

Track Test Assignment

Analysis of Results



Data required from test

To find the average coefficient of friction for the two front tyres μ_{fx} we need F_{xfb} and W_{fb}

- F_{xfb} longitudinal braking force is found from the rate of deceleration of the car
- W_{fb} is the vertical wheel load for two wheels at the time deceleration is taking place

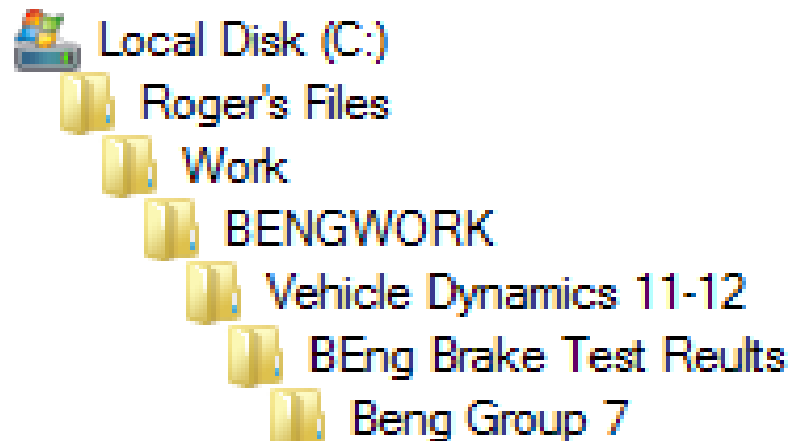
Vehicle data

For this example certain values will be assumed. You must use the actual values measured at Pembrey if they differ from these:

- $M_s = 496 \text{ kg}$
- $M_{sf} = 38 \text{ kg /wheel}$
- $M_{sr} = 42 \text{ kg/wheel}$
- CG height for sprung mass = 0.299m
- CG distance from rear axle (b) = 1.17m
- Wheelbase = 2.351m
- Rolling radius = 0.275 m
- Front spring rate 350 lb/in
- Rear spring rate 170 lb/in
- Front Suspension leverage of wheel to spring = 1.85
- Velocity ratio of damper wheel to pot = 2
- Rear Suspension leverage of wheel to spring = 1.0
- Velocity ratio of damper wheel to pot = 1.0

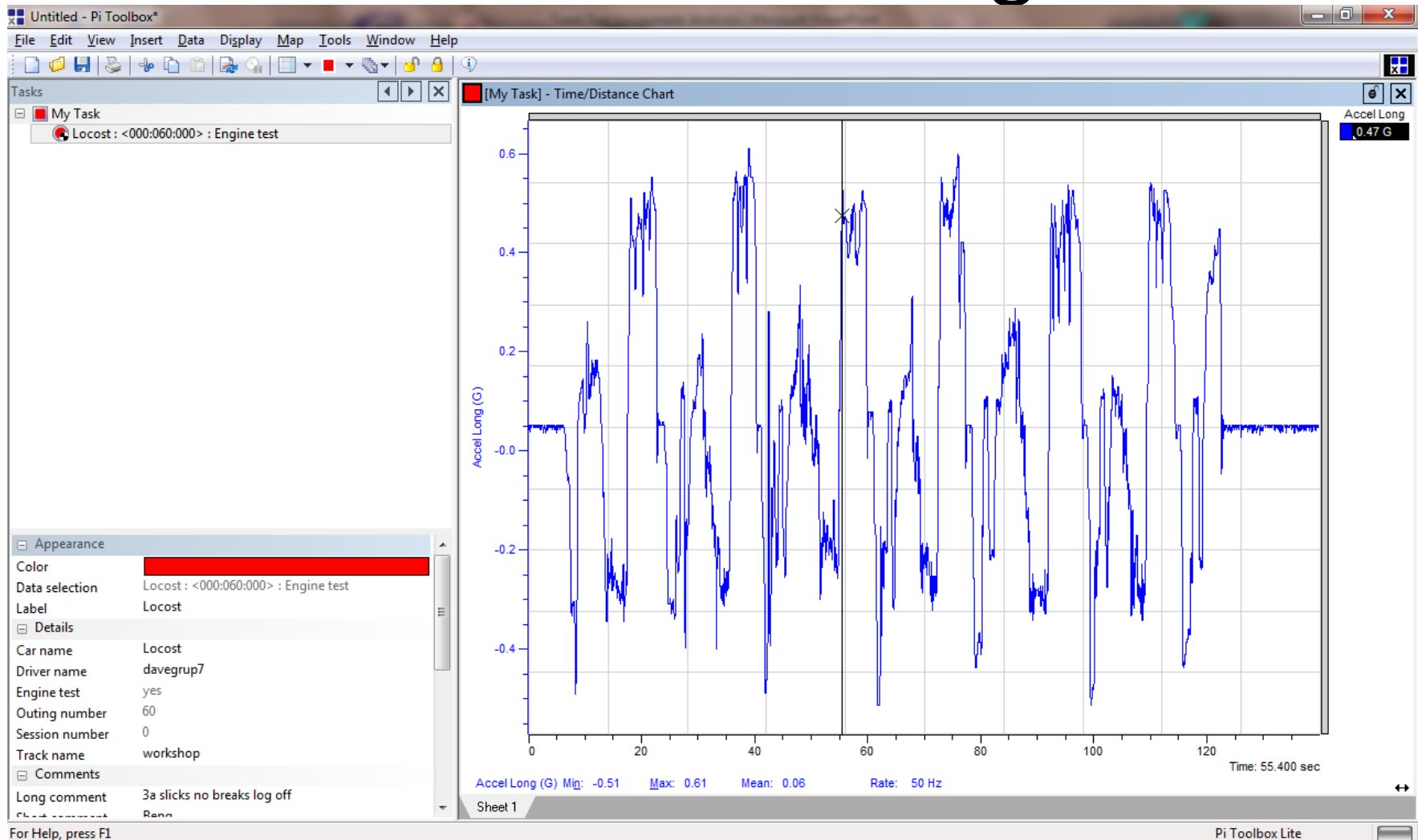
Finding F_{xfb}

Example data set



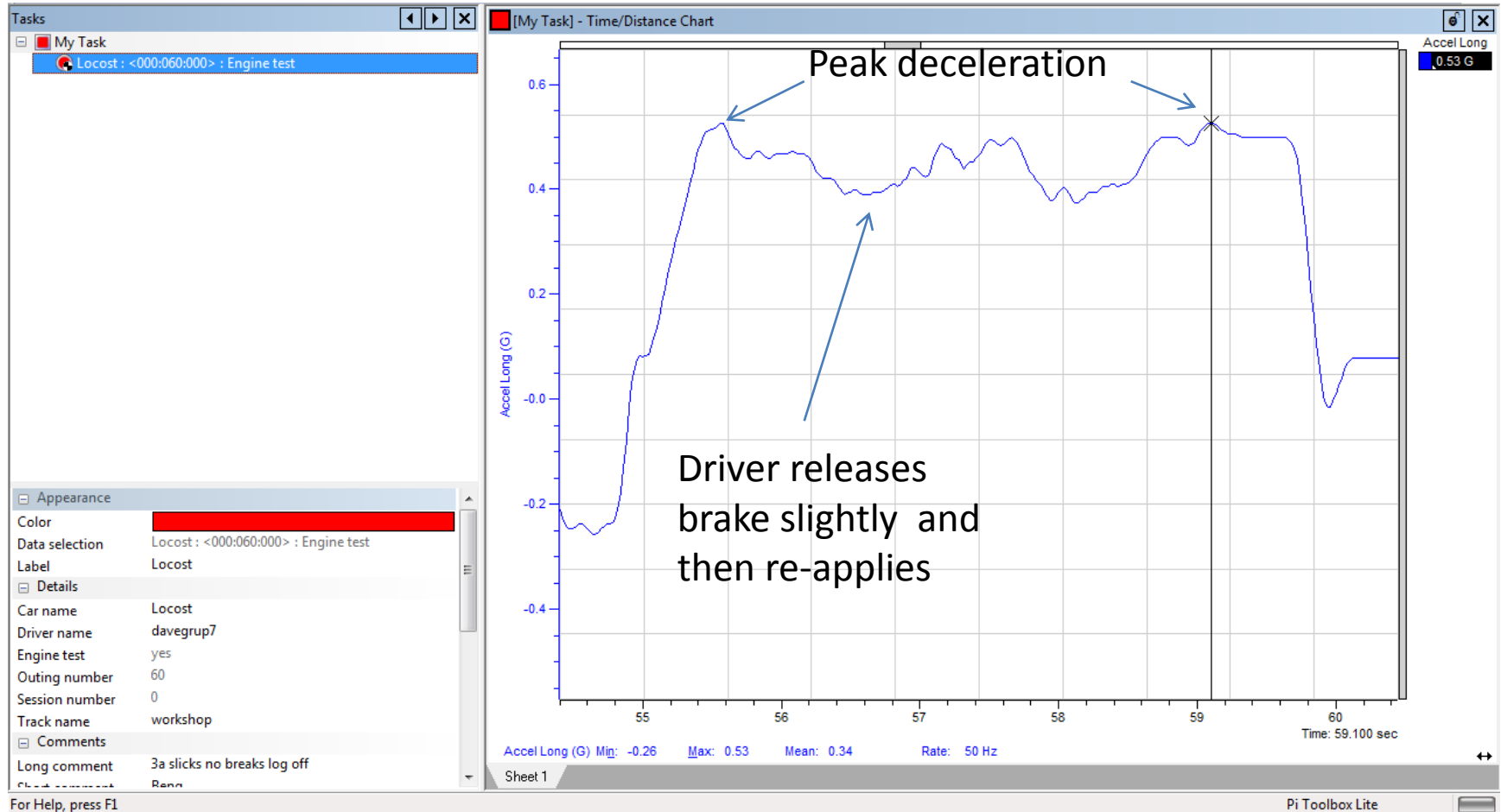
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One test run – 6 braking events

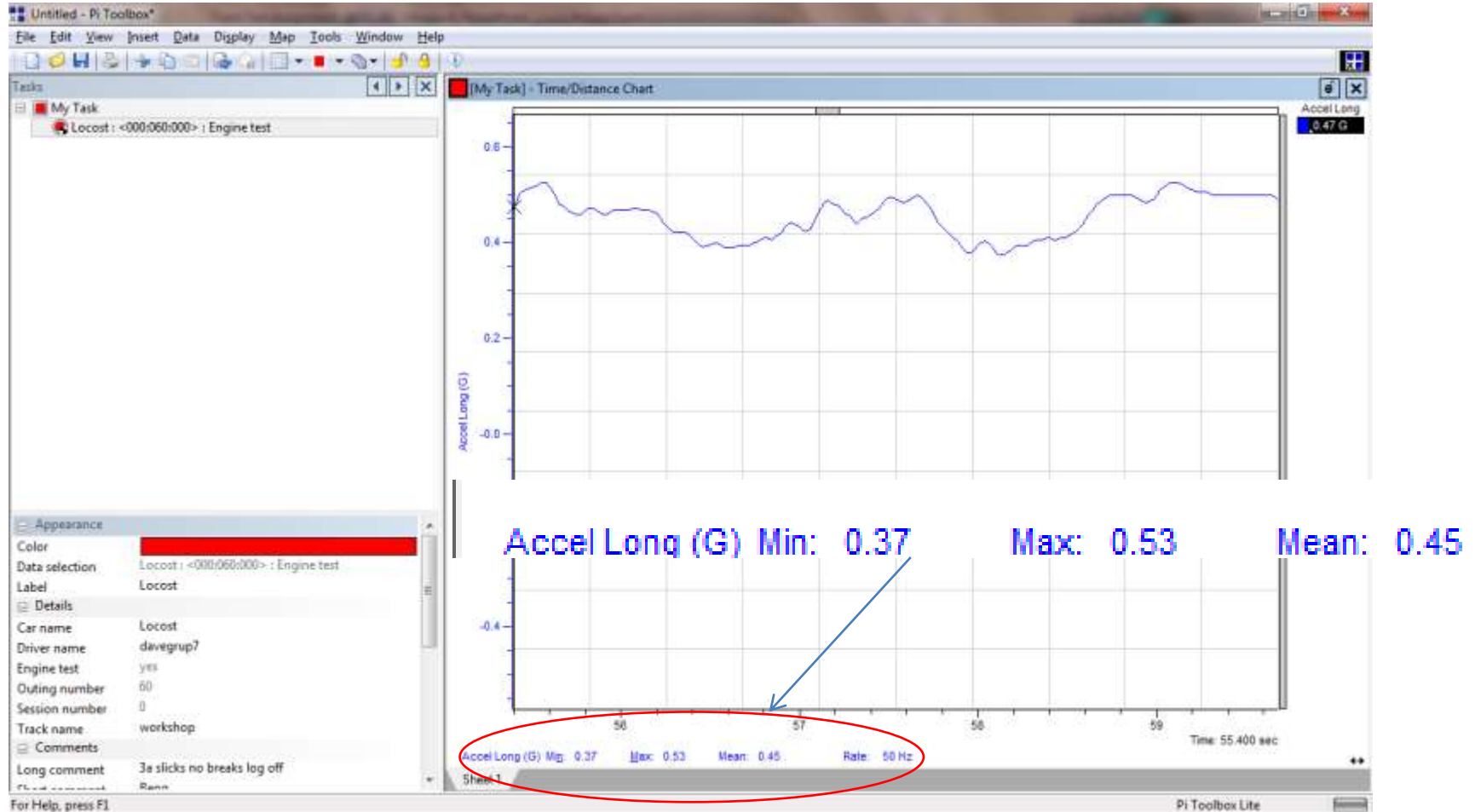


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Single braking event



Maximum minimum and mean decelerations



Longitudinal force at maximum deceleration

$$\begin{aligned} F_{\text{xbf}} &= (M_s + M_{\text{us}}) \times a_x \times g \\ &= (496 + 160) \times 0.53 \times 9.81 \text{ N} \\ &= 3410.74 \text{ N} \end{aligned}$$

Vertical Load W_{fb}

This can be determined without load cells fitted to the suspension by calculating weight transfer at the measured deceleration and adding it to static vertical load

By using wheel deflection and wheel rate to calculate load increase due to sprung mass and compare it with that found by calculation a check on the validity of the load increase can be made

Calculating vertical wheel load W_{fb} from Static load + WT

$$W_{fb} = M_{usf} \times g + \frac{M_s \times g \times b}{L} + \frac{M_s \times a_x \times H}{L} + \frac{M_{us} \times a_x \times r}{L}$$

$$W_{fb} = 76g + \frac{496 \times g \times 1.17}{2.351} + \frac{496 \times 0.45g \times 0.299}{2.351} + \frac{160 \times 0.45g \times 0.273}{2.351}$$

$$W_{fb} = 745.56 + 2421.5 + 278.47 + 82.02$$

Giving

$$W_{fb} = 3527.55$$

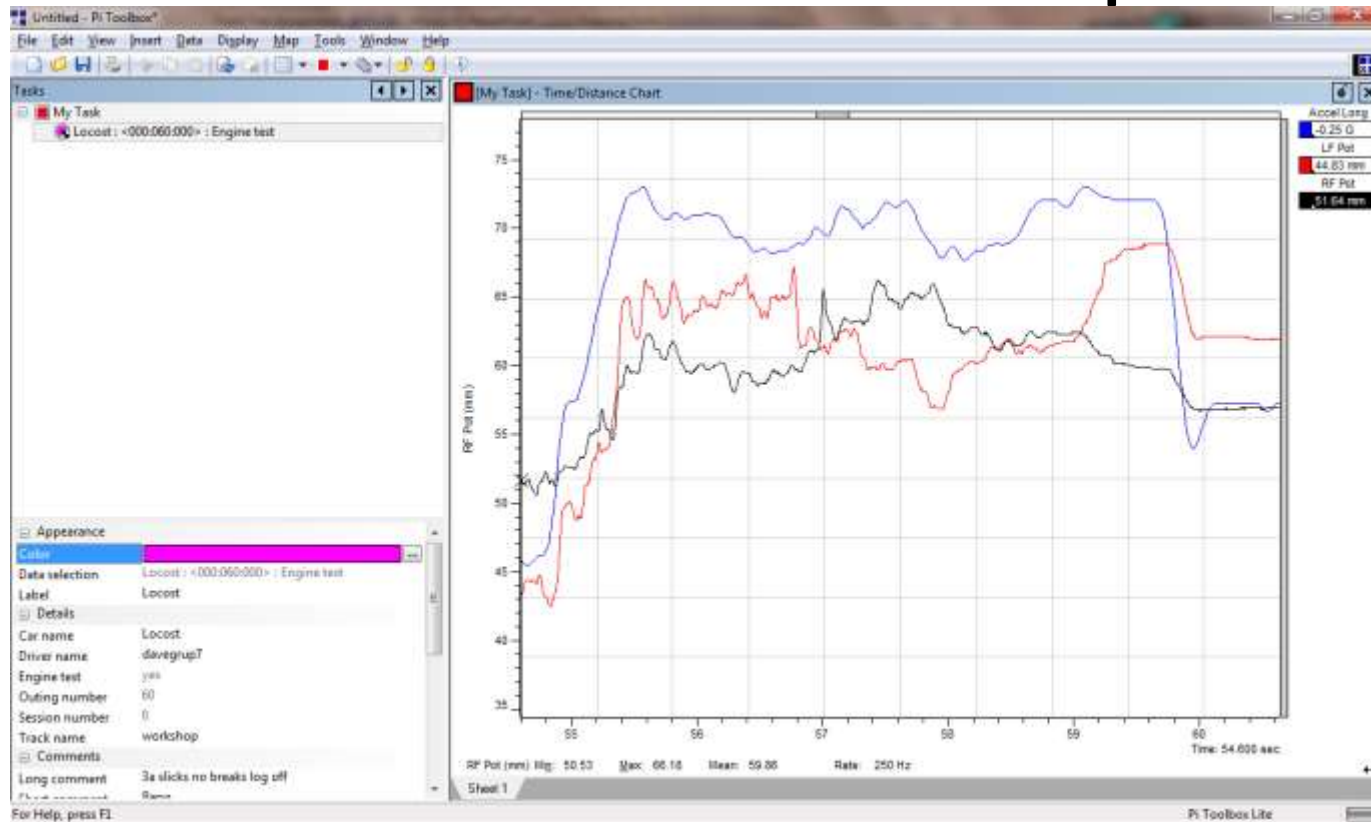
Finding μ_{fx}

$$\mu_{fx} = \frac{E_{\underline{xbf}}}{W_{bf}}$$

$$\mu_{fx} = \frac{3410.74}{3527.55}$$

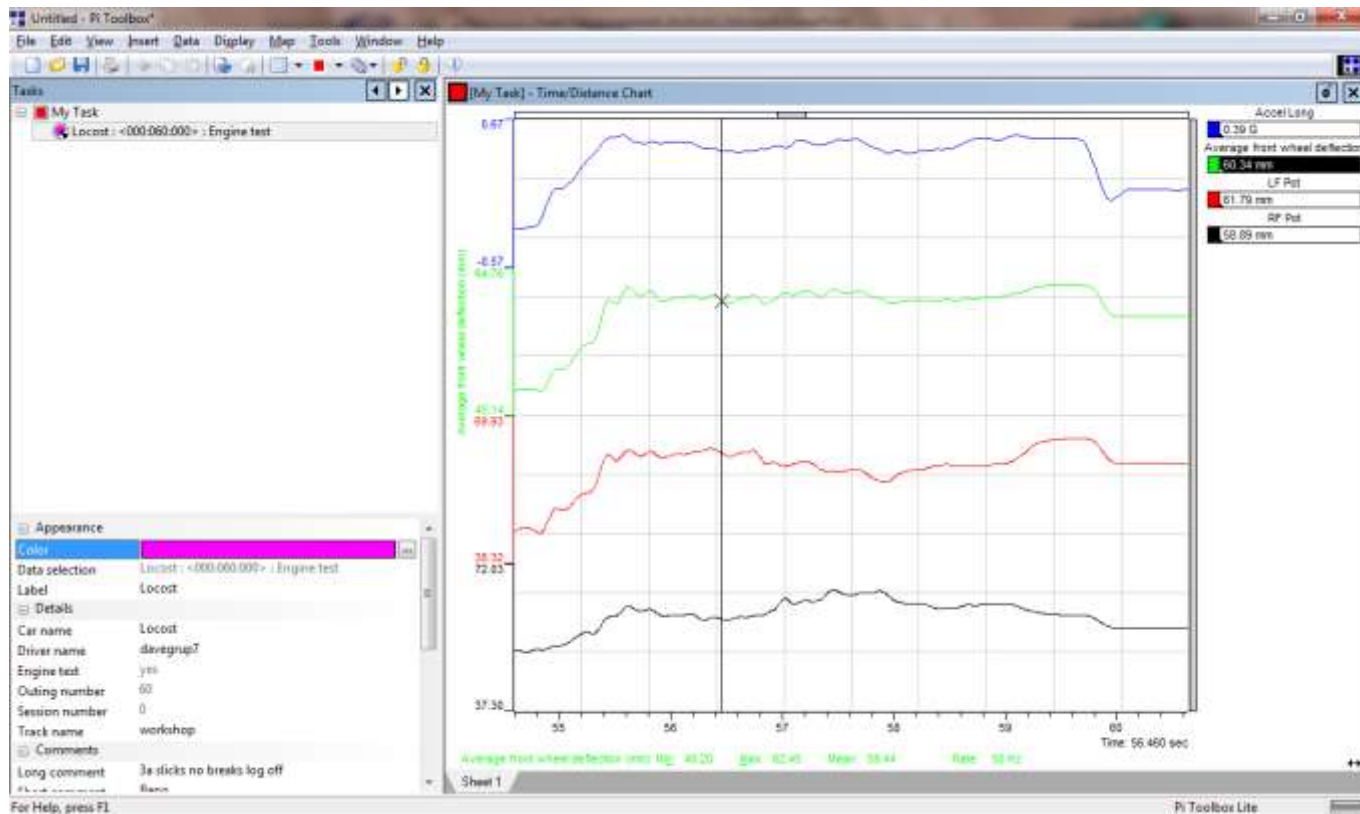
$$\mu_{fx} = 0.967$$

Finding increased wheel load from wheel deflection for comparison



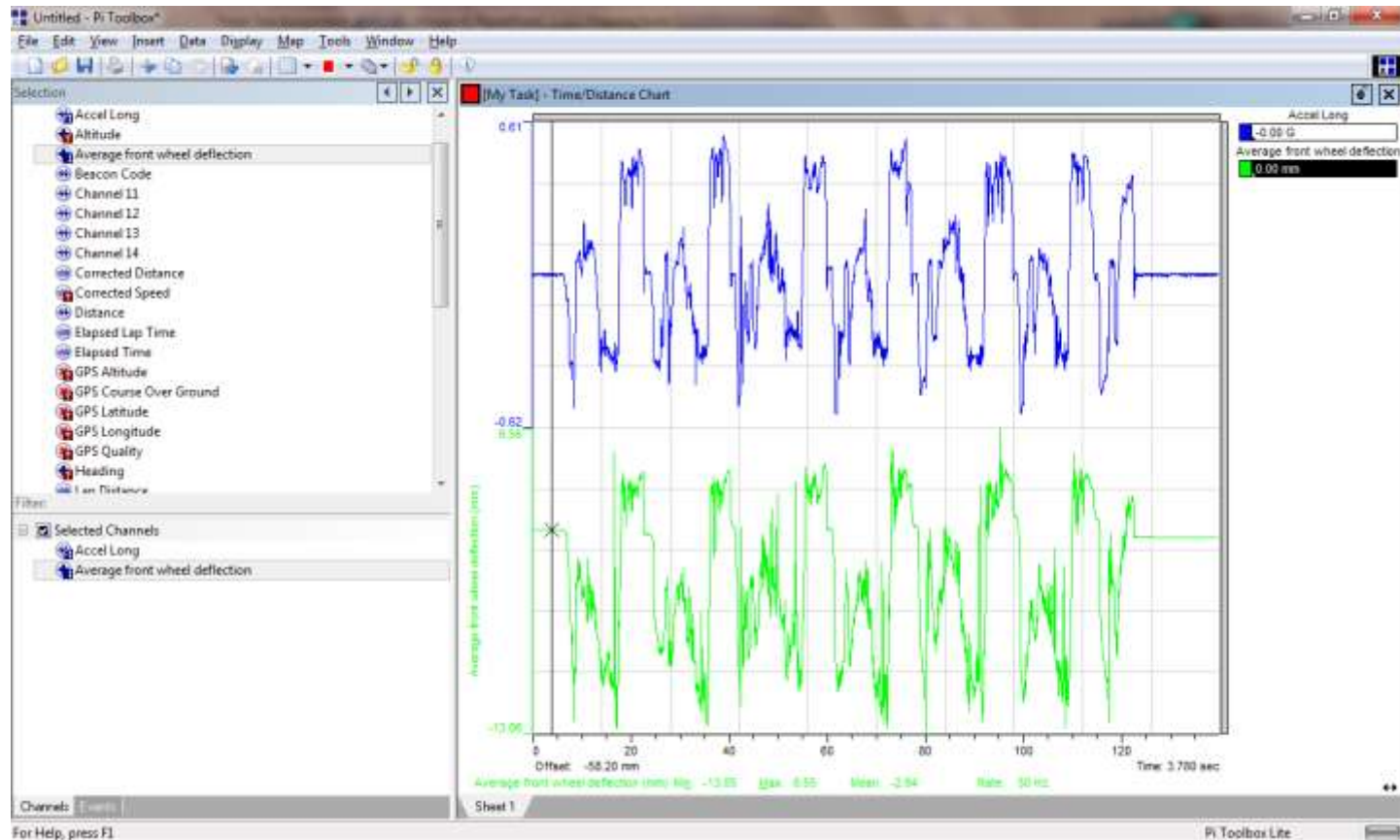
Showing left and right front pot displacements and longitudinal acceleration

Averaged front wheel deflection



Averaging the two front pot displacements

Zero average wheel deflection at static



Zeroing both acceleration and displacement channels when the car is stationary

Mean Acceleration and deflection



Zooming in on traces to find average values though braking event

Load from wheel deflection

Mean Deflection of pot = 2.94 mm

Velocity ratio = 2

So deflection of wheel = 5.88mm

Spring rate = 350 x 171.5 N/m

$K_s = 60.025 \text{ N/mm}$

$SL = 1.85$

$K_w = K_s / SL^2$

$K_w = 17.54 \text{ N/mm}$ so for two wheels this equals 35.077 N/mm

Increased load = 206.25N

This compares to 278 N found by calculation

Validity of load transfer value

The load increase from weight transfer of the sprung mass found by calculation is significantly different from that found by measurement of the wheel deflection

Possible causes :

- *Inaccurate masses and CG heights*
- *Damping on front suspension limiting travel during braking*
- *Inaccurate suspension leverage and velocity ratio values*
- *Friction*

Possible areas of investigation for your analysis

- Look at the at the peak deceleration achieved on each braking event of a run. Does the peak deceleration increase or decrease with each braking event?
- When the run is repeated - is the average of the peak decelerations or the average of the average decelerations the same for each run?

Auxiliary Test

- What is demonstrated by your auxiliary test ?
- How do the results obtained compare with the results of the original tests ?
- If the test was changing a parameter such as pressure or damping what is the value of the parameter that gives the highest acceleration?
- If the test was for a different tyre type is the profile of the longitudinal acceleration changed?