



@EVSymposium29
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Electric Vehicle Symposium & Exhibition

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DRIVE ELECTRIC INNOVATION
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xEV Brake Loading on Front and Rear Axles During Track Testing

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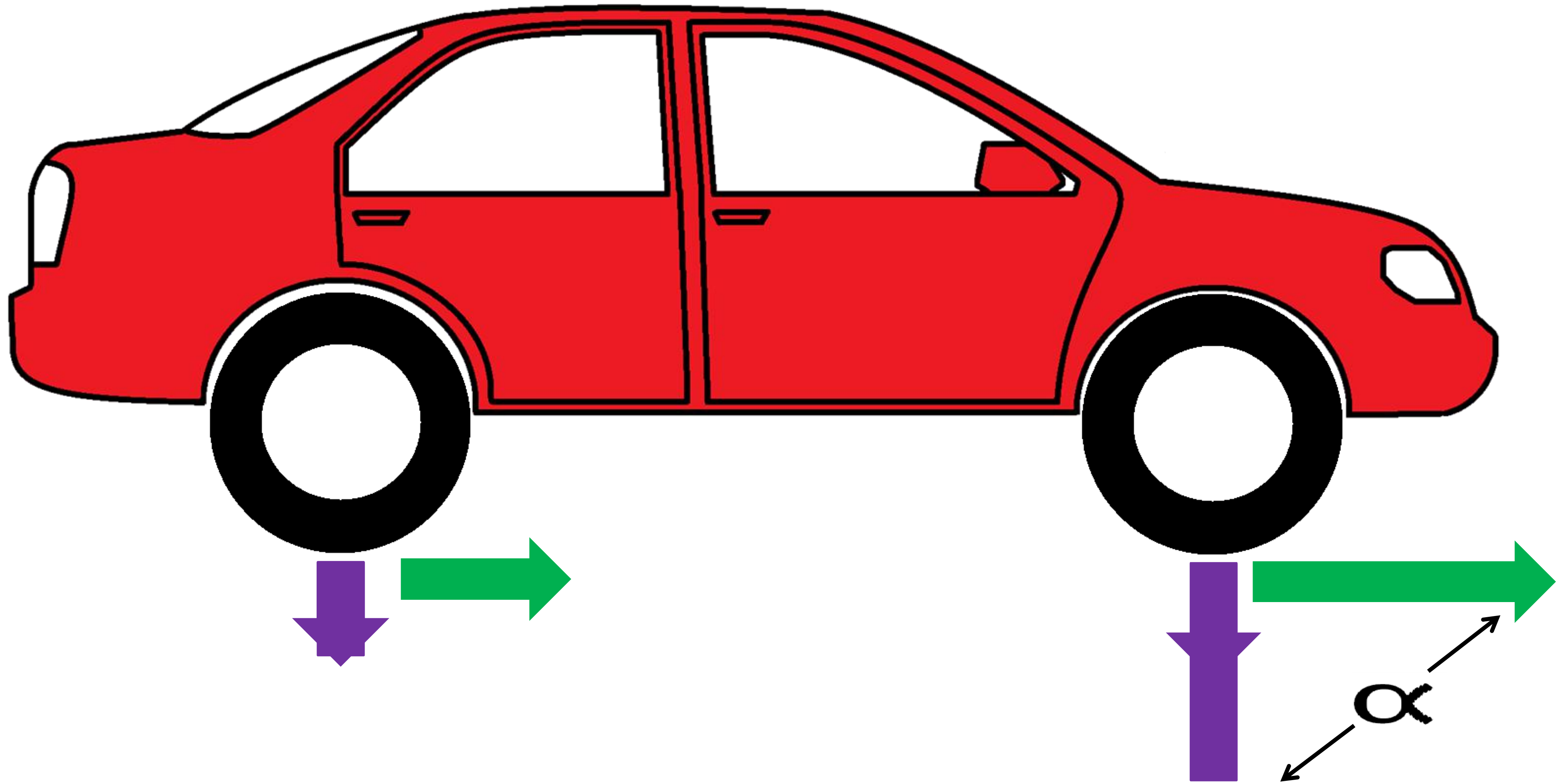
Martha Christenson

ecoTECHNOLOGY for Vehicles Program

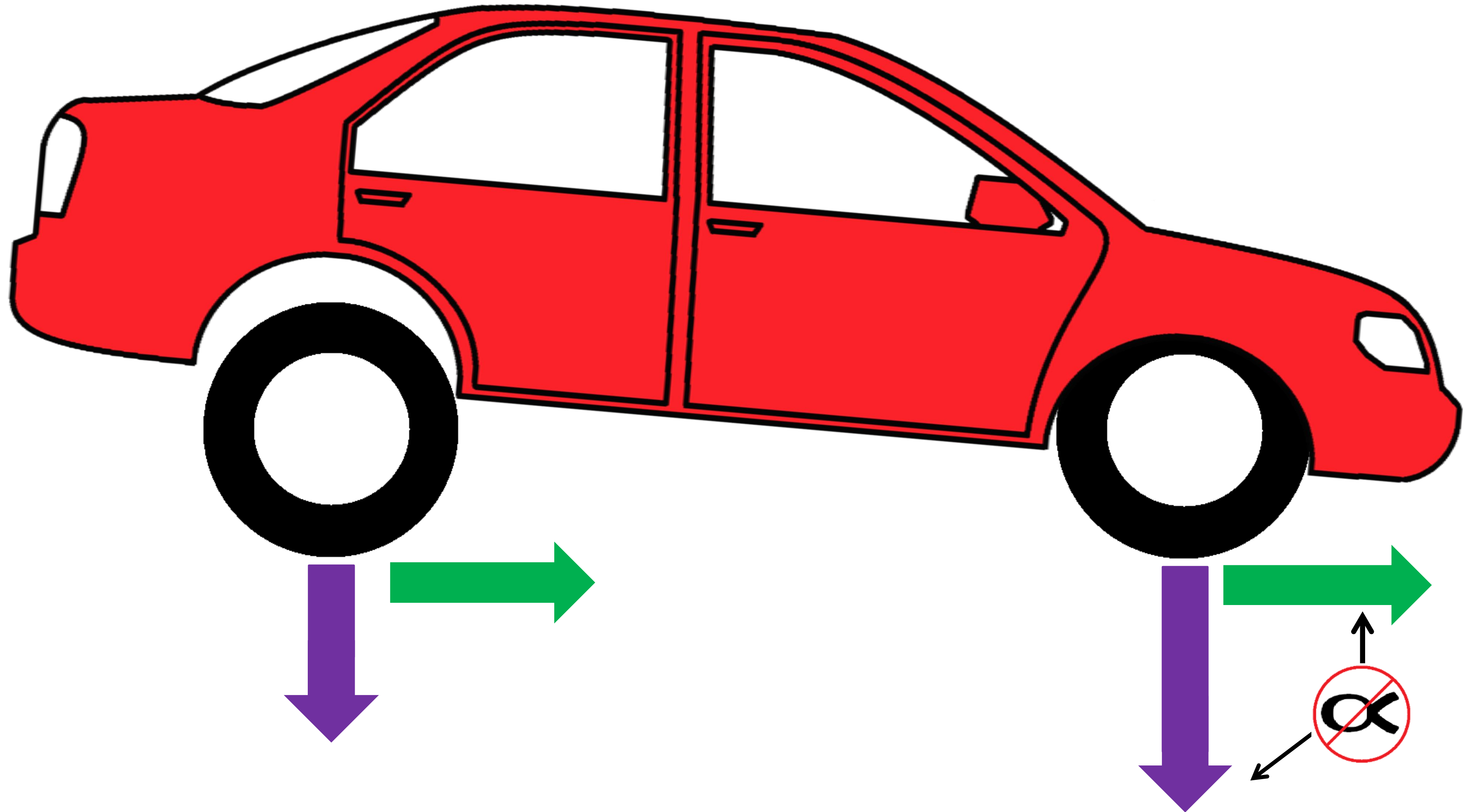
Transport Canada

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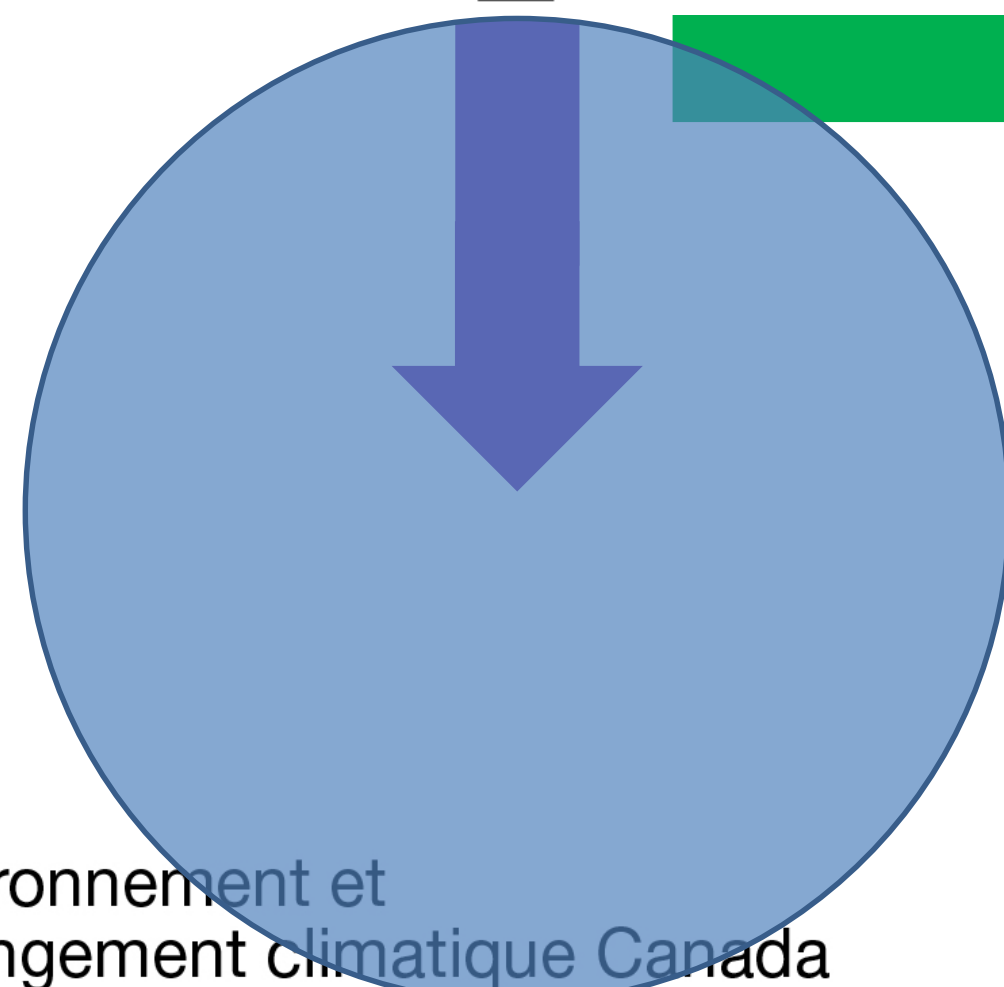
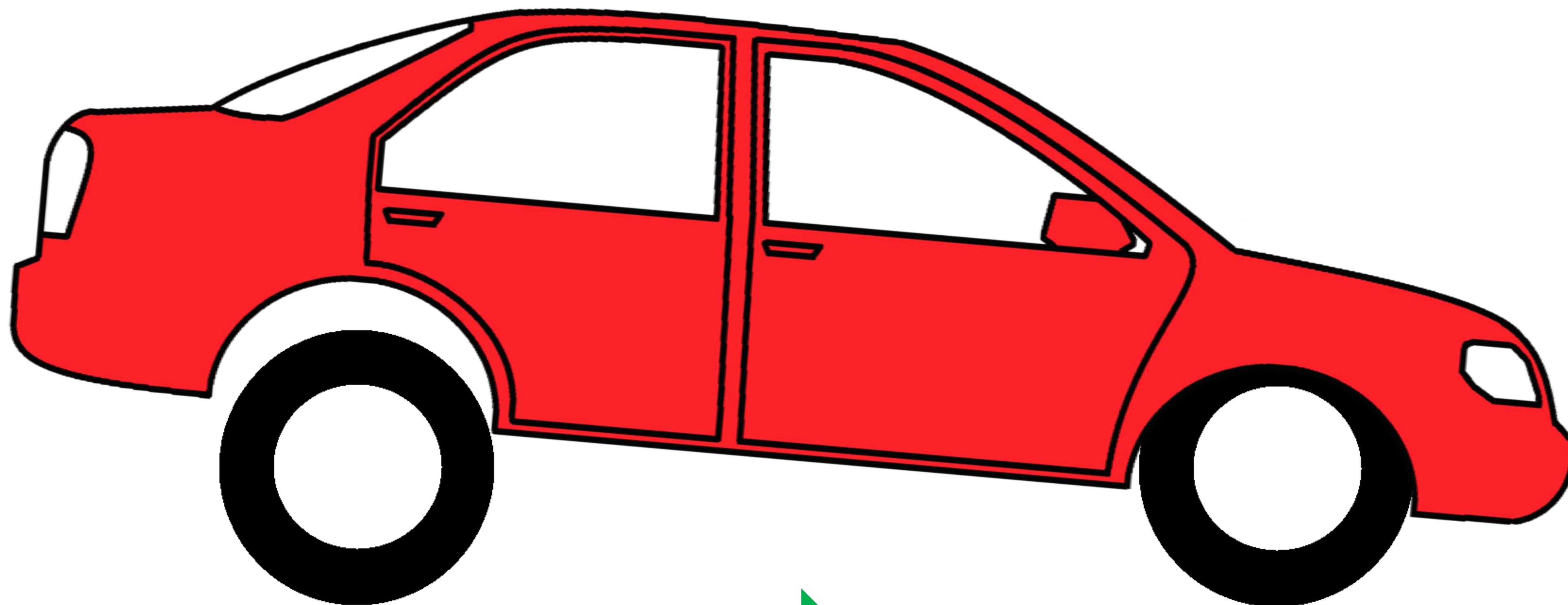
xEV Braking and Chassis Dynamometers



xEV Braking and Chassis Dynamometers



xEV Braking and Chassis Dynamometers



Dynamometer
Roller



3-Phase Study

Goal: Determine if current testing practices are underestimating CO₂, range (for BEVs), and fuel (energy) consumption rates for RWD xEVs during compliance tests due to a positive bias on regenerative braking

Study Milestones (Phases)

1. Test 2 RWD xEVs on a rear-axle and 4-wheel chassis dynamometer
Baseline emissions, fuel consumption and energy consumption & Difference between 2- and 4-wheel testing



2. Conduct constant deceleration tests on a closed-loop track
Real braking loads and on front and rear axle

3. Apply the results of Part 2 to the rear-axle dynamometer controller
Difference between standard and real-world based brake loads





xEV Braking and Chassis Dynamometers

Vehicle ID	EV1	EV2
xEV Type	<u>HEV</u>	<u>BEV</u>
Model Year	2013	2013
ETW (kg)	<u>3000</u>	<u>1100</u>
Drive	<u>RWD</u>	<u>RWD</u>
Transmission	CVT	eCVT
Fuel	Gasoline	Electric
Emission Standard	Tier2 Bin 5	Tier 2 Bin 1
ESS Type	NiMH	Li-Ion
ESS Capacity (kWh)	2	18
System Voltage (V)	300	300
Motor Power (kW)	60	55

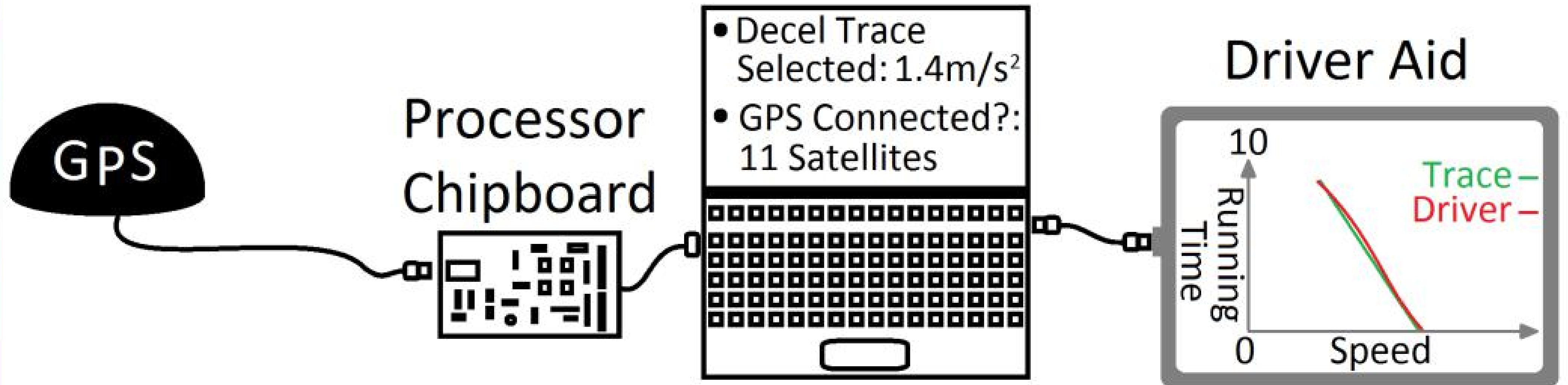


Test Design

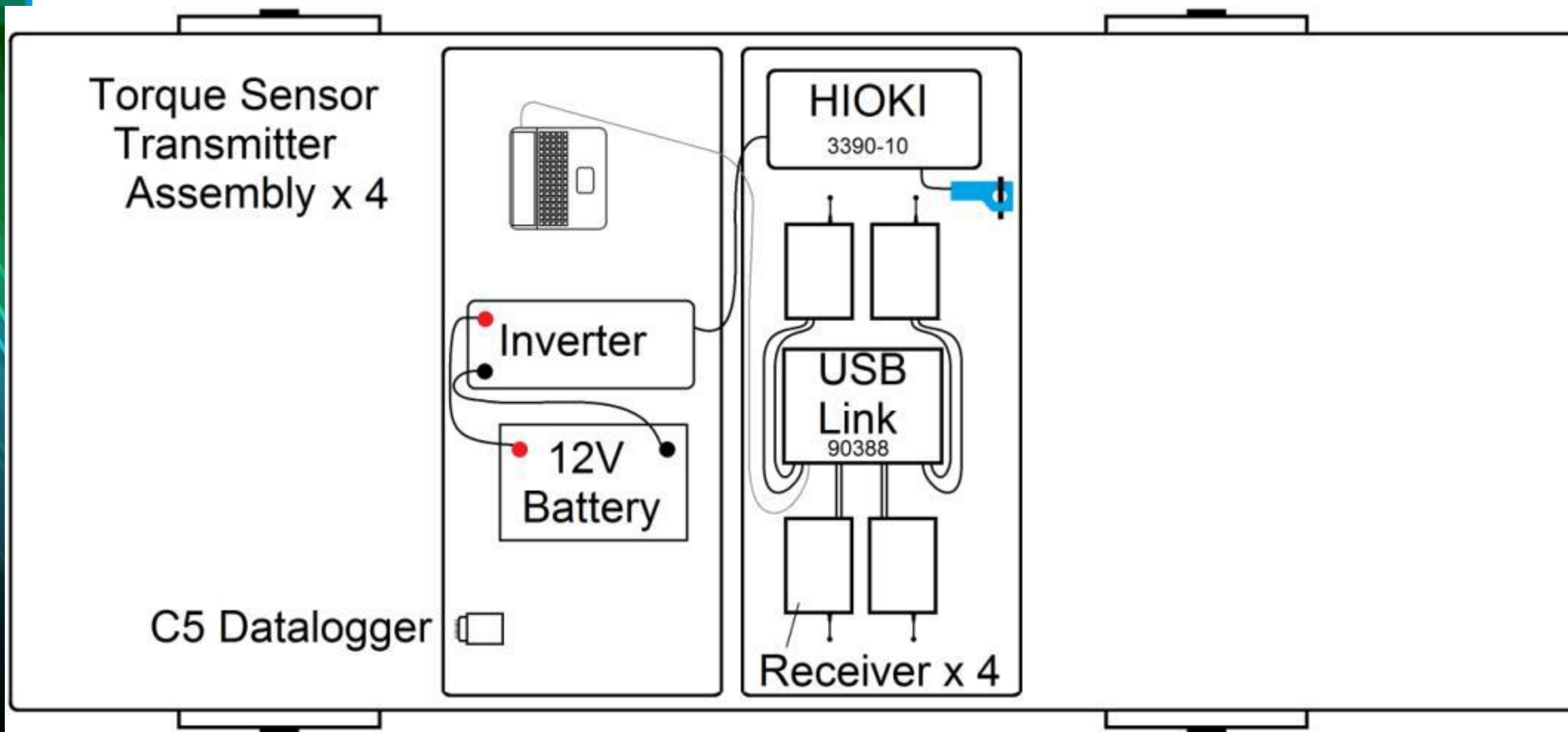
- Test Matrix
 - 27.8 m/s $\rightarrow$ 0 m/s on straight section only
 - 1 km/h/s (90 s) to 21 km/h/s (4 s)

	Test Repeats																									
Drive Cycle [m/s ²]	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.7	1.9	2.2	2.5	2.8	3.1	3.3	3.6	3.9	4.2	4.4	4.7	5.0	5.3	5.6	5.8	
EV1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
EV2					3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

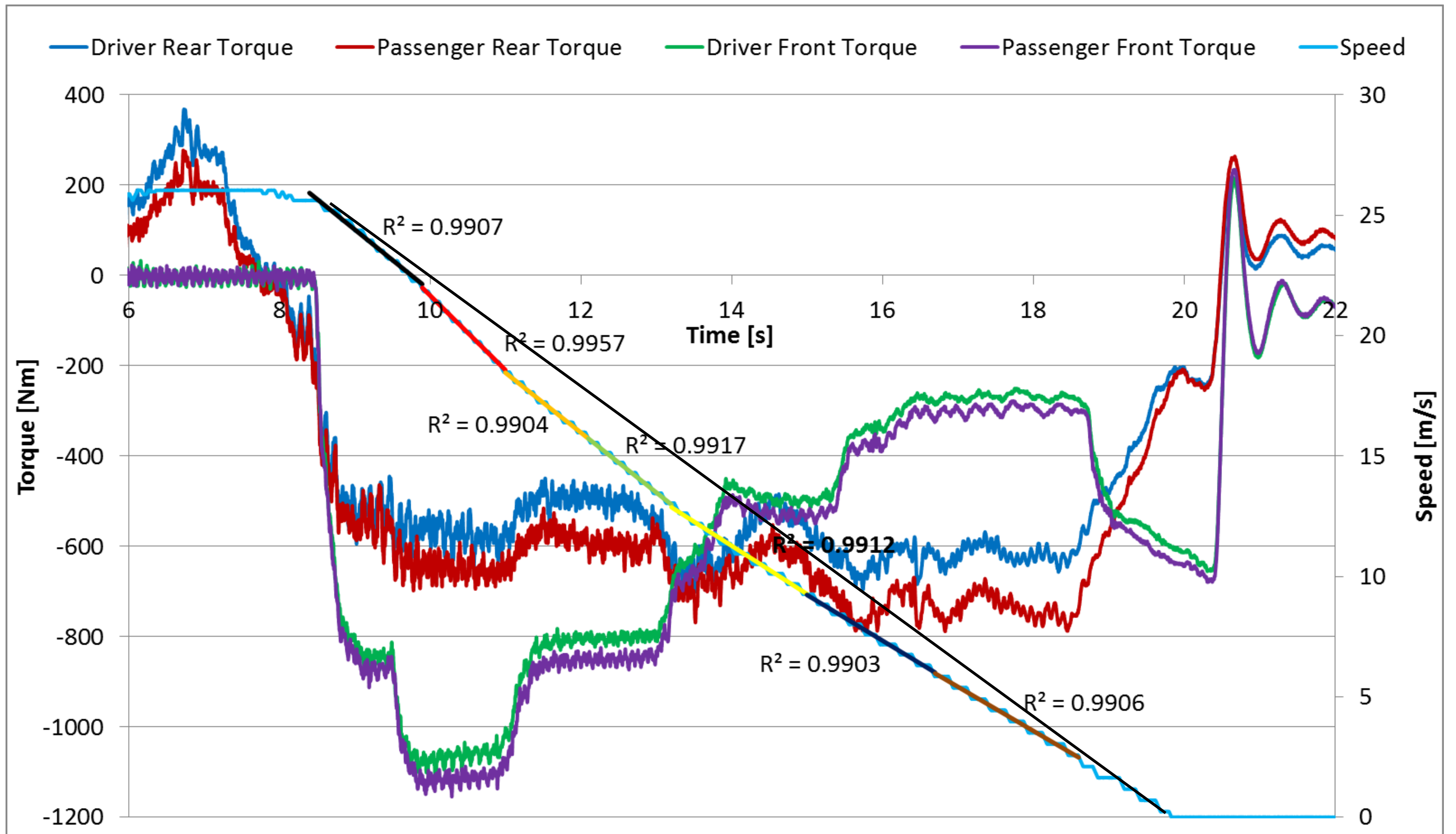
- Instrumentation



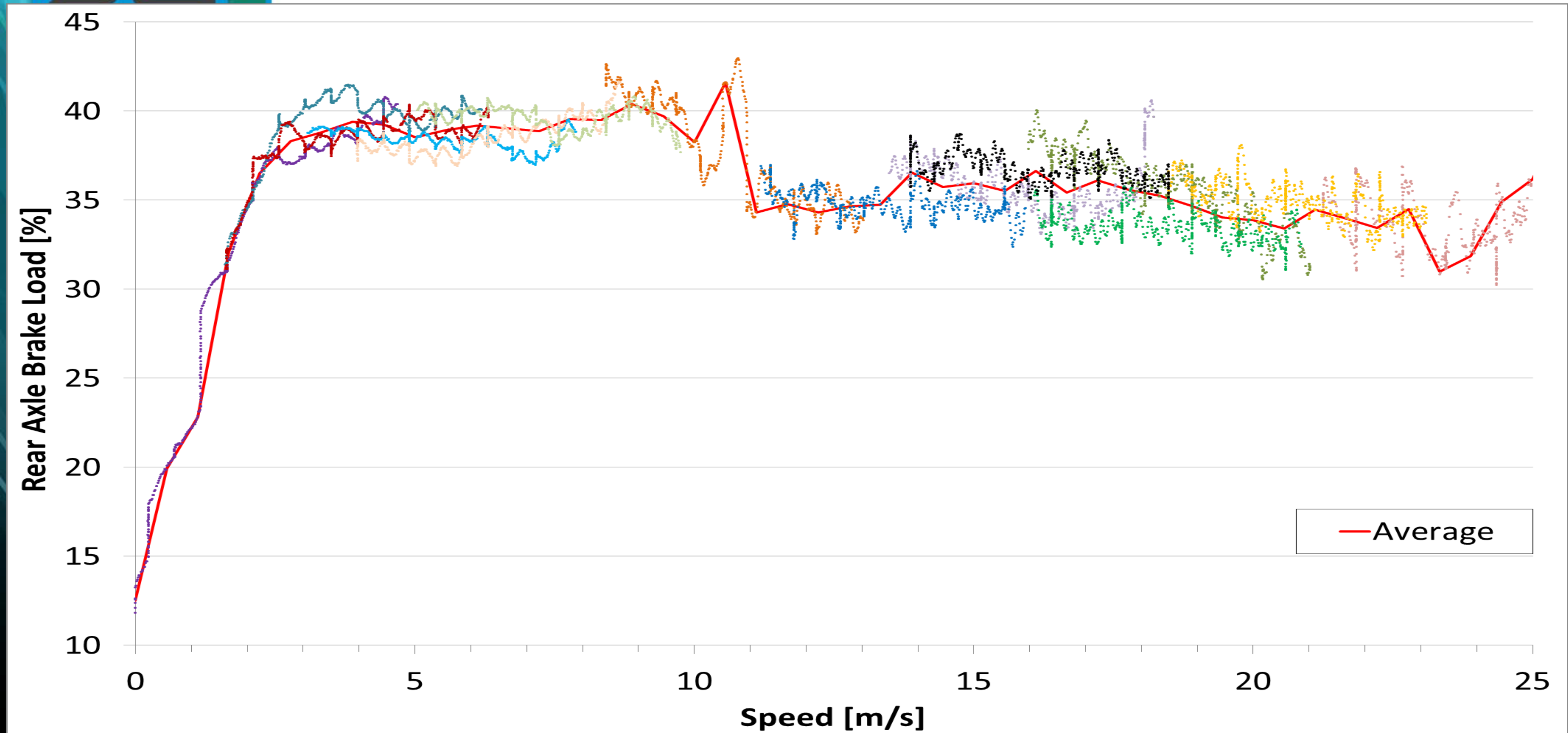
Instrumentation Cont'd



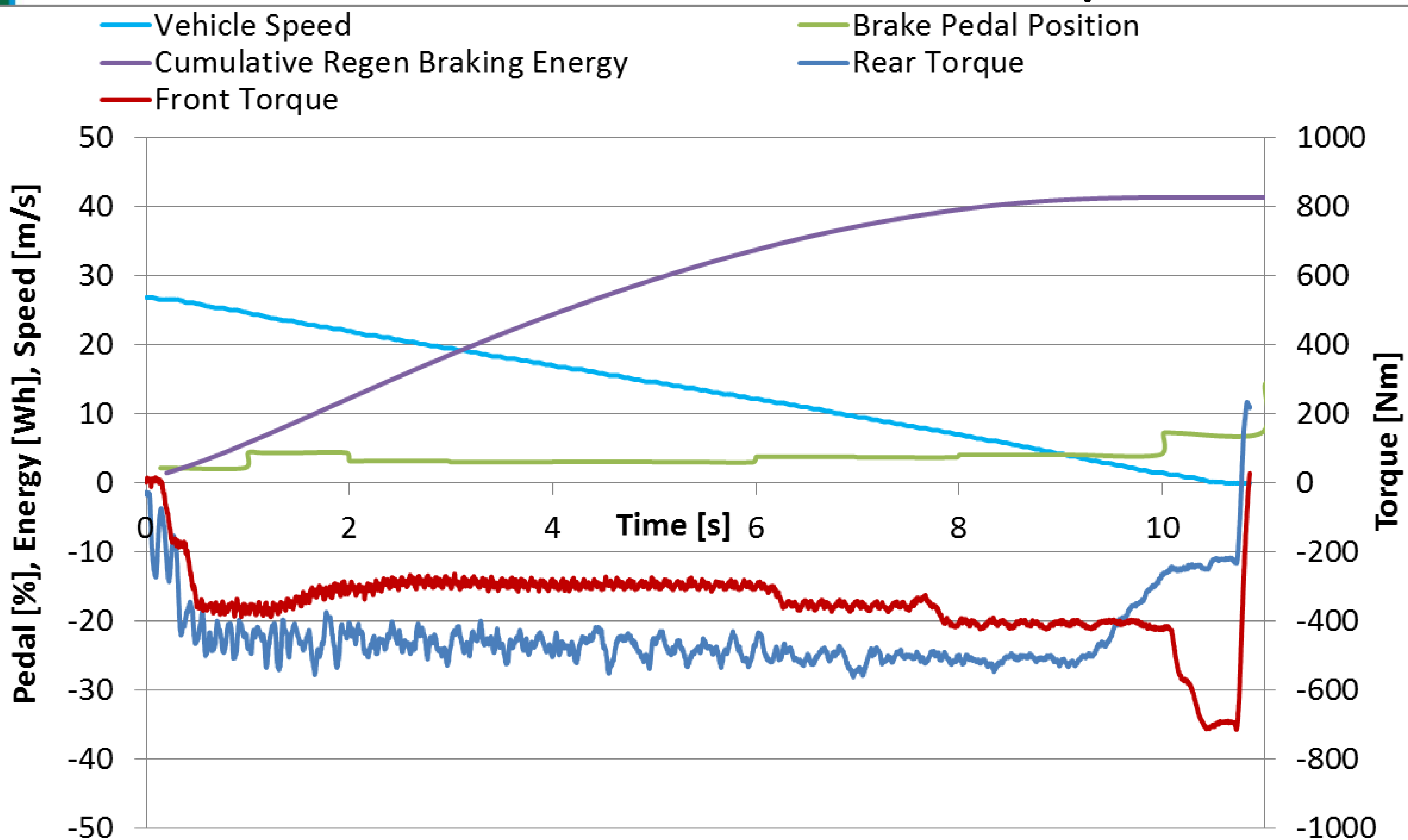
Calculations



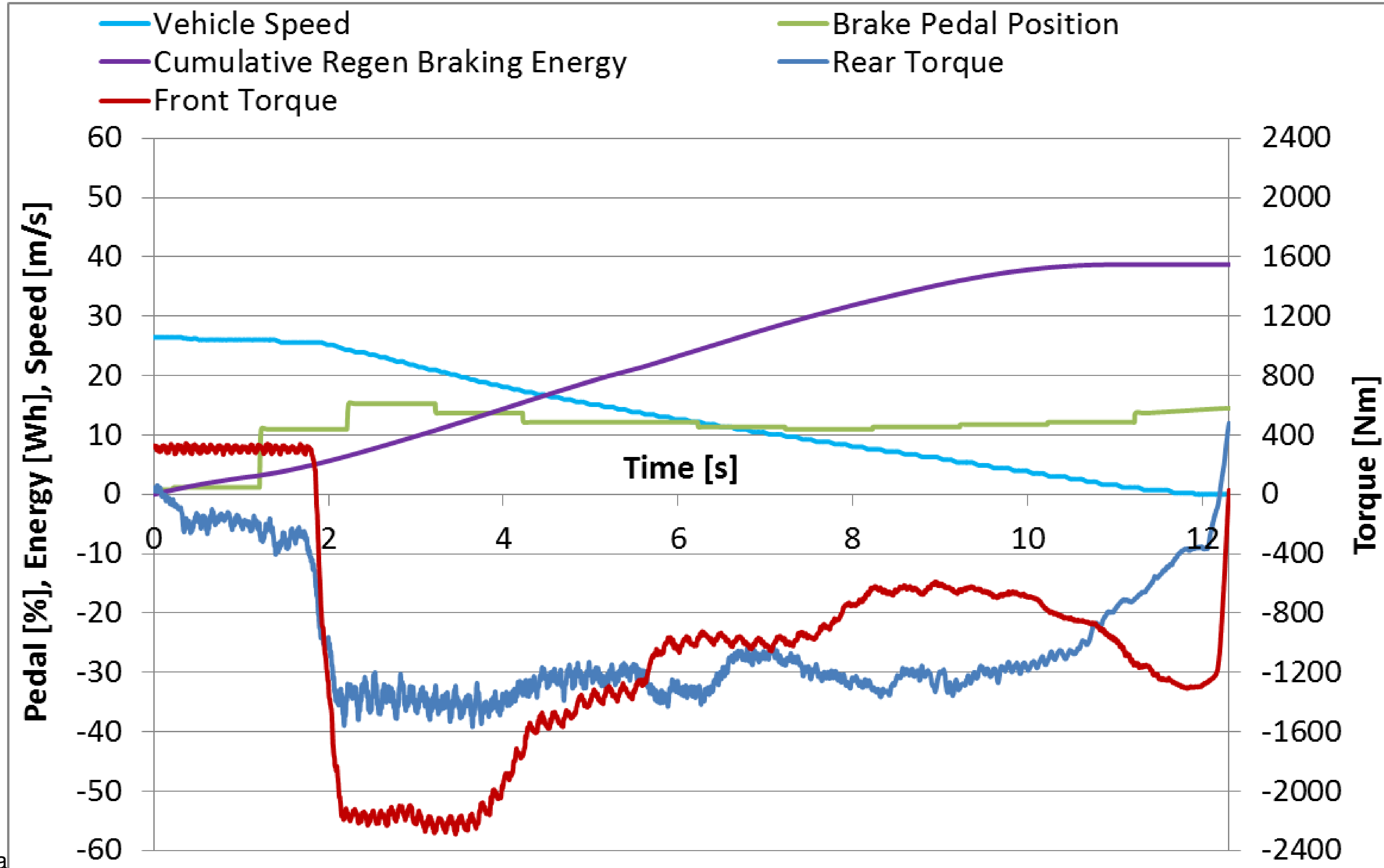
Results: Aggregated brake load curves



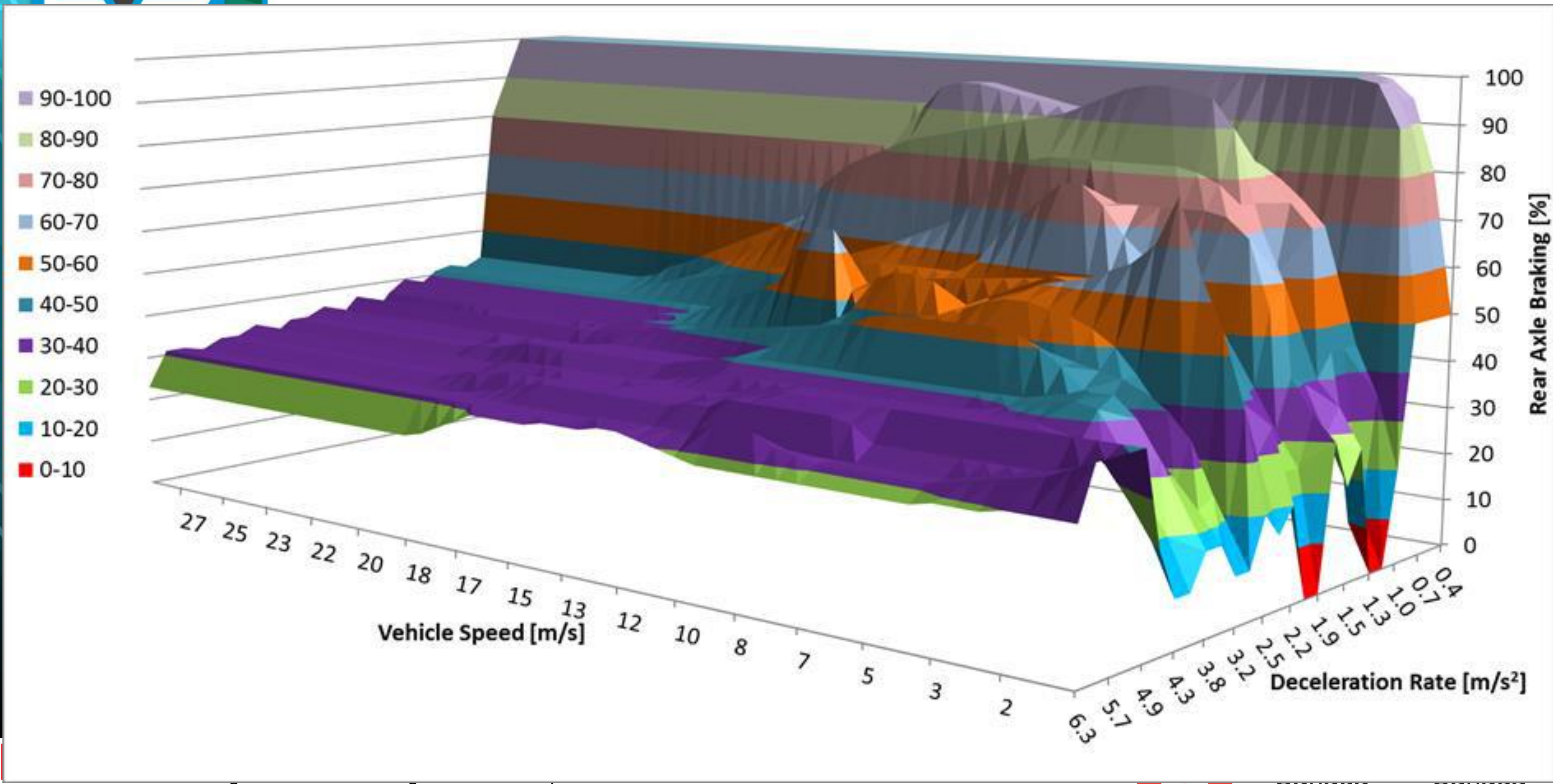
Results: Modal BEV Example



Results: Modal HEV Example

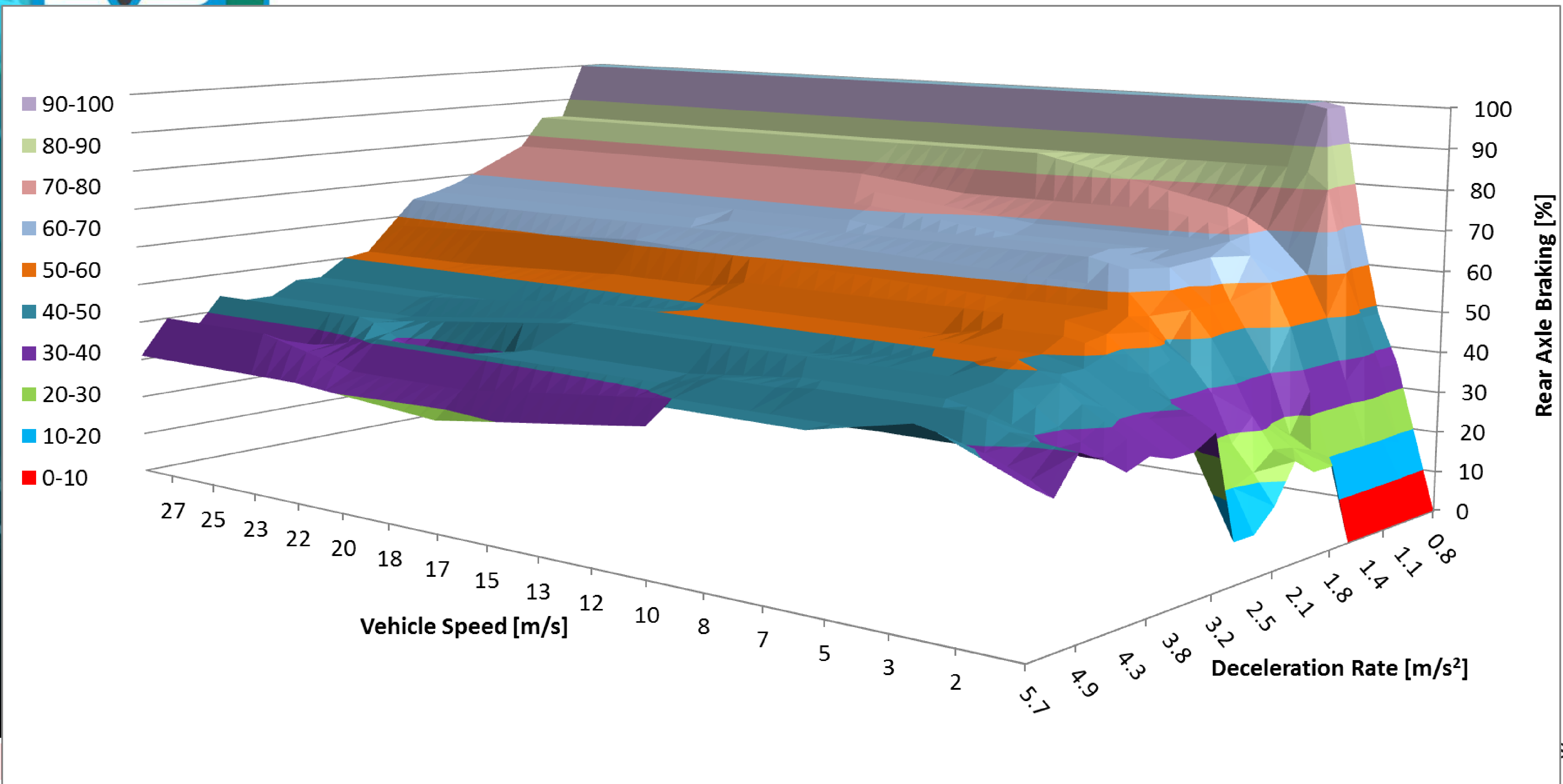


Results: Aggregated HEV Profiles

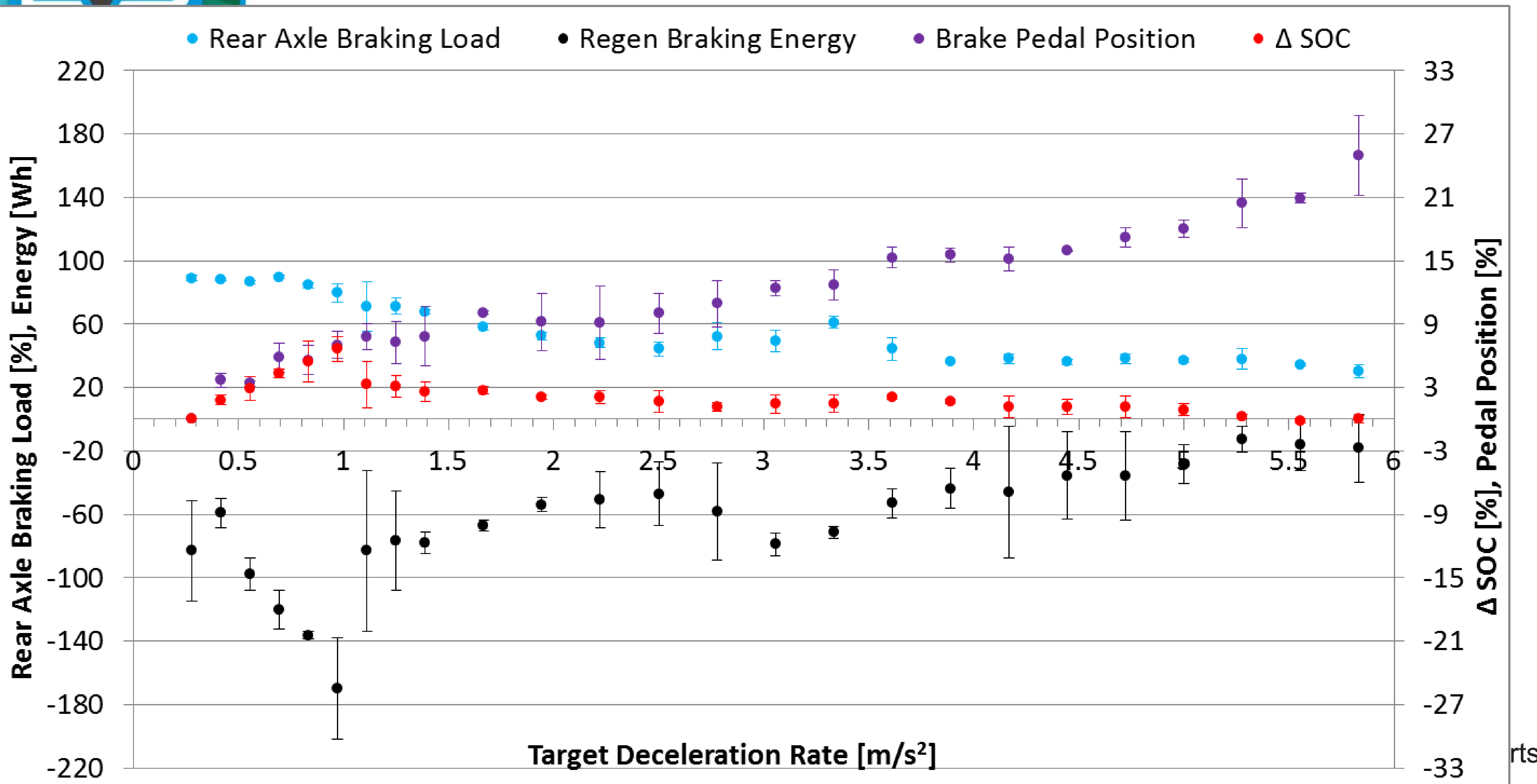




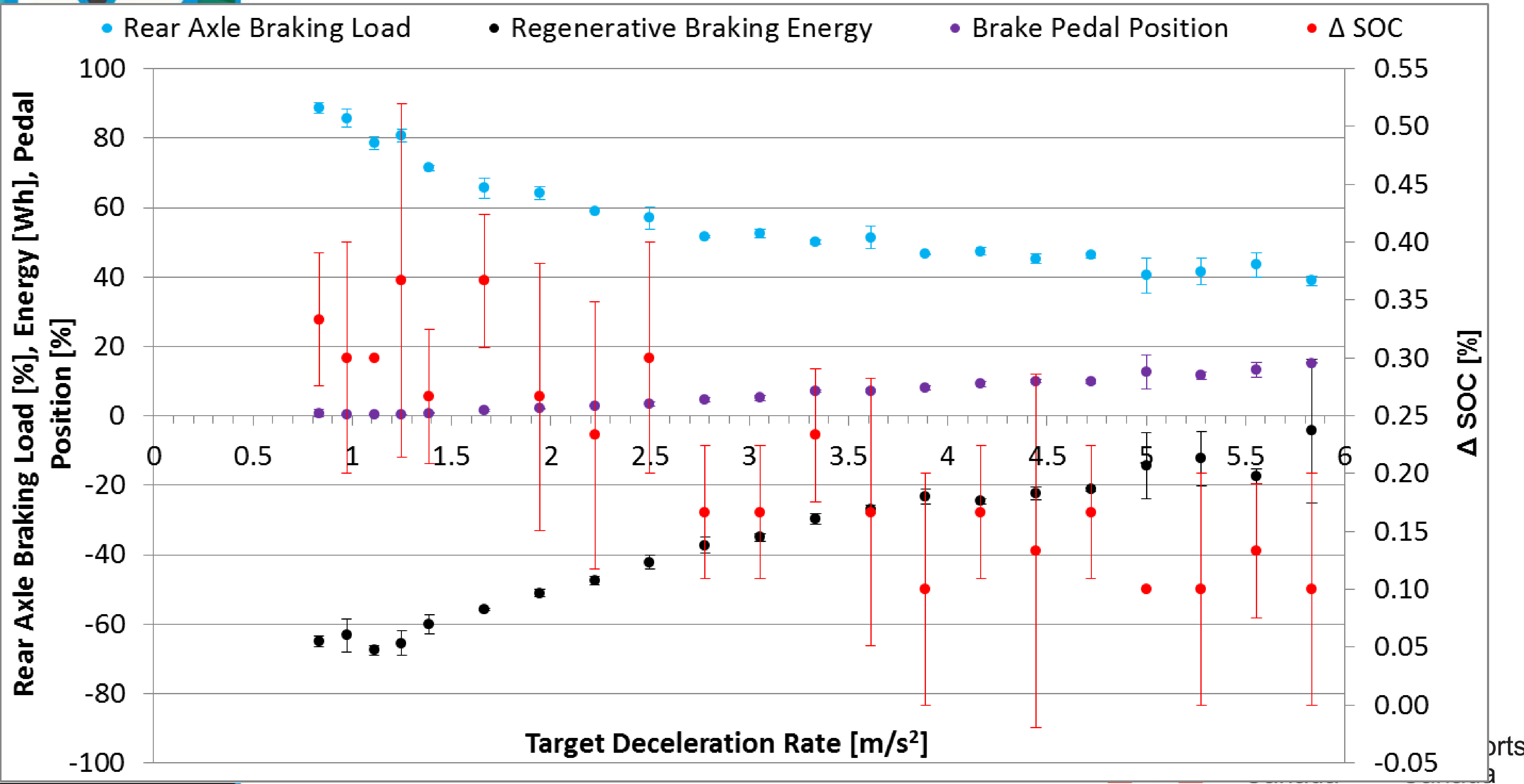
Results: Aggregated BEV Profiles



Results: Summary of HEV Results



Results: Summary of BEV Results





Conclusions

- Constant decelerations from 27.8 m/s to stop were generally not achieved
- Partitioning individual tests into unique deceleration events was a successful endeavour
- 100% of the HEV braking load was absorbed by the rear-axle for decelerations rates less than 0.8m/s^2
- 100% of the BEV braking load was absorbed by the rear-axle for deceleration rates less than 1.0m/s^2
- The HEV reached a maximum regenerative braking energy of 170Wh at 0.97m/s^2 while the BEV reached a maximum of 67Wh at 1.1m/s^2 .

