



**SCCA NATIONAL  
CONVENTION**  
January 17-19, 2019

# Using Data to Improve You and Your Cars Performance

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# Today's Agenda

- Introduction
- Overview of Data Acquisition and Analysis
- Improving *Driver Performance*
- Improving *Vehicle Performance*
- Improving *Vehicle Health*
- Questions and Answers ?





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# Overview of Data Acquisition and Analysis



# How to Use Data Acquisition

## Basic Data Analysis Steps

What is Happening (many stop here!)

Where is it Happening

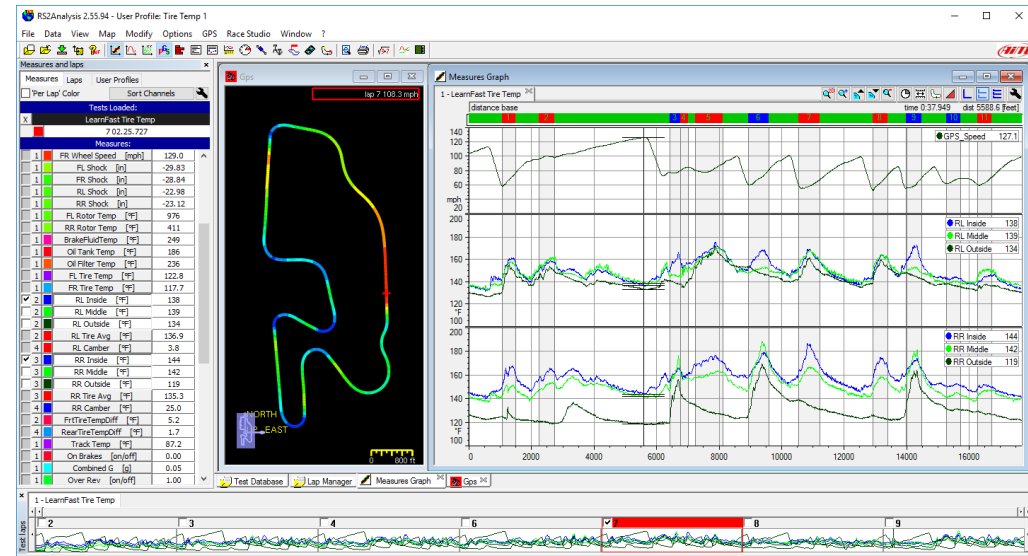
Why is it Happening

## Data Analysis Triangle

Driver Performance

Vehicle Performance

Vehicle Health



## Money Channels

Lap Times and Speed

All Other Channels Strongly Support the Money Channels

## Vehicle or Driver

Is the Driver Reacting to the Vehicle Movement

Or is the Driver Creating the Vehicles Movement

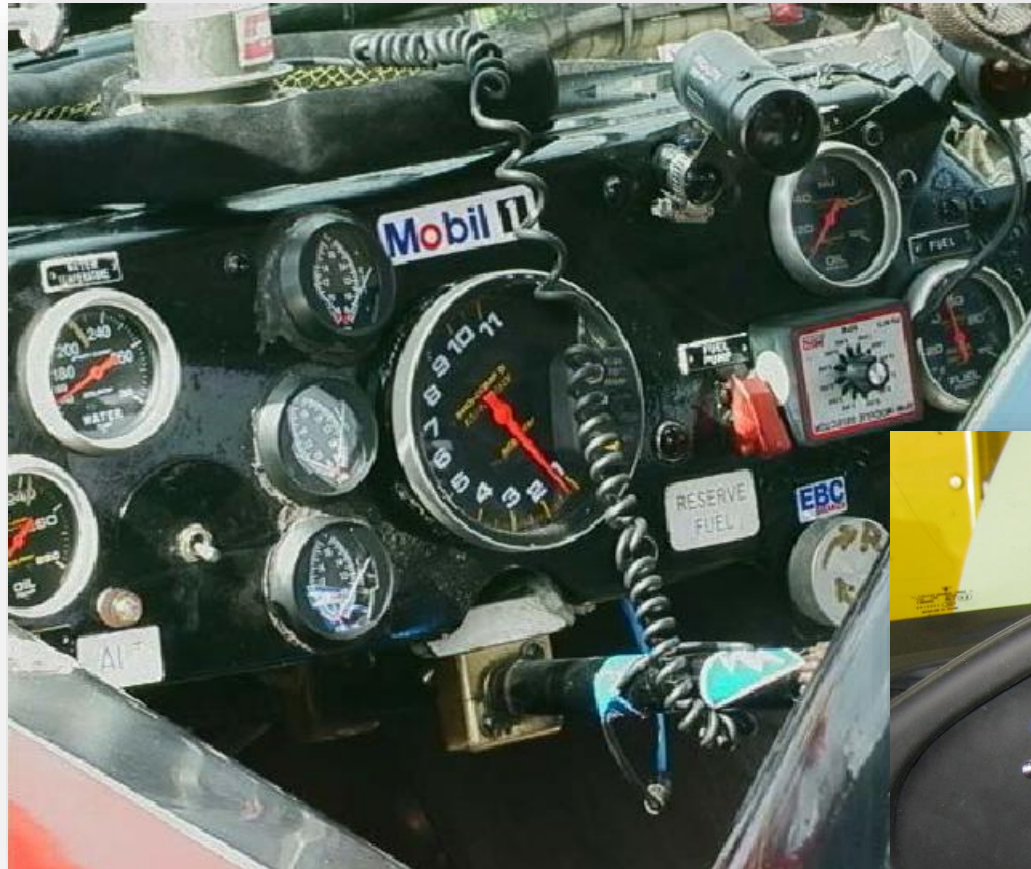
Critical Component of the 'Why is it Happening'





# Why Use an Electronic Display Dash?

Replace This:



Simple, less clutter

Easy to change

Display only what you need, when you need it

Programmable lights to help you brake harder,  
not just when to shift

With This:



# What Does the Dash Do?

## Display or Convey Information – Now in Color

Lap time, speed, temperatures, etc.

Controls shift lights & warning lights

Trigger audible tones directly into ear piece for brake lockup

Rear view camera display, provides better view out the back

## Alarms

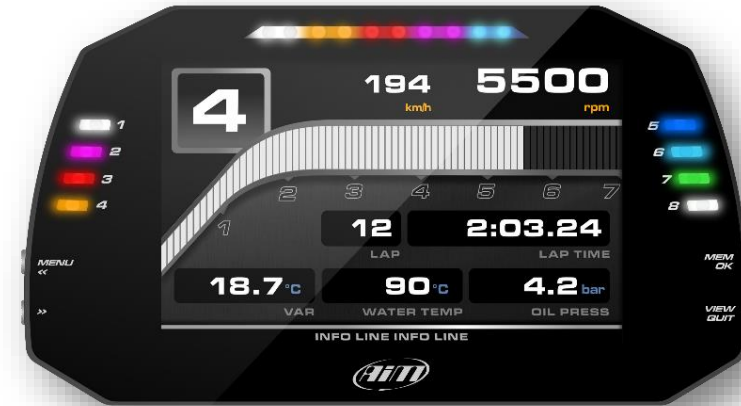
Notify driver of alarms, water hot, low oil press, etc.

## Calculate Things

Lap gain/loss (predicted lap timing), gear detection,  
fuel prediction of laps remaining, engine logs

## Last but Most Important

Logging data!



## What is Data Acquisition

The act of recording information which can be measured on the race car, then analyzing to benefit the driver or car





# What Kind of Sensors Exist?

Liquid Temperature



G Forces



Brake Rotor or Tire Temp



Wheel Speed



Linear Shock Movement



Tire Pressure



Pressure



Sensors measure physical things, outputting a voltage. The voltage is measured by the dash and converted to the physical measurement

## Some other sensors:

Driver Inputs: Steering, Throttle Position, Brake Pressure

Ride Height: Roll, Pitch, Tire squish

Yaw Rate: Rate of turn

Strain Gauges: Measure load on tire, Downforce

Air Pressure: Barometric, Ram air effect of intake, etc.

Pitot Tube: Air speed over car

Crankcase Pressure: Tells you if your piston is cracking

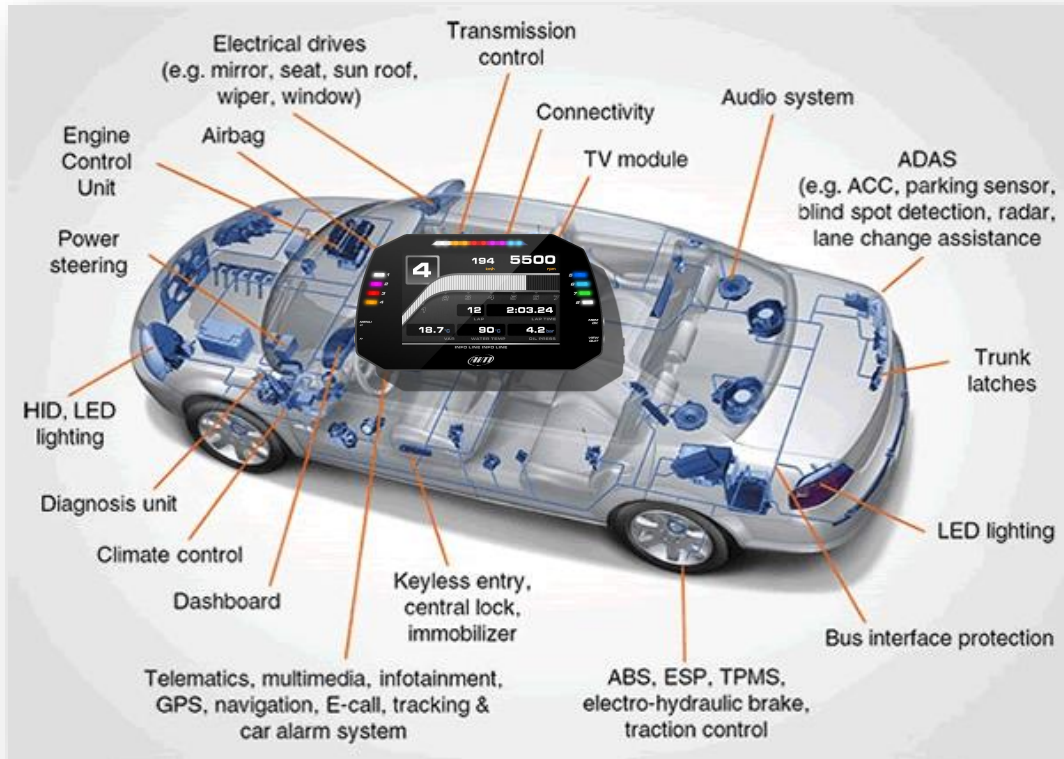
Air/Fuel (lambda): Rich or lean mixture

Tire: Pressure & Temperatures



# Now & In The Future

All current cars have a huge network of electronics on the car. And they all talk to each other on the CAN Bus....



So we can listen in and get overloaded with every kind of data for almost no extra cost!

Even cars from 1999 had a CAN bus....

Example; a BMW E46 car provides all of these channels or sensors for free!

Wheel Speeds, Vehicle Speed, Brake Pressure, Brake Switch, ASC active + error, DSC active + error, Steering Wheel Angle, Engine RPM, Throttle Pedal, Throttle Pos, Engine Torque Actual, Engine Torque Theoretical, Air Temp/Pressure, Gear, Oil Level Low, Oil Temp, Water Temp, Gearbox Oil Temp, Fuel Used, Fuel Level, Clutch Switch, MAF error, Odometer, more!





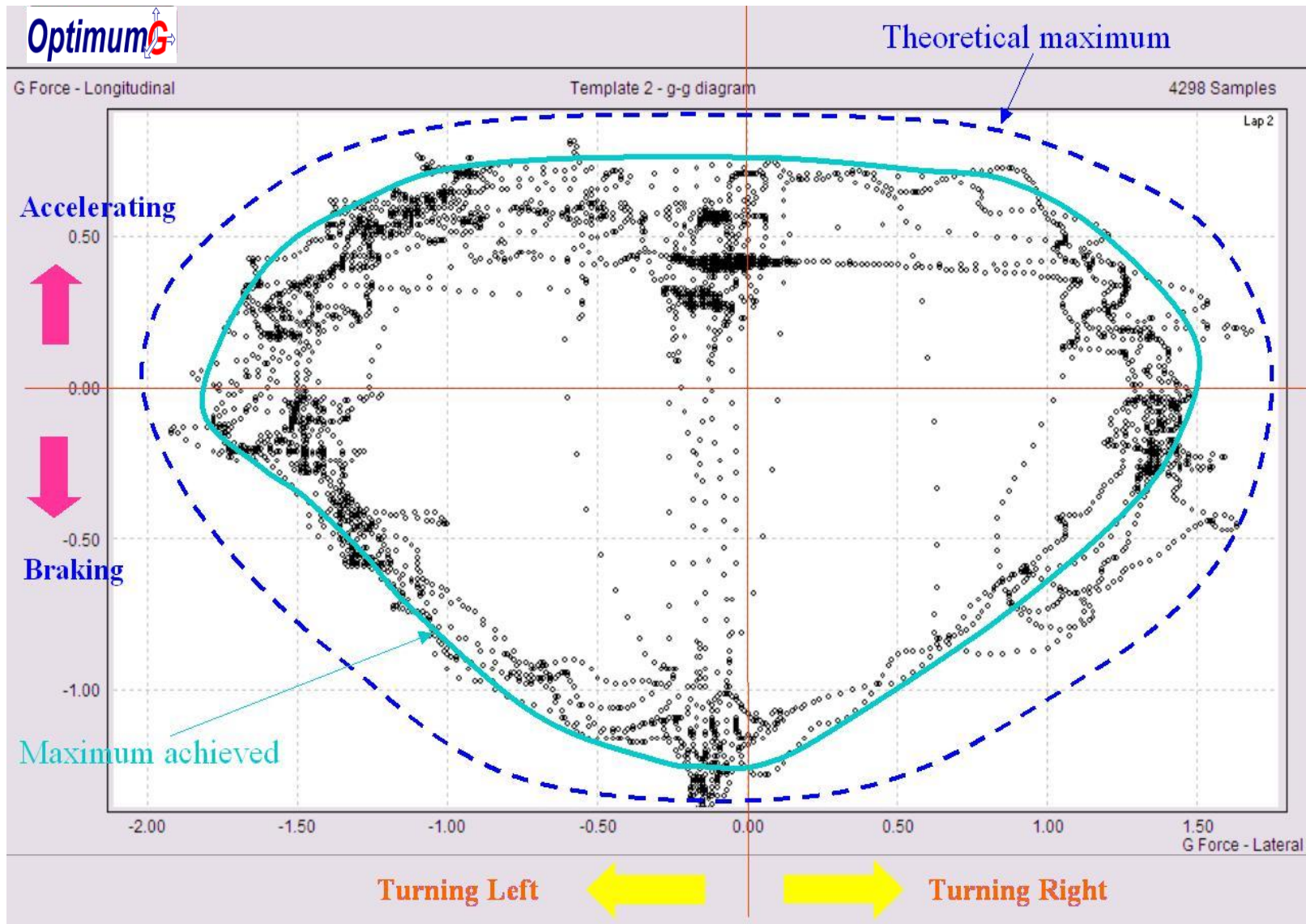


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# Improving Driver Performance



# G-G Diagram or Scatter Plot

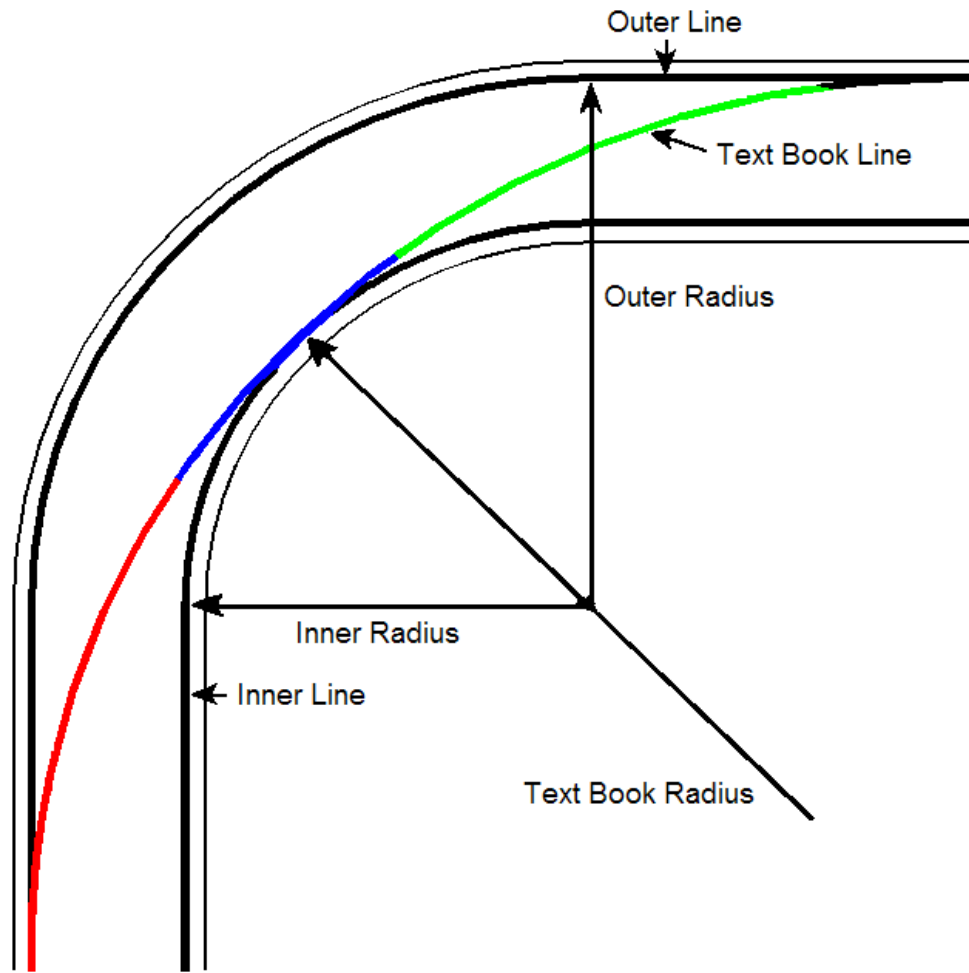


Drive the Tire Grip Curve all the time!

Maximize your tires at every point around the race track by driving at the car's maximum. Let the data tell you where to go faster... safely!

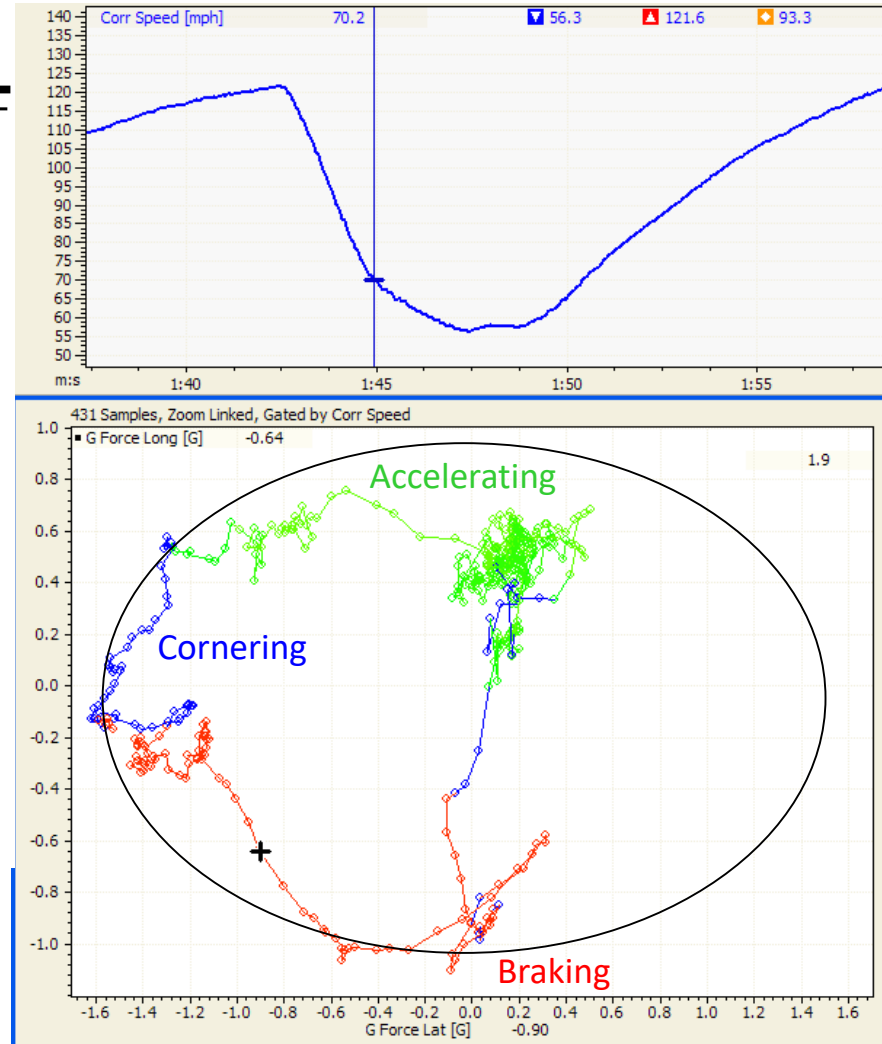


# Text Book Line



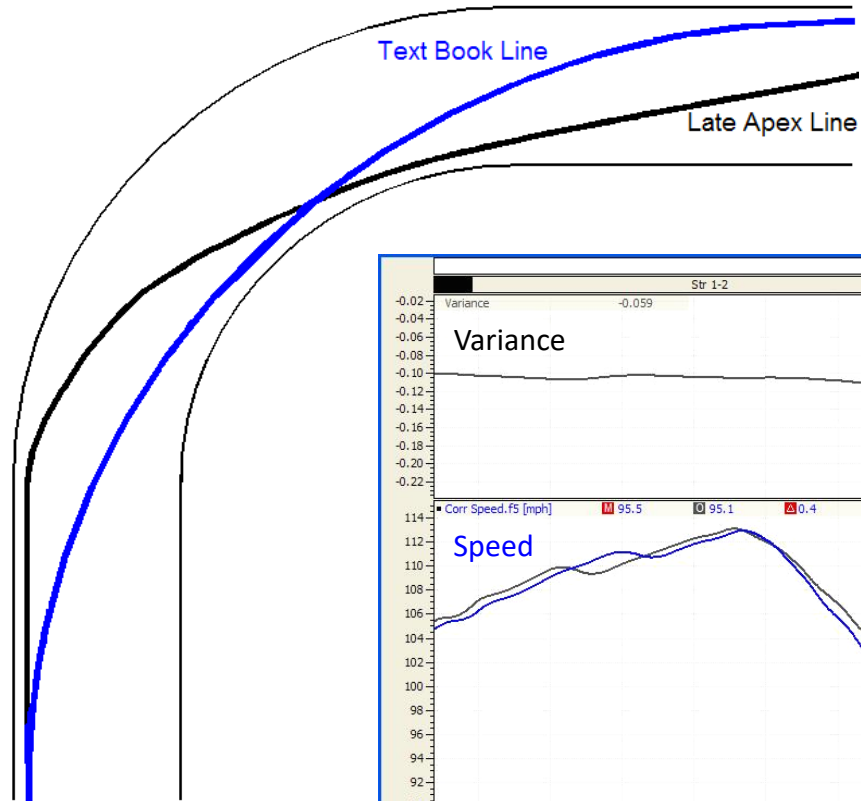
Inner Radius Speed = 45mph  
 Outer Radius Speed = 50mph  
 Text Book Radius = 60mph

This method maintains the highest “minimum corner speed” possible through a corner. Driving the *Traction Circle* is the fastest way through this corner.





# Late Apex Line



When a corner precedes a long straight, it might be better to NOT drive the Traction Circle. That is no trail braking. A later apex results in a lower minimum corner speed, but allows a faster exit speed. That extra exit speed is carried down the entire length of the straight.



0.05 seconds slower in middle of corner, but 0.15 faster down straight  
Net gain = 0.10 seconds



# How to Compare 2 Laps



These two lap times look identical, but how would you know there's 0.5 seconds of difference is between them!



# Section Timing – Identify which laps to study

Blue = fastest section times

Eclectic is the theoretical best lap time if you add up all of the fastest sections

Time Report - Track Sections (All Laps)

	Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6	Eclectic	Rolling Minimum
Str 0-1 (End)	0:04.297	0:04.298	0:04.236	0:04.211	0:04.228	0:04.288	0:04.211	0:04.288
Turn 1	0:05.352	0:05.288	0:05.177	0:05.216	0:05.273	0:05.374	0:05.177	0:05.374
Str 1-2	0:08.258	0:08.051	0:08.117	0:08.007	0:08.181	0:08.213	0:08.007	0:08.213
Turn 2	0:06.711	0:06.415	0:06.567	0:06.653	0:06.780	0:06.403	0:06.403	0:06.403
Str 2-3	0:16.615	0:16.561	0:16.765	0:16.550	0:16.511	0:16.566	0:16.511	0:16.566
Turn 3	0:04.067	0:04.146	0:04.043	0:04.162	0:03.946	0:03.911	0:03.911	0:03.911
Turn 4	0:05.829	0:05.855	0:05.785	0:05.867	0:05.808	0:05.669	0:05.669	0:05.669
Turn 5	0:03.734	0:03.817	0:03.818	0:03.797	0:03.811	0:03.816	0:03.734	0:03.811
Turn 6	0:03.039	0:03.041	0:03.027	0:03.018	0:03.061	0:03.084	0:03.018	0:03.061
Str 6-7	0:02.599	0:02.610	0:02.597	0:02.615	0:02.636	0:02.622	0:02.597	0:02.636
Turn 7	0:03.899	0:03.904	0:03.925	0:03.865	0:03.828	0:03.822	0:03.822	0:03.828
Str 7-8	0:04.933	0:04.934	0:04.937	0:04.916	0:04.871	0:05.013	0:04.871	0:04.871
Turn 8	0:02.537	0:02.558	0:02.592	0:02.495	0:02.539	0:02.502	0:02.495	0:02.539
Turn 9	0:02.479	0:02.581	0:02.576	0:02.497	0:02.551	0:02.541	0:02.479	0:02.551
Str 9-10	0:02.575	0:02.592	0:02.602	0:02.608	0:02.567	0:02.602	0:02.567	0:02.567
Turn 10	0:05.601	0:05.616	0:05.660	0:05.739	0:05.616	0:05.721	0:05.601	0:05.616
Turn 11	0:03.275	0:03.237	0:03.199	0:03.186	0:03.181	0:03.205	0:03.181	0:03.181
Str 0-1 (Start)	0:01.134	0:01.125	0:01.117	0:01.114	0:01.114	0:01.119	0:01.114	0:01.114
Totals	1:26.944	1:26.536	1:26.749	1:26.523	1:26.511	1:26.480	1:25.376	1:26.208

Track

Mid-Ohio

The diagram shows the Mid-Ohio race track layout. Key sections labeled include Str 0-1, Str 1-2, Str 2-3, Str 6-7, Str 7-8, Str 9-10, and Str 0-1 (Start). Turns are numbered 1 through 11. A red arrow points to the start of Str 0-1.

Time Report Properties

Report | Display | Colour Bands

More Green = More Consistent

Colour Bands :

Value (%)	Colour
<= 1.0	Green
<= 2.0	Green

Add... Remove...

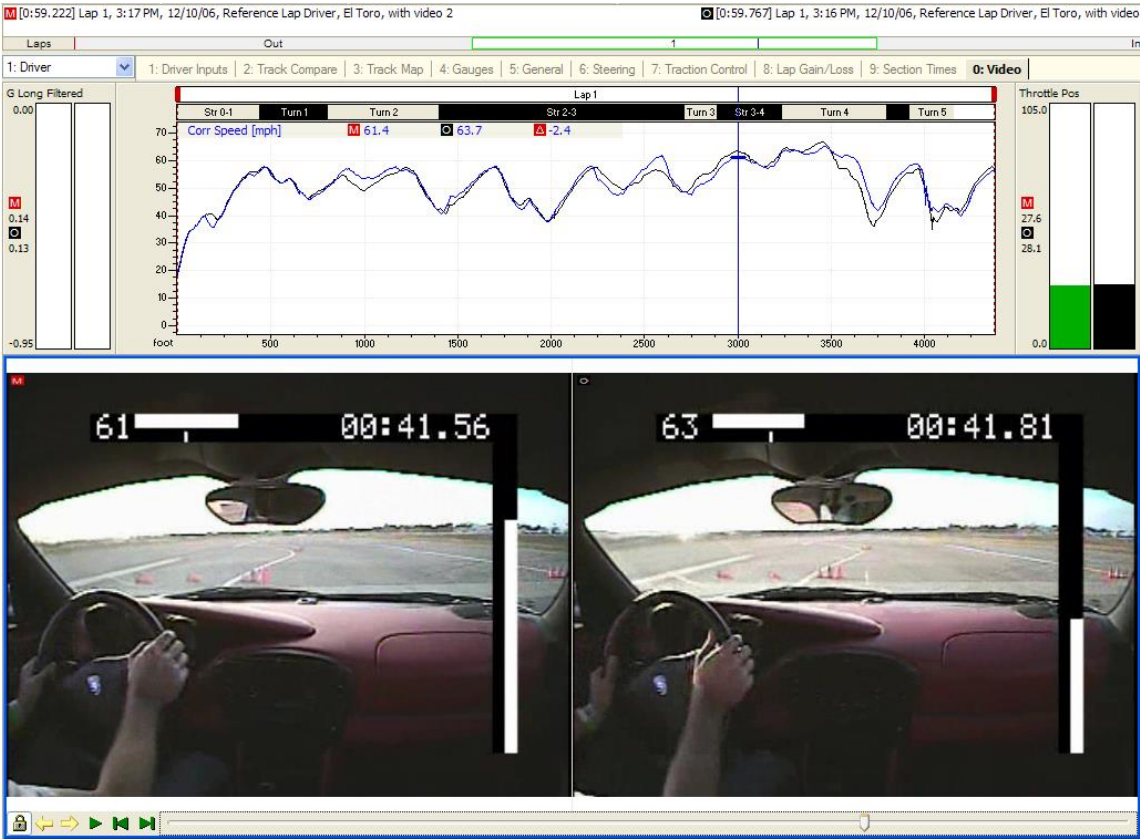
Fastest rolling lap





# Video & GPS

Unbelievable study material when you combine video + data



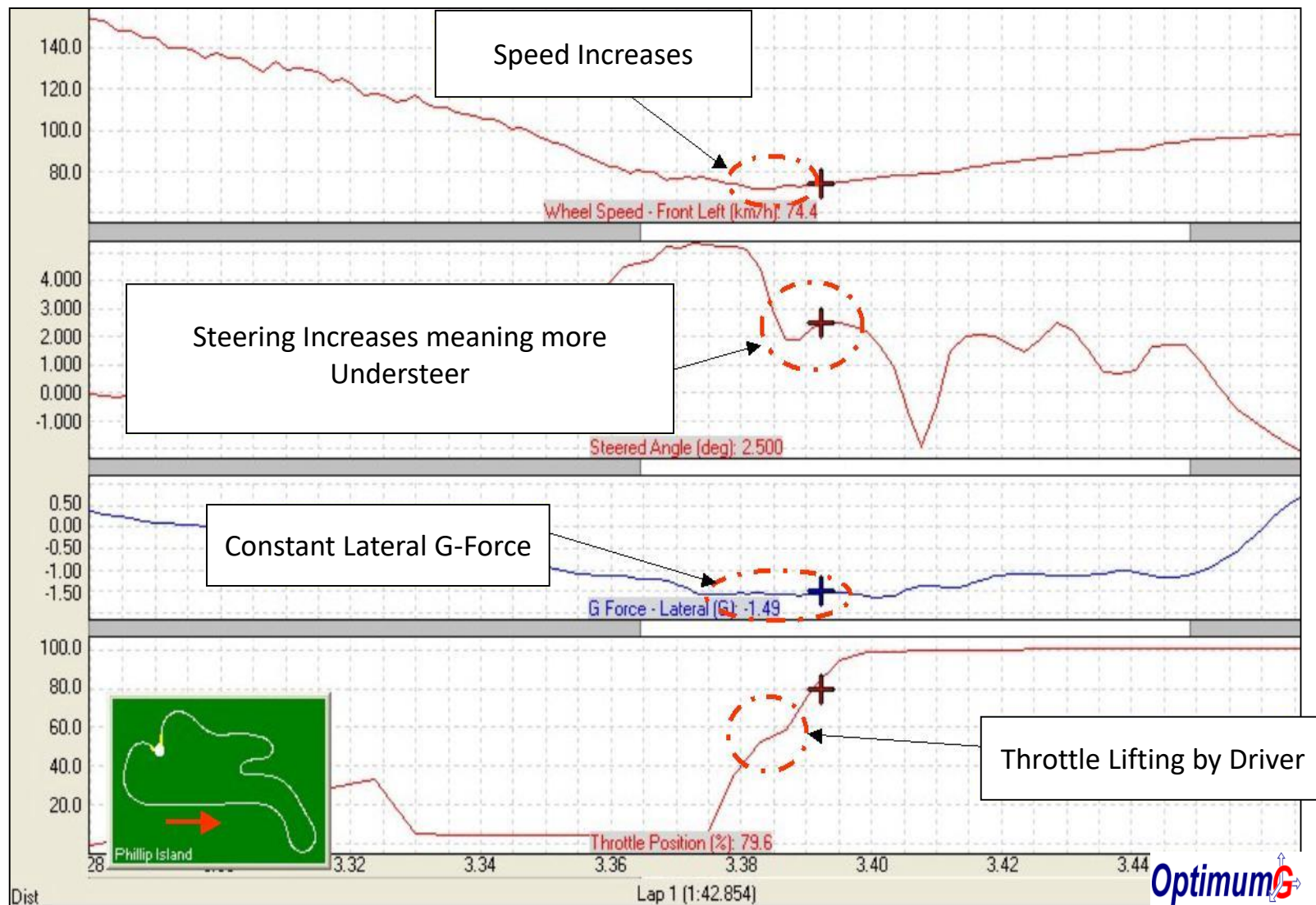


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# Improving Vehicle Performance

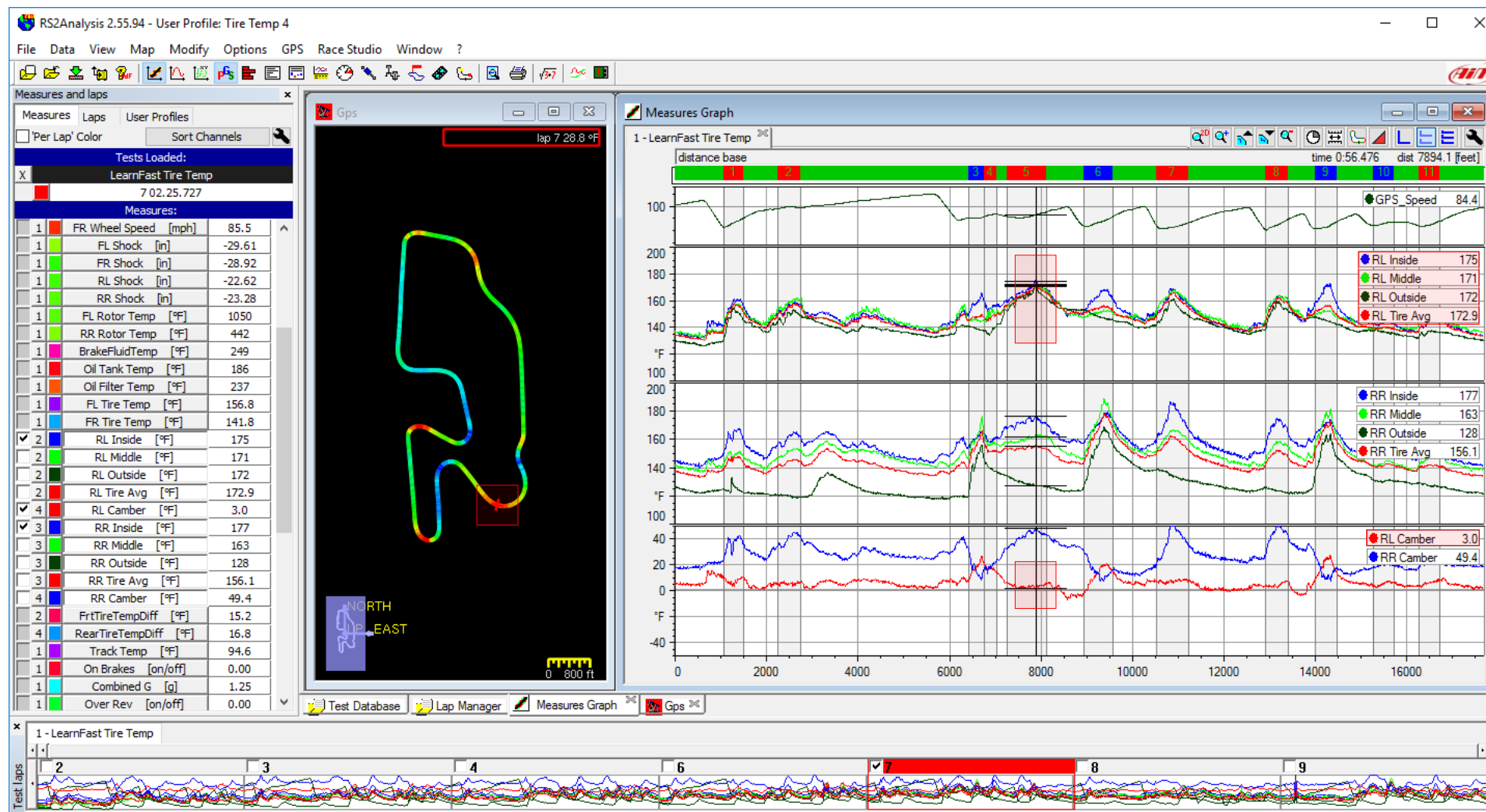


# How to Find Understeer / Oversteer





# Tire Temperatures



We are showing rear tire temps sampled in 3 places across each tire. The **Rear Left** tire is not too bad while the **Rear Right** tire has some significant differences.

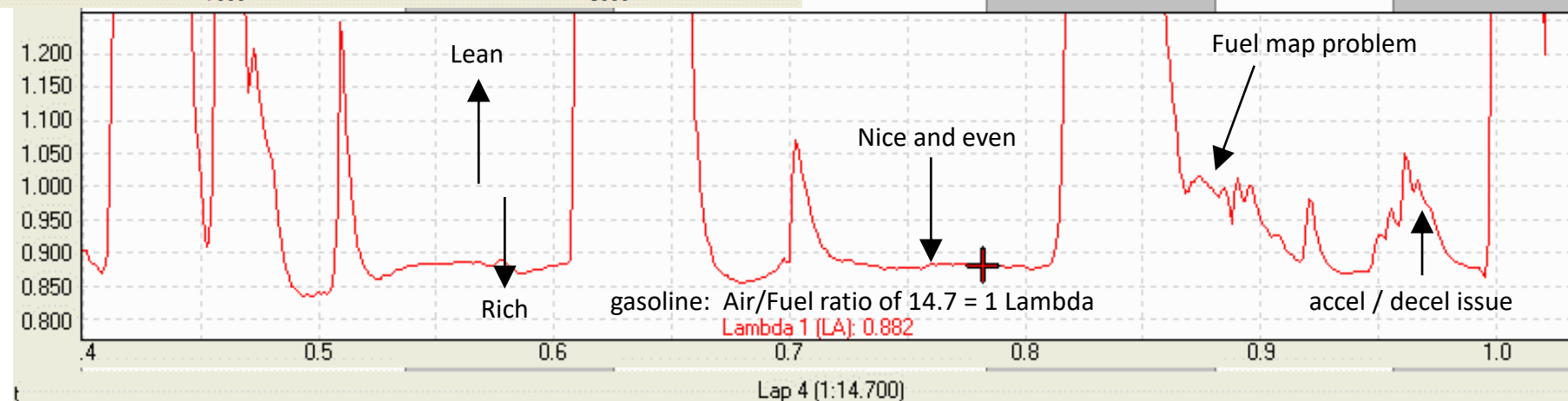
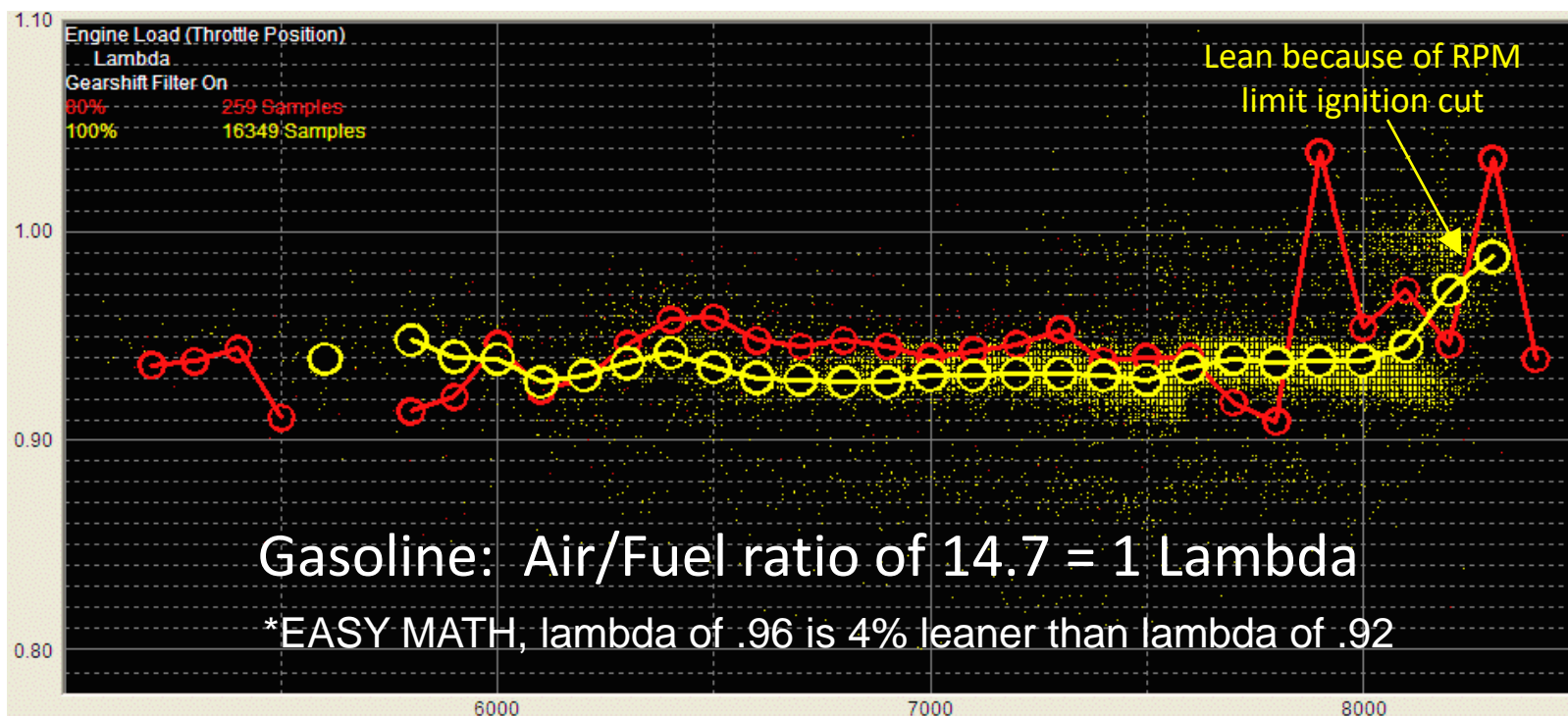
Rear Left Inside Tire Temp  
Rear Left Middle Tire Temp  
Rear Left Outside Tire Temp

Rear Right Inside Tire Temp  
Rear Right Middle Tire Temp  
Rear Right Outside Tire Temp

Rear Left In-Out Temp Diff  
Rear Right In-Out Temp Diff



# Fuel Mixture to Help Your Engine Run Better



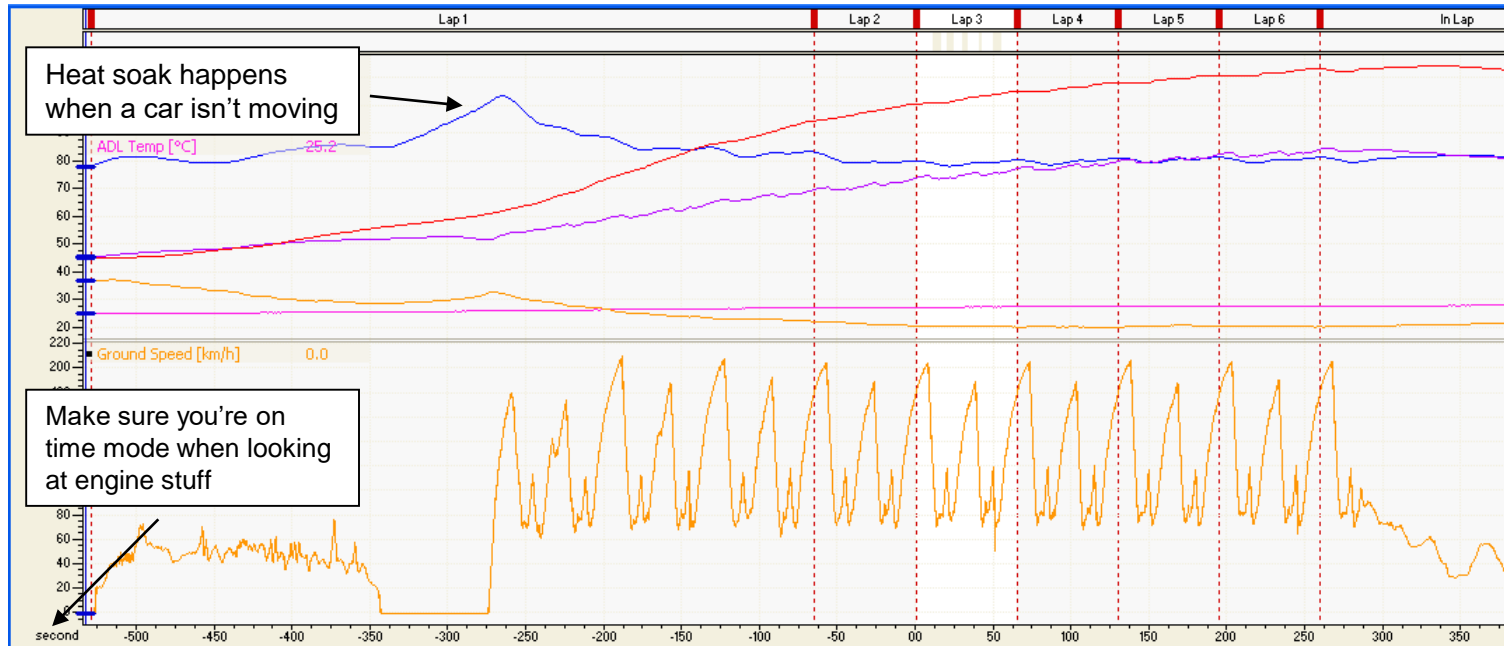


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# Improving Vehicle Health



# Lap Reports



Quick easy way to see minimums, maximums & averages for every lap!

Channel Report - Laps

		Mid-Ohio, Formula Ford, 3:56 PM,					
		Lap 1 [1:26.944]	Lap 2 [1:26.636]	Lap 3 [1:26.749]	Lap 4 [1:26.523]	Lap 5 [1:26.511]	Lap 6 [1:26.480]
Corr Speed [mph]	Max	137.8	138.2	137.5	137.6	138.1	138.0
	Avg	5716	5728	5750	5671	5755	5731
Engine RPM [rpm]	Max	6942	7086	7350	6804	7050	6906
	Avg	55.5	58.5	57.5	57.5	57.3	57.2
Engine Temp [°C]	Max	86.6	86.8	86.8	87.1	87.1	86.8
Eng Oil Temp [°F]	Max	241.5	248.9	252.5	254.3	256.1	257.7
	Min	32.57	33.36	30.96	28.49	26.90	27.74
Eng Oil Pres [psi]	Max	70.69	67.42	66.22	67.83	65.28	65.87
	Min	13.82	13.86	13.85	13.86	13.90	13.86
Bat Volts ADL [V]	Min	13.82	13.86	13.85	13.86	13.90	13.86

RACE REPORTS2002.xls [Read-Only]

	A	B	C	D	E	F	G	H
1			AGP 2002					
2								
3				PRACTICE 1	QUALIFYING	RACE 1	RACE 2	RACE 3
4				CAR 55	CAR 55	CAR 55	CAR 55	CAR 55
5	Laps Completed	Laps		12	11	12	14	3
6	Start Position			6	12	12	15	17
7	Finish Position			6	12	15	17	DNF
8	Fastest Lap	min		2:00.601	2:00.054	2:02.032	2:12.667	n/a
9	Fastest Session Lap	min		1:59.809	1:58.671	1:59.477	2:05.765	2:03.1
10								
11	Start 0-100km/h	sec				4.02	5.62	5.3
12	Start T.P.	%				87.9	55	44.6
13	Start RPM	RPM				7392	5004	3156
14								
15	Fuel Used per Lap	litres Avg.		3.04	2.95	3.25	3.18	0
16	Fuel Used for Session	litres Max.				39	44.5	
17	Speed	km/h Max.		247	248.3	247.9	234	232.5
18	RPM	RPM Max.		8070	7914	8268	8352	7614
19	Lateral G-Force	G Max.		1.85	1.97	1.82	1.5	-4.7(1.2)
20								
21	Ambient Temp	°C Avg.		20.8		19.6	18.9	18.1
22	Track Temp	°C Avg.		23.3		22.3	20.4	19.5
23	Engine Oil Temp	°C Max.		92	90.1	103	89.6	86.2
24	Engine Water Temp	°C Max.		70	70	81	70	70
25	Diff Oil Temp	°C Max.		82.4	89.5	90.4	87.6	56.3
26	Gearbox Oil Temp	°C Max.		75.6	80.6	85.2	82.5	55.5
27	Oil Pressure	psi Min.		62.32	58.51	50.75	60.41	64.1
28	Fuel Pressure	psi Min.		50.39	50.31	50.39	52.03	50.39
29	Cock Pit Temp	°C Max.						
30	Battery Voltage	V Min.		13.68	13.72	13.43	14.2	13.73
31								
32								
33								
34								

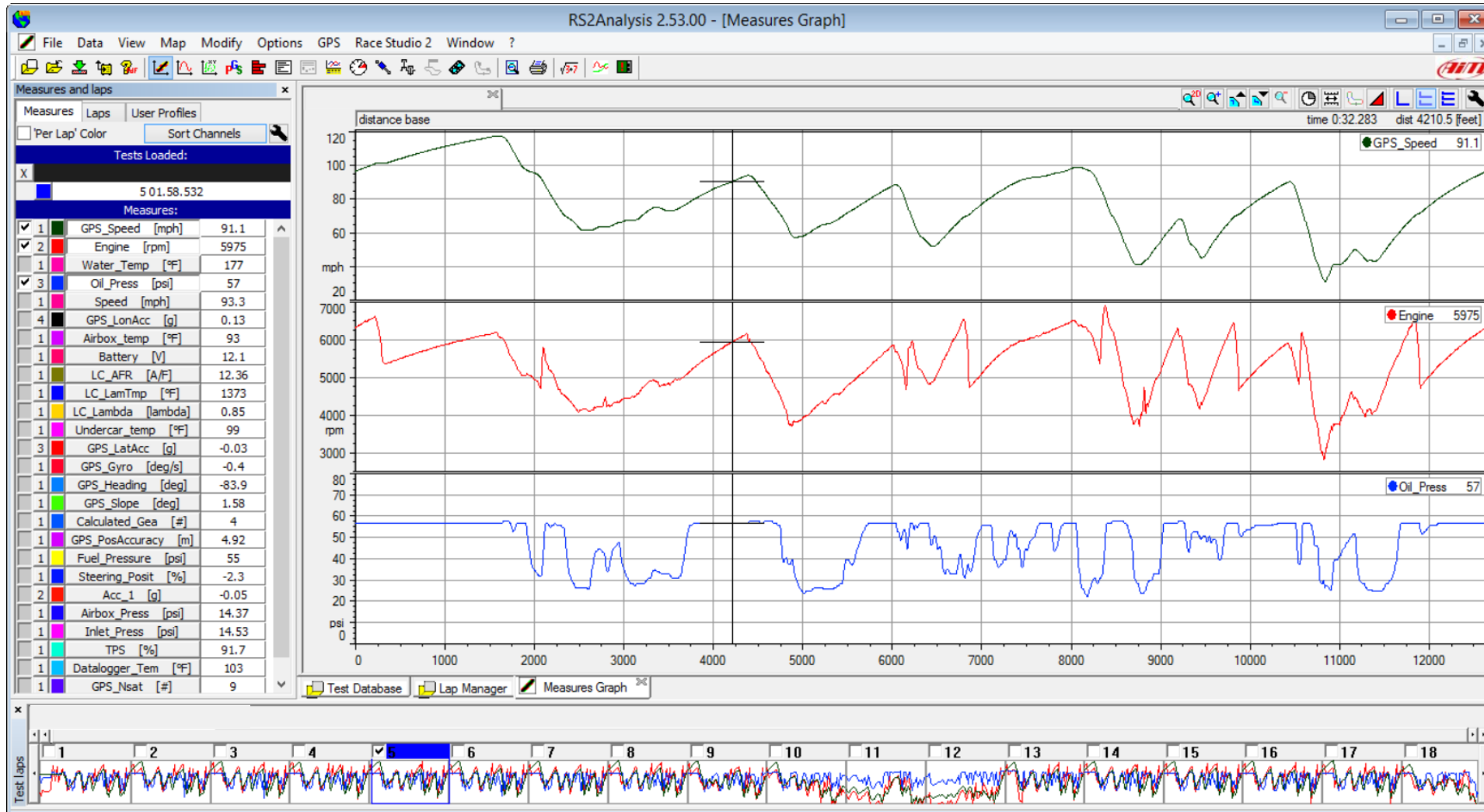
AGP Adelaide Phillip Island Eastern Creek Hidden Valley Canberra

Export your data to easy to read Excel reports





# Engine Oil Pressure Drops



We are showing:

GPS\_Speed

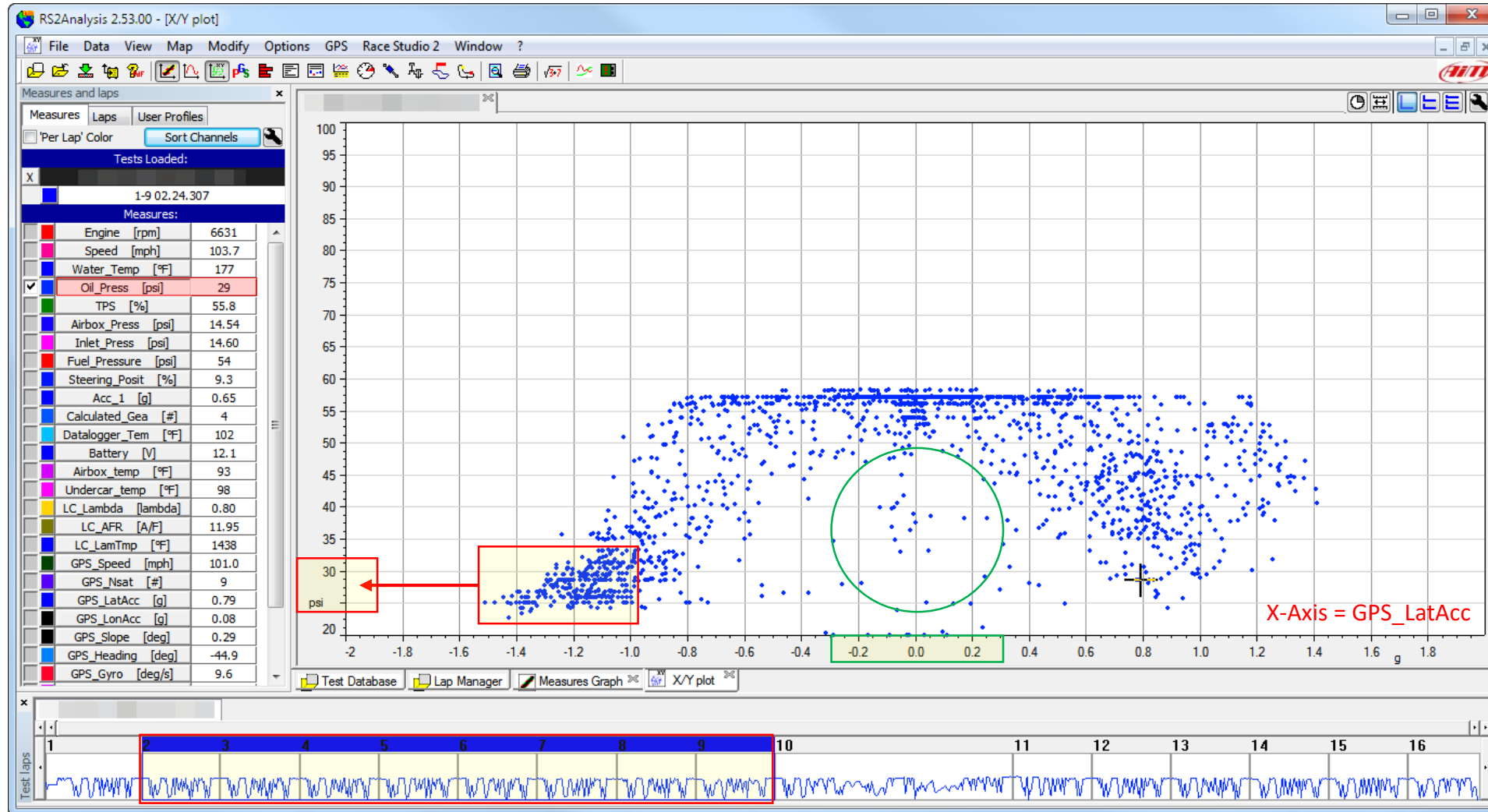
Engine RPM

Oil Pressure

The Oil Pressure is showing drops at seemingly random positions on the track



# Engine Oil Pressure Drops



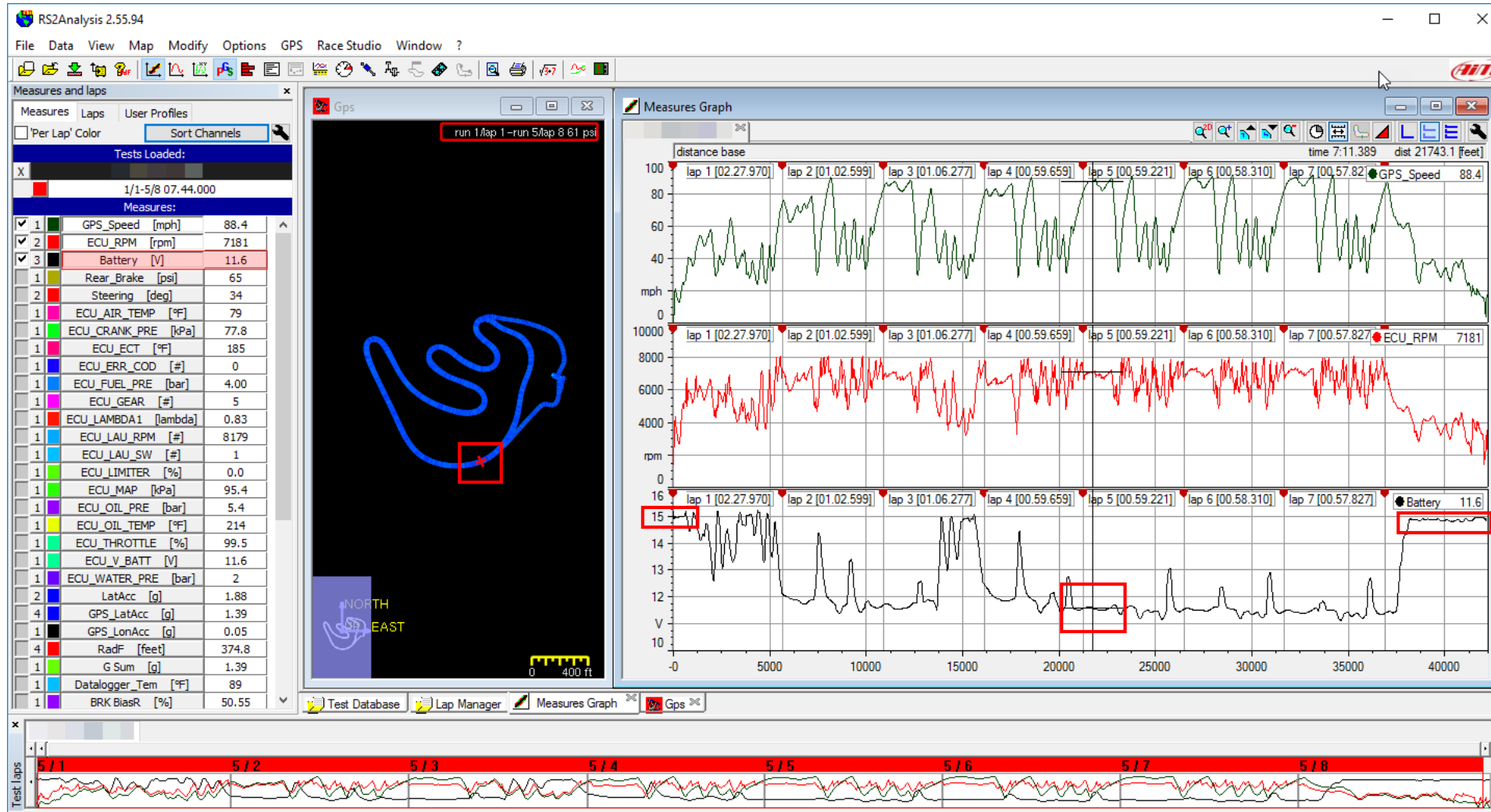
We are showing:

Oil Pressure  
vs Lateral G's  
(GPS\_LatAcc)

The Oil Pressure is showing consistently low when (down to 25psi) when the Lateral G's are exceeding appx -1.0g (left cornering)



# Battery Voltage Drops



We are showing:

GPS\_Speed

Engine RPM

Oil Pressure

The Oil Pressure is showing drops at seemingly random positions on the track





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# Questions?

## Contact Information:

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