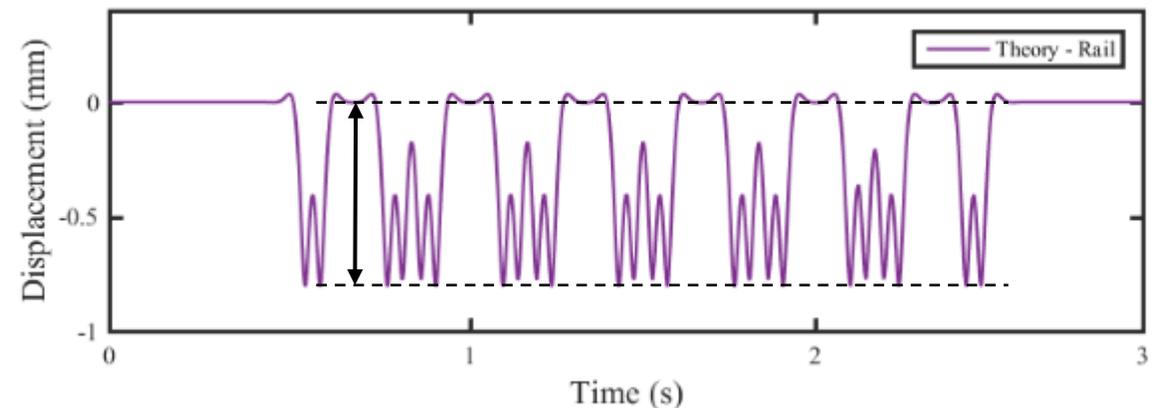
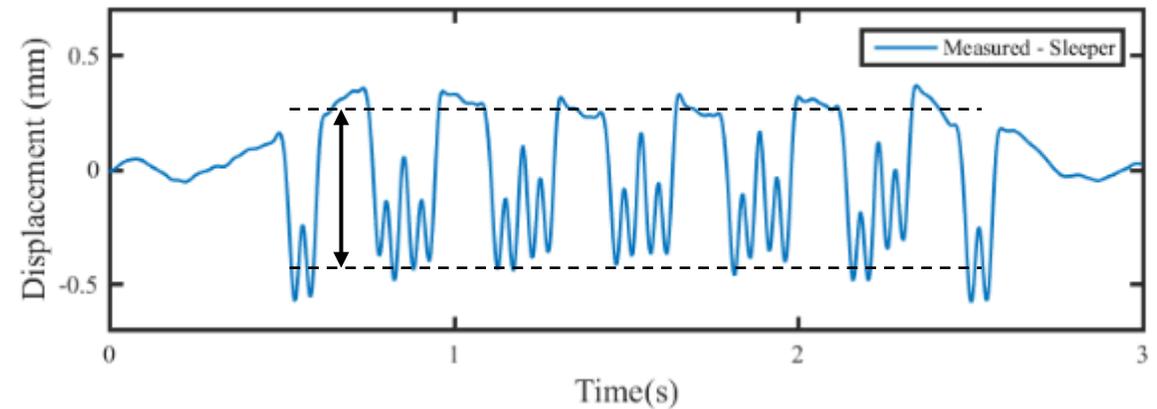
Data interpretation

- Long term trackside monitoring produces lots of data
- Not feasible to analyse every time history
- Desirable to characterise each passage automatically
- Displacement and Track modulus
- Can a model help?



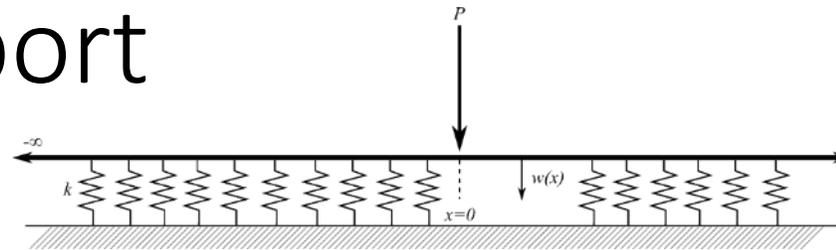
Characterising Displacement

- At rest position lost by filtering data
- Want downwards displacement
- Match analytical model of railway track by inspection or by algorithm

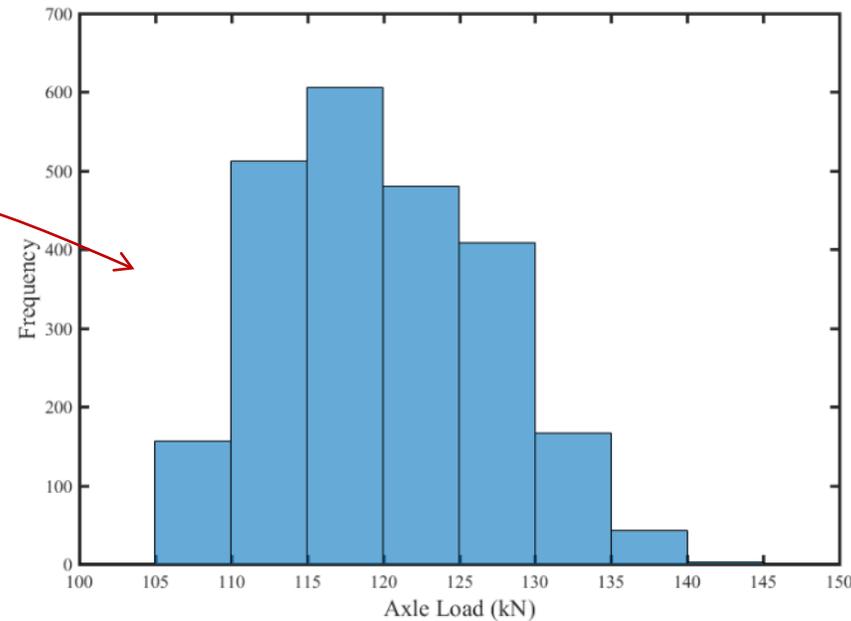




Characterising Support



- Characterise support
 - Track Modulus: Supporting force per unit length of rail
 - Typically calculated using load-deflection relationships
- Load uncertain
 - Capacity
 - Dynamics ?





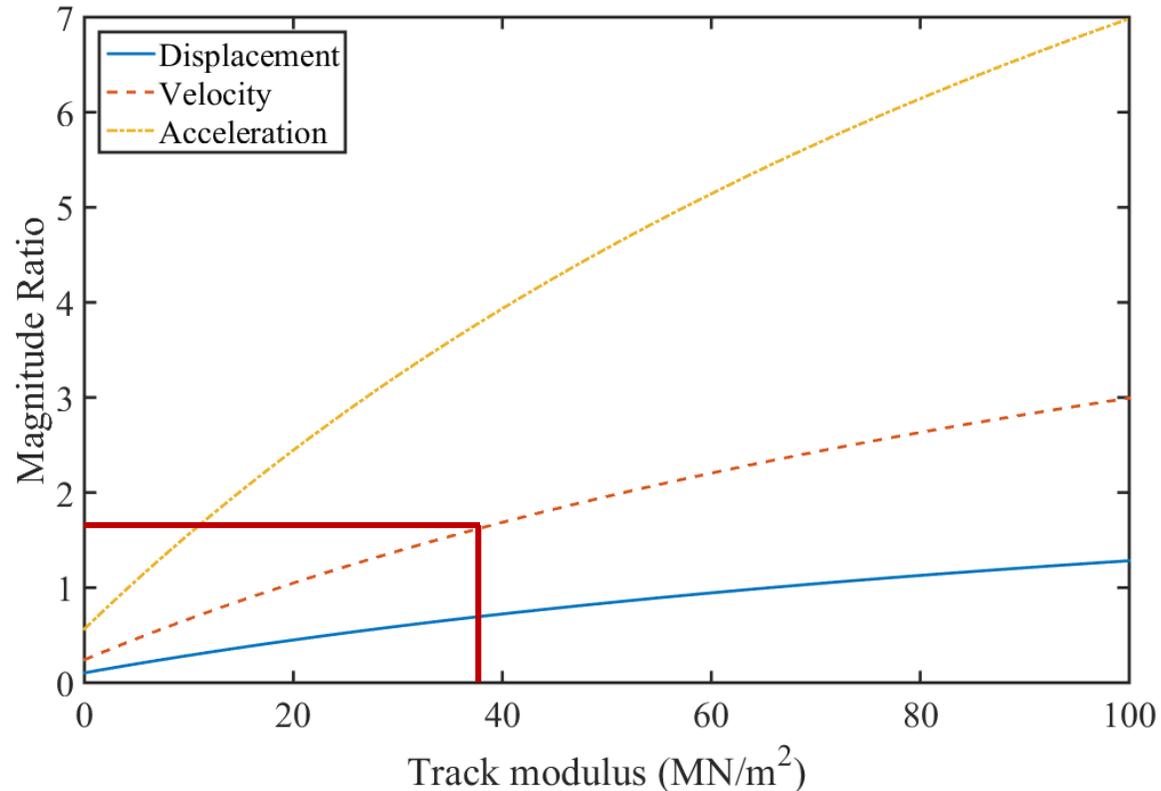
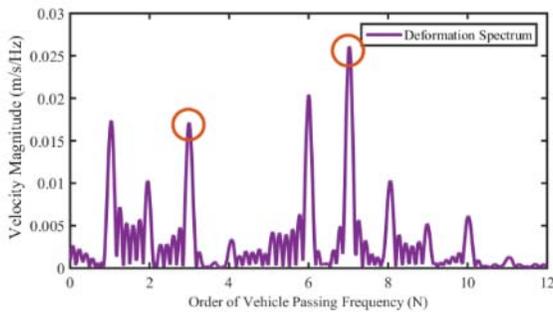
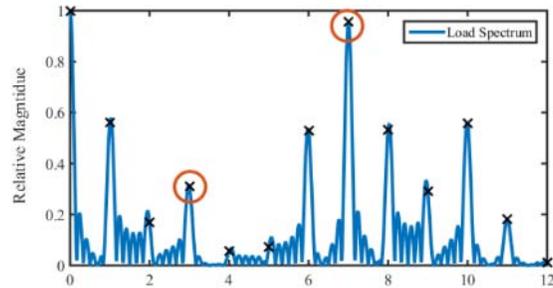
Characterising Support

- A different approach!
- Fit a model of track behaviour in the frequency domain
 - Le Pen, L., Milne, D., Thompson, D. & Powrie, W. (2016) Evaluating railway track support stiffness from trackside measurements in the absence of wheel load data. *Canadian Geotechnical Journal*.
- Utilise properties of the Fourier transform for:
 - lineside measurements (deflection, velocity or acceleration)
 - track model
 - train loads



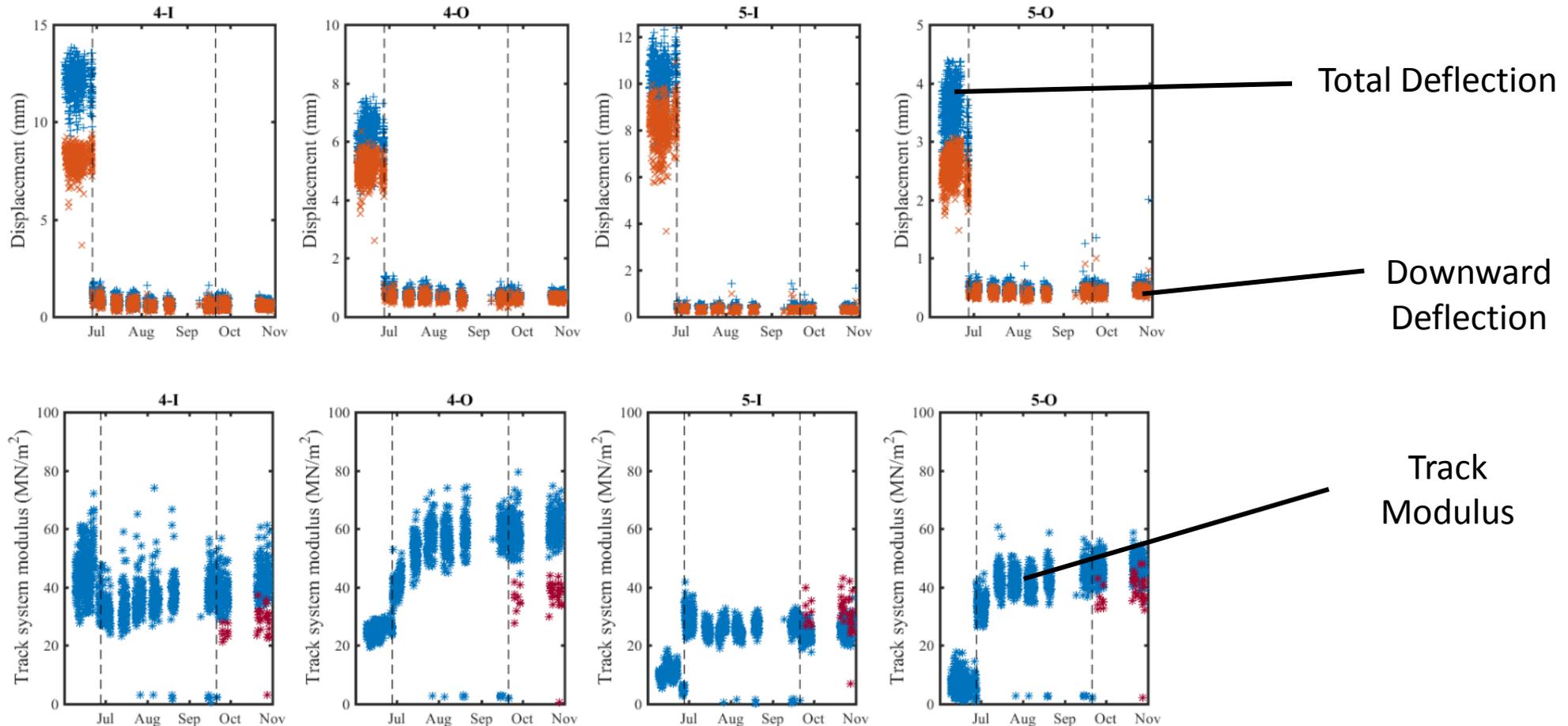
Obtaining track modulus

$$\bullet W \left(\frac{N_a}{N_b} \right) = \frac{kL_v^4 + 16\pi^4 E I N_b^4}{kL_v^4 + 16\pi^4 E I N_a^4} \cdot \frac{\cos\left(\frac{\pi N_a L_v}{L_b}\right) \cos\left(\frac{\pi N_a L_v}{L_w}\right)}{\cos\left(\frac{\pi N_b L_v}{L_b}\right) \cos\left(\frac{\pi N_b L_v}{L_w}\right)}$$





Monitoring displacement and stiffness





Summary

- Track defects are a problem
 - Want to understand accelerated deterioration and effect of maintenance
- Monitoring provides the necessary type of evidence
 - Larger longer term deployments are possible with low cost instrumentation
- Large quantities of data need to be processed by algorithm
 - Displacement and track support modulus
- Methods allow us to track changes in performance and evaluate track performance