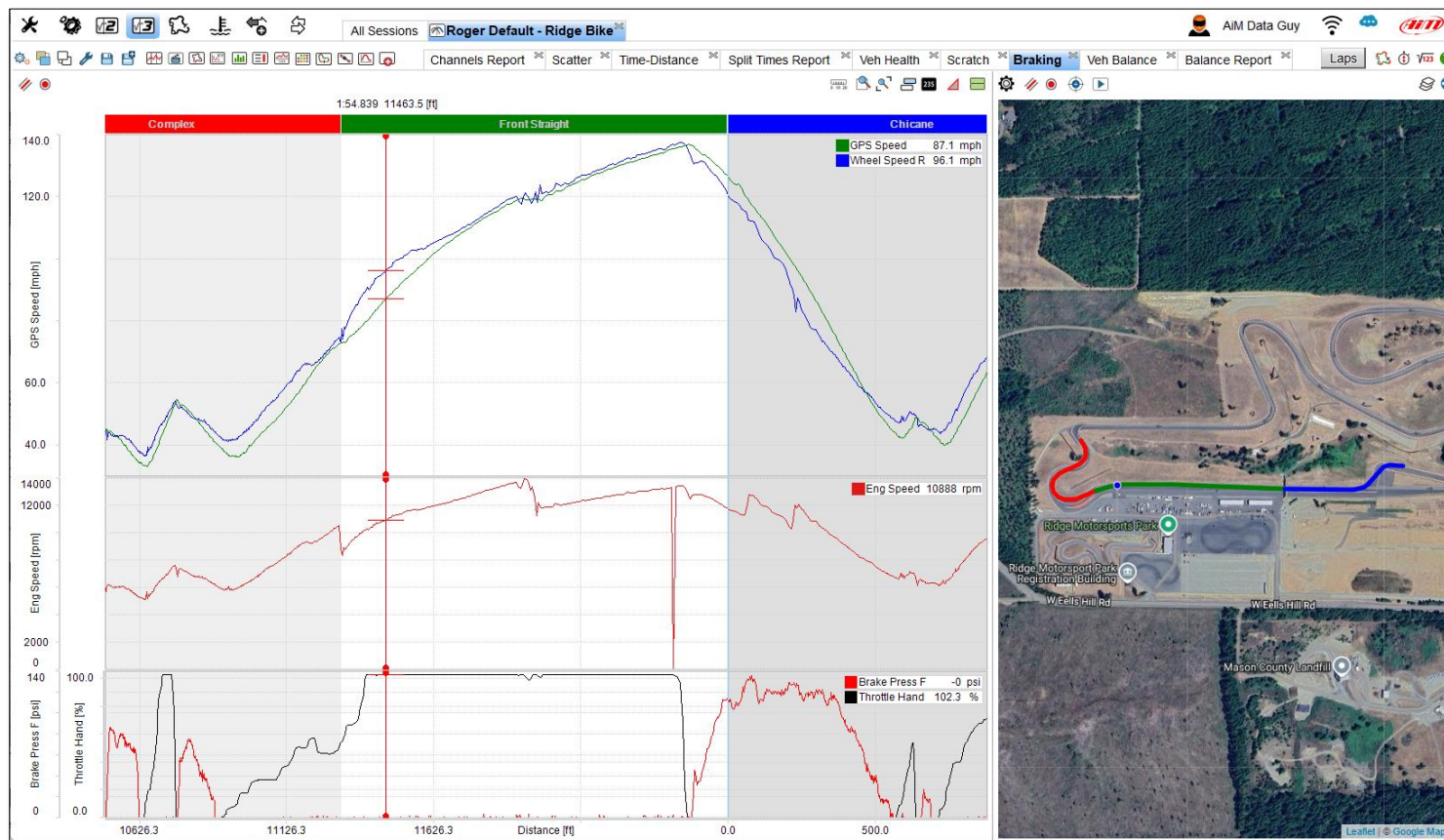


GPS vs. Wheel Speeds

in Racing Data Analysis



Host:

Roger Caddell

AiM Sports - National Training Manager



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Different Speed Sources



GPS vs. Wheel Speeds

Different Speed Sources



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GPS Speed

GPS Speed



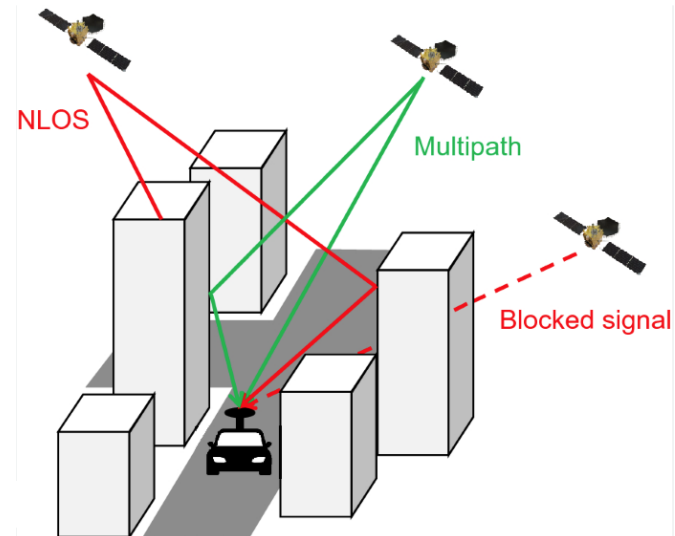
Strengths –

- The technology continues to improve
- Speed is most reliable value from GPS sensor
- Price is now lower, included with every AiM system
- Errors are constant, so higher speed, less error
- Not relying on other things (tire size, etc)
- With AiM, plug & play



Weaknesses –

- Relative low power signal, easily blocked
- Electronic technology can have issues
- Antenna must have clear view of the sky
- Non Line of Sight and/or Multipath (mostly an urban location issue)



GPS vs. Wheel Speeds

GPS Speed

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Wheel Speeds

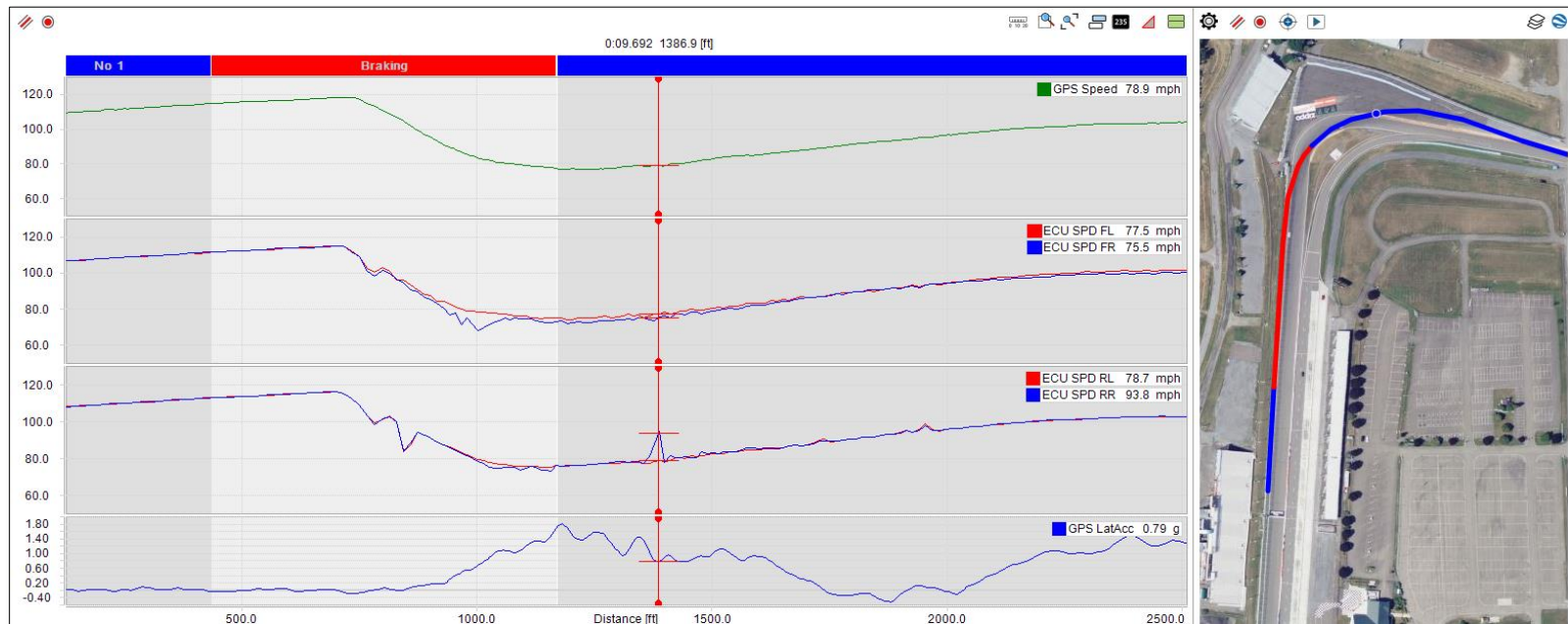


Strengths –

- Available from most/all ECU connections
- Often all 4 wheels
- If not, easy to install AiM sensor

Weaknesses –

- Several sources of error; tire size, magnets, etc
- Tire spin, tire lockup (also a strength!)



GPS vs. Wheel Speeds

Wheel Speeds

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AiM Speed Sensor Setup



Tools: [Icons] | All Configurations | AiM Webinar MXS v2 | User: AiM Data Guy | [Icons]

Buttons: Save, Save As, Close, Transmit

Tabs: Channels, ECU Stream, CAN2 Stream, CAN Expansions, Math Channels, Status Variables, Parameters, Shift Lights and Alarms, Commands, Icons Manager, Display, SmartyCam Stream, CAN Output

ID	☒	Name	Function	Sensor	Unit	Freq	Parameters
RPM	☒	RPM	Engine RPM	RPM Sensor	rpm	20 Hz	max: 16000 ; factor: /1 ;
Spd1	☒	FR Speed	Wheel Speed	Speed Sensor	mph 0.1	50 Hz	wheel: 65.25 ; pulses: 4 ;
Spd2	☐	Speed2	Speed	Speed Sensor	mph 0.1	20 Hz	wheel: 40 ; pulses: 1 ;
Spd3	☐	Speed3					wheel: 40 ; pulses: 1 ;
Spd4	☐	Speed4					wheel: 40 ; pulses: 1 ;
Ch01	☒	Channel01					
Ch02	☒	Channel02					
Ch03	☒	Channel03					
Ch04	☒	Channel04					
Ch05	☒	Channel05					
Ch06	☒	Channel06					
Ch07	☒	Channel07					
Ch08	☒	Channel08					
Acc1	☐	InlineAcc					
Acc2	☐	LateralAcc					
Acc3	☐	VerticalAcc					
Gyr1	☐	RollRate					
Gyr2	☐	PitchRate					
Gyr3	☐	YawRate					
PAccu	☒	GPS PosAccuracy					
Spd	☒	GPS Speed					
Alt	☒	Altitude					
OdD	☒	Odometer					
Luma	☒	Luminosity	Brightness	Luminosity	% 0.01	1 Hz	
Fuel	☐	FuelUsed	Fuel Level	Fuel Used	gal 0.01	10 Hz	

Channel Settings

Name: FR Speed

Function: Wheel Speed

Position: Front Right

Sensor: Speed Sensor

Sampling Frequency: 50 Hz

Unit of Measure: mph

Display Precision: 1 decimal place

Speed Parameters

Wheel circumference [in]: 65.25

Pulse per wheel revolution: 4

Save Cancel

GPS vs. Wheel Speeds

AiM Speed Sensor Setup

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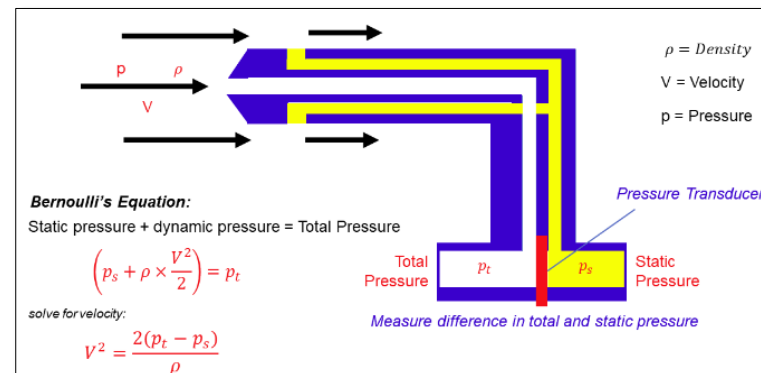


Strengths –

- Can give data you can not get any other way
- You can 'see' the airflow
- Price is much reduced over last few years

Weaknesses –

- Install will be unique to your vehicle
- Needs clean airflow
- Learning curve to analyzing data, noisy data
- Deeper analysis may need aero knowledge



GPS vs. Wheel Speeds

Pitot Tube

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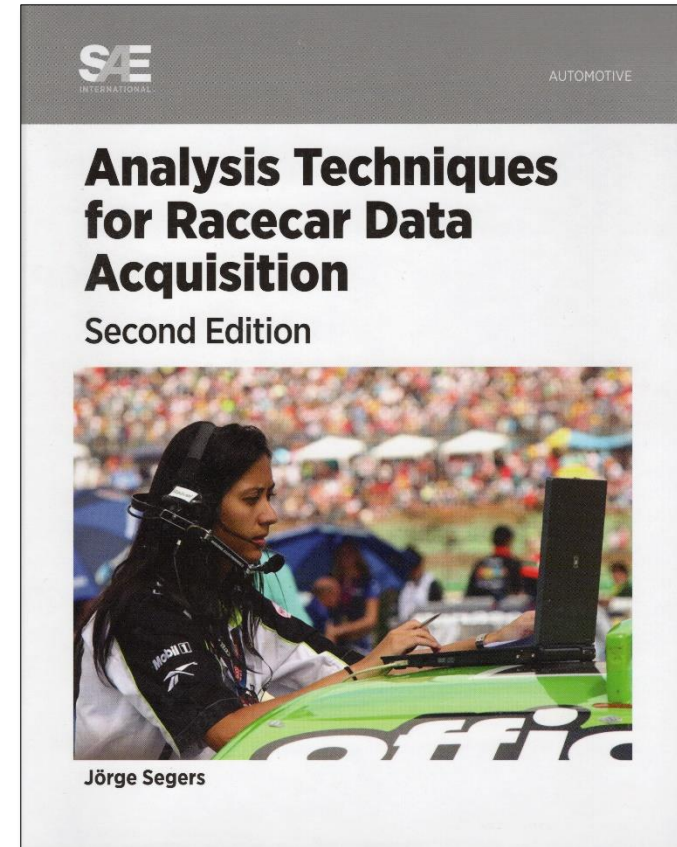
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GPS Info

Analysis Techniques - Jörg Segers

"GPS integration has two major advantages. The quality of track maps is much better than when only inertial sensor signals are used to calculate the map... The second advantage of using GPS is the higher speed accuracy, which typically is within 0.1-0.2%. This is far better than that obtained with a magnetic pickup sensor measuring wheel speed. Speed accuracy is of vital importance to calculate the lap distance, and improving it increases the quality of the lap segment calculations and lap overlays." (page 14)

"GPS does not increase only the accuracy of track maps. Speed measurements are not influenced by wheel spin, lockup, or changing a tire radius due to load or wear. This means the distance function becomes more accurate, thereby increasing the quality of lap overlays. More confidence can be put in the lap time variance calculation." (page 61)



Analysis Techniques for Racecar Data Acquisition (Second Edition) – Jörg Segers

GPS vs. Wheel Speeds

GPS, Some Details

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Wheel Speed Errors

Squiggly Lines – Chris Brown



Unfortunately, this speed measurement is prone to errors. While the logger calculates a very accurate time from its internal clock, the rolling circumference is always changing while on the race track. The tire which flattens to form the contact patch, gets pushed and pulled in all directions; forward, backwards and sideways. A tire's circumference is therefore continuously changing throughout a lap due to the following effects:

- Centripetal forces from a tire's rotational speed
- Static load from vehicle weight
- Dynamic squish from load transfer when braking or cornering
- Temperature and pressure changes

Every tire has a different reaction to these forces based on its internal construction. Radial tires have cords inside that restrict longitudinal strain much more than bias ply tires which have its cords laid at an angle. The circumference of a radial tire might vary by 1%, while bias ply tires can change up to 3%. But even 1% at 160 mph results in a 1.6 mph error. I've seen driver's complain they are down on engine power and request an engine change because of 1.6 mph.

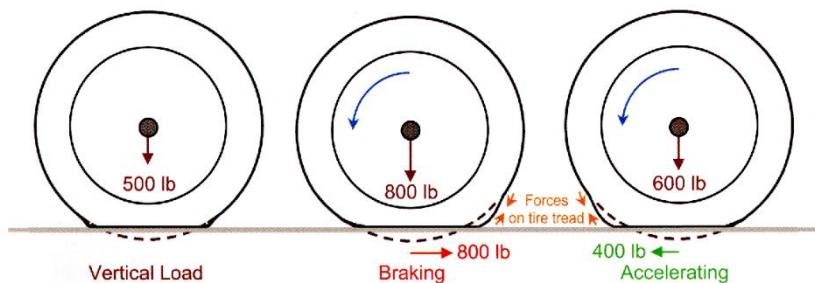


Figure 2.3 Tire circumference changes whenever forces are applied to the tire.

Making Sense of Squiggly Lines

the
Basic Analysis
of
Race Car Data Acquisition



written by:
Christopher Brown



Page 26: Making Sense of Squiggly Lines – Christopher Brown

GPS vs. Wheel Speeds

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Wheel Speed Errors

Squiggly Lines – Chris Brown



selecting how the two rolling wheel speeds (FL and FR) should be combined when creating a single speed channel for analysis. Three options exist; the fastest, the slowest or an average of both.

One observable fact to remember is the radius differences between the inside and outside tires during a corner. When the car is turning, the inside tire must rotate slower as it is forced to cover a smaller distance. The outside tire spins faster as it follows a larger arc. So the inner tire reports a speed that is slower than the true speed of the car, while the outer tire reports a speed that is faster. The true speed of the car is an average of the two tires. This effect gets larger the tighter the corner. In Turn 11, also known as the hairpin of the Long Beach Grand Prix circuit, speed differences between the inner and outer lines will reach 10%.

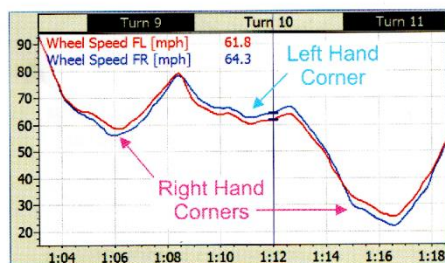
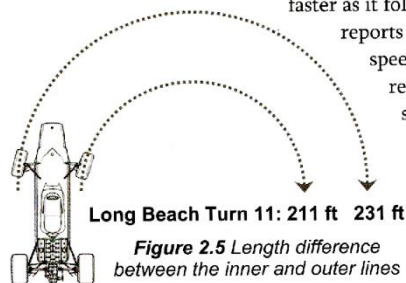
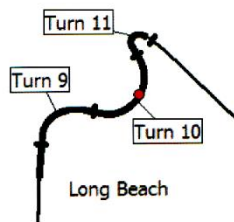


Figure 2.6 Wheel speeds vary based on the inside and outside radii when a car travels around a corner.



Making Sense of Squiggly Lines

the
Basic Analysis
of
Race Car Data Acquisition



written by:
Christopher Brown



Page 28: Making Sense of Squiggly Lines – Christopher Brown

GPS vs. Wheel Speeds

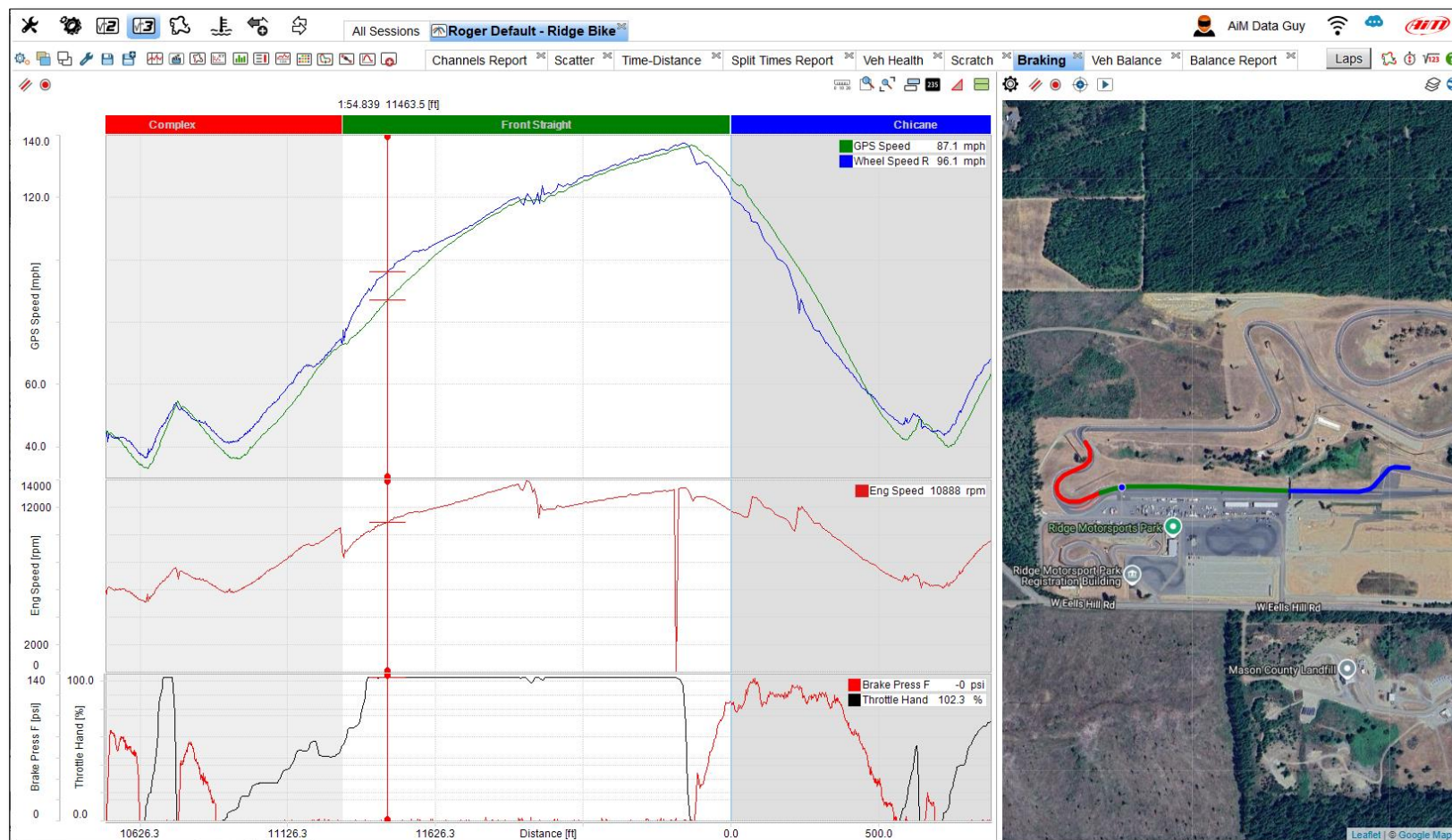
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Road Race Motorcycle



GPS vs. Wheel Speeds

Road Race Motorcycle

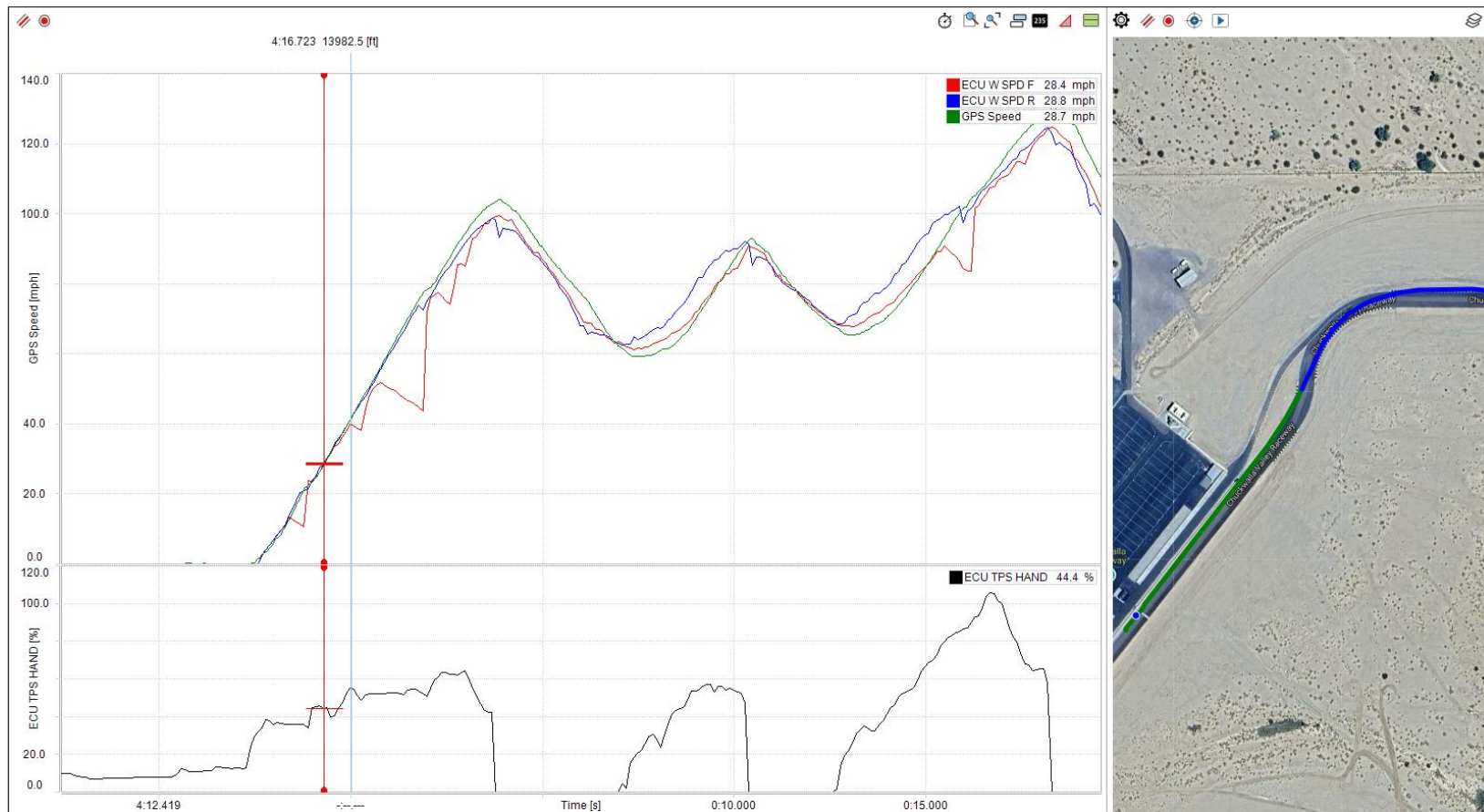
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Road Race Motorcycle



GPS vs. Wheel Speeds

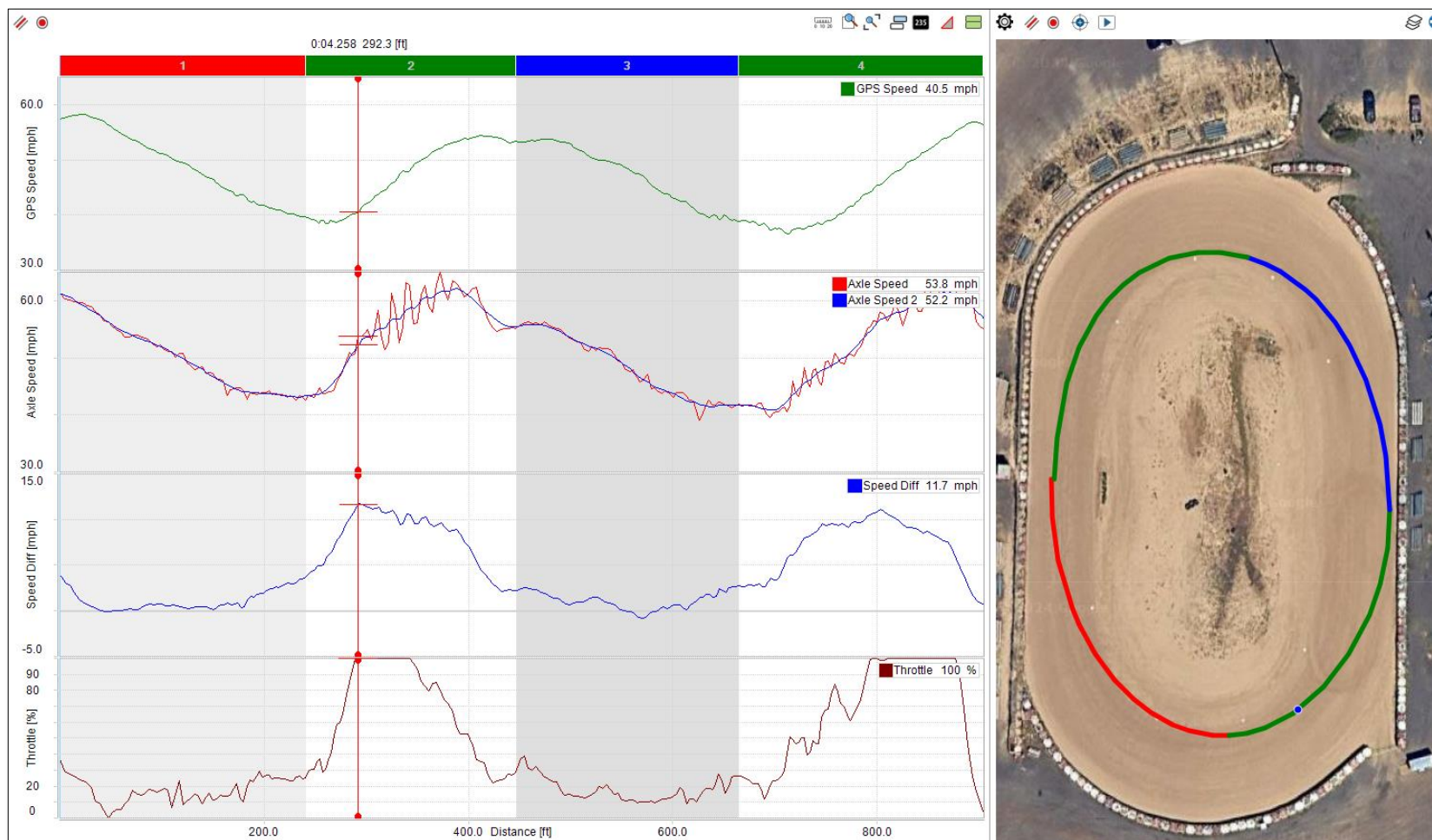
Road Race Motorcycle

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Dirt Kart Oval



GPS vs. Wheel Speeds

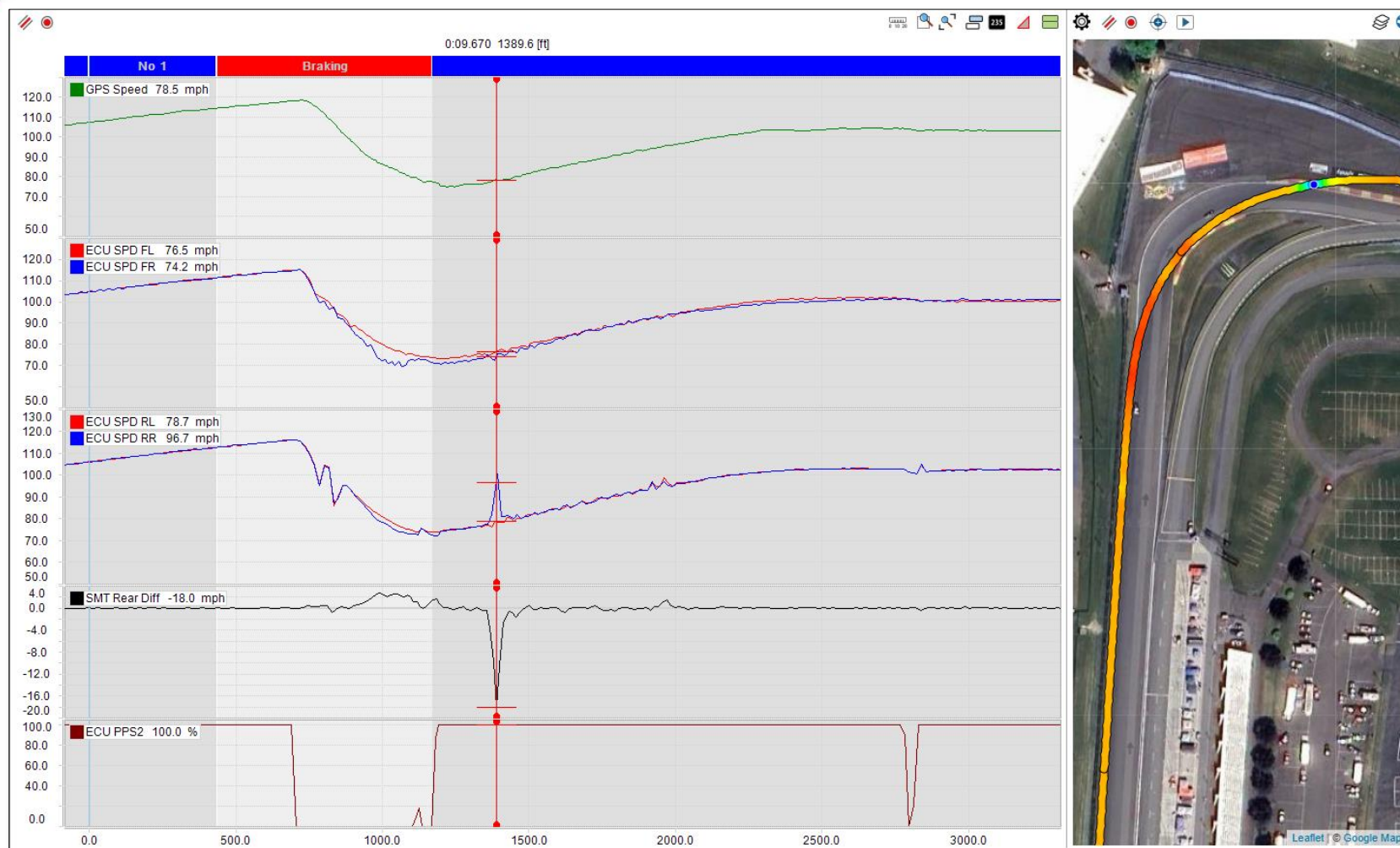
Oval Dirt Kart

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Tire Spin



GPS vs. Wheel Speeds

Tire Spin

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Drag Racing



GPS vs. Wheel Speeds

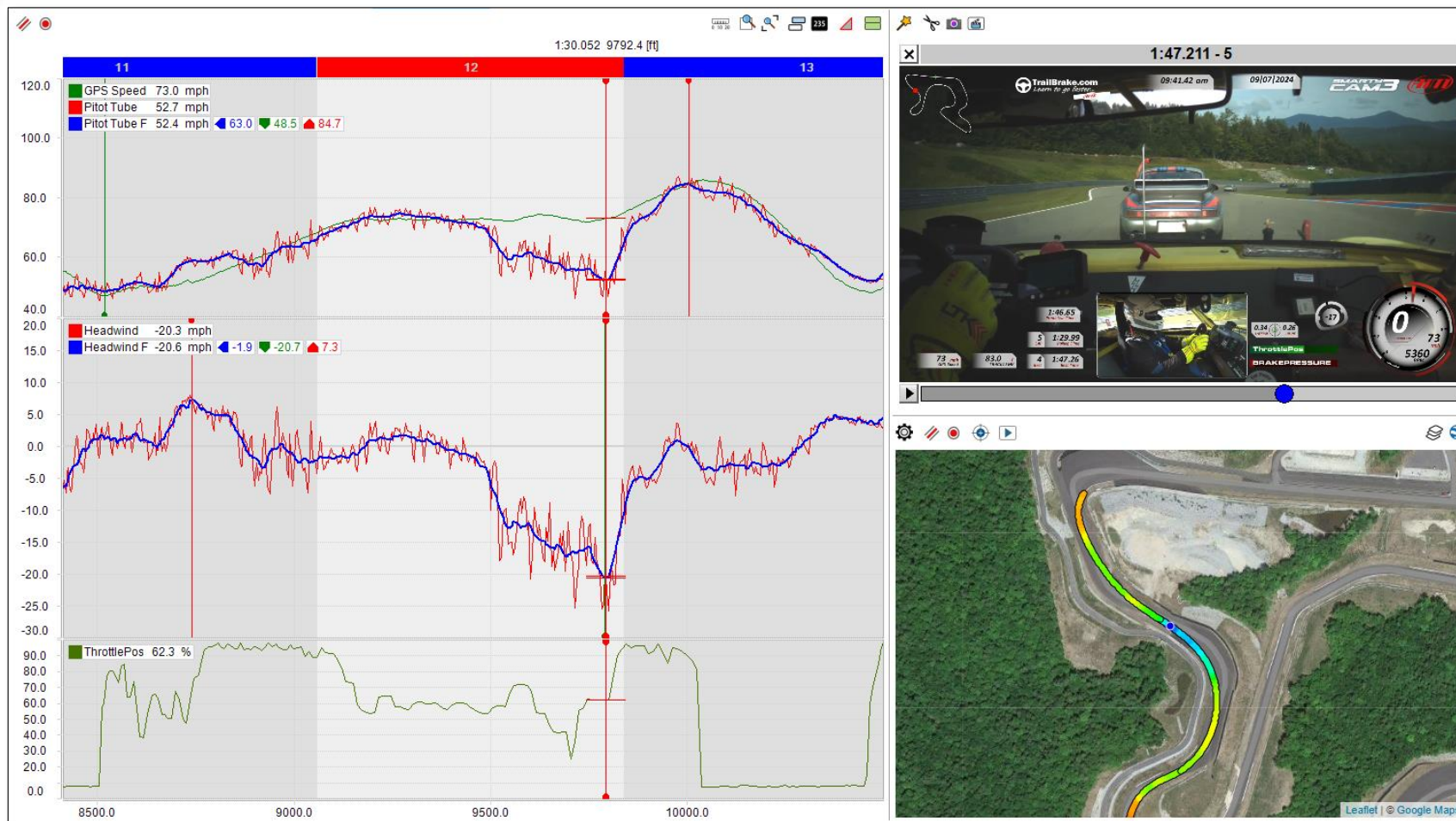
Drag Racing

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Air Speed



GPS vs. Wheel Speeds

Air Speed



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GPS vs. Wheel Speeds
in Racing Data Analysis

Host:
Roger Caddell
AIM Sports - National Training Manager

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 - **I Have Downloaded my Data, Now What - Part 2*
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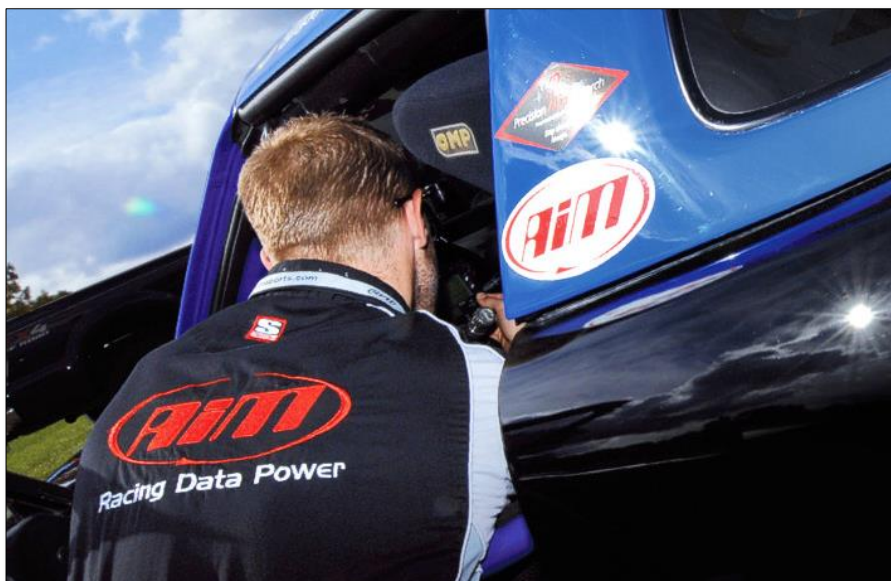
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AiM Sports Users and the 2024 SCCA Runoffs 'Alternative Start/Finish Line'

For the 2024 SCCA Runoffs at Road America, an 'Alternative Start/Finish Line' official timing loop will be used for all SCCA Test Days (Sept 28-30) and Qualifying (Oct 1-3) located in the middle of the 'Kettle Bottoms' section. Then for the Hagerty Race Days (Oct 4 thru 6) the conventional Start/Finish timing loop located on the front straightaway of the track will be used for official timing. See the track map image on this page.

From a pure data focused perspective, AiM Sports data users can simply ignore the SCCA's use of an alternative S/F line and create lap times and data analysis from the standard S/F line on the front straight of the track. This will however create a situation where your lap times will NOT match the official SCCA lap times (and possibly teammates) and you will not realize the real benefits of practicing and qualifying while using the alternative S/F line.

There are several things an AiM Sport User can do to prepare for this event and then do during the event that will make this alternate S/F line a non-issue.

This document gives you information, some best practices, and specific solutions. Here is a hyperlinked Table of Contents to help you find the specific topic you need.

SCCA 2024 Runoffs - Road America Track Map

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Revised: August 30th, 2024
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[AiM Sports/SCCA Runoffs 'Alternate Start/Finish Line' Document](#)

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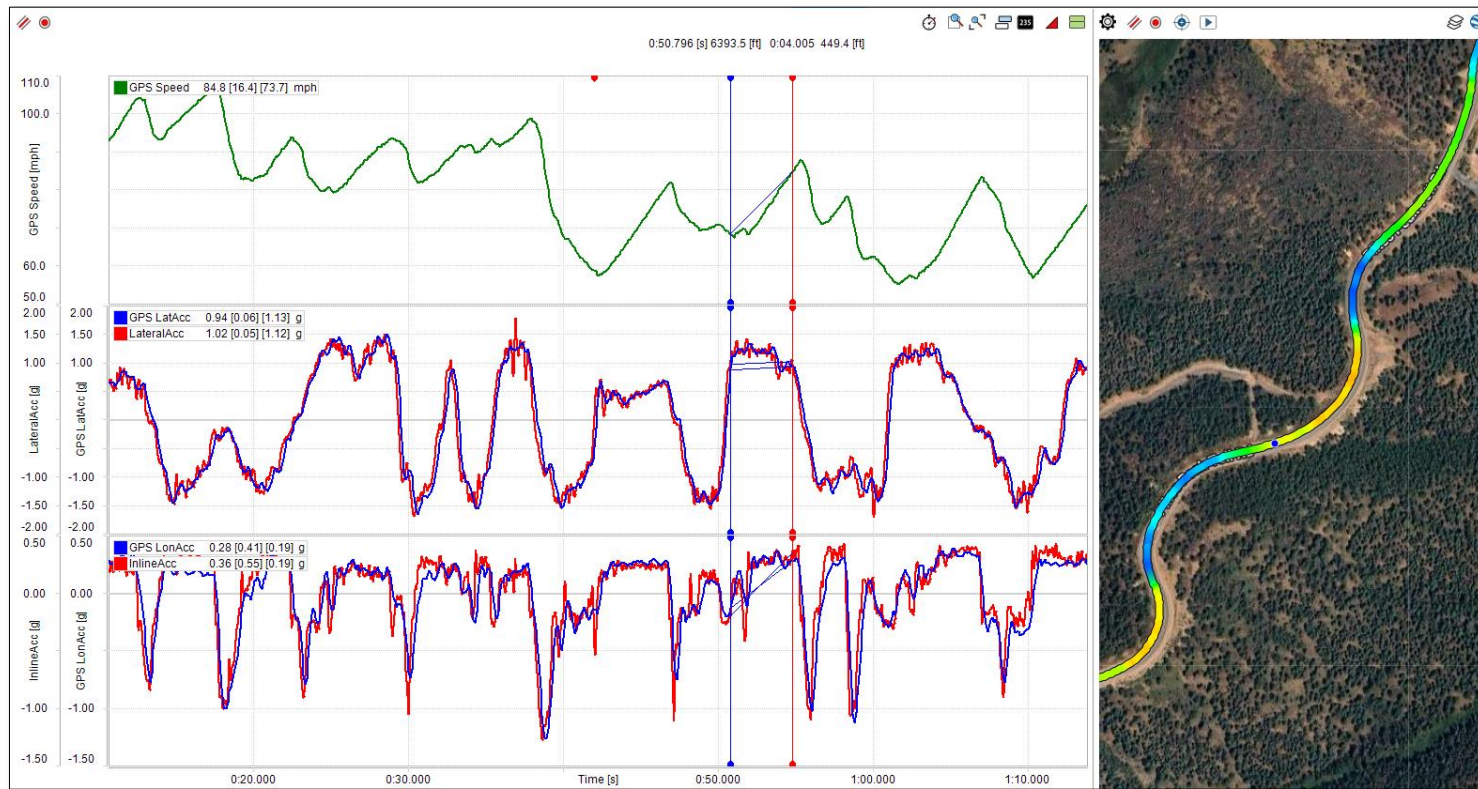
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Next AiM Sports Webinar

Tuesday, October 8th, 2024 – 6pm Pac / 9pm East



Accelerometer Data – When, Why, How?



Roger Caddell

AiM Sports - National Training Manager

Next Webinar

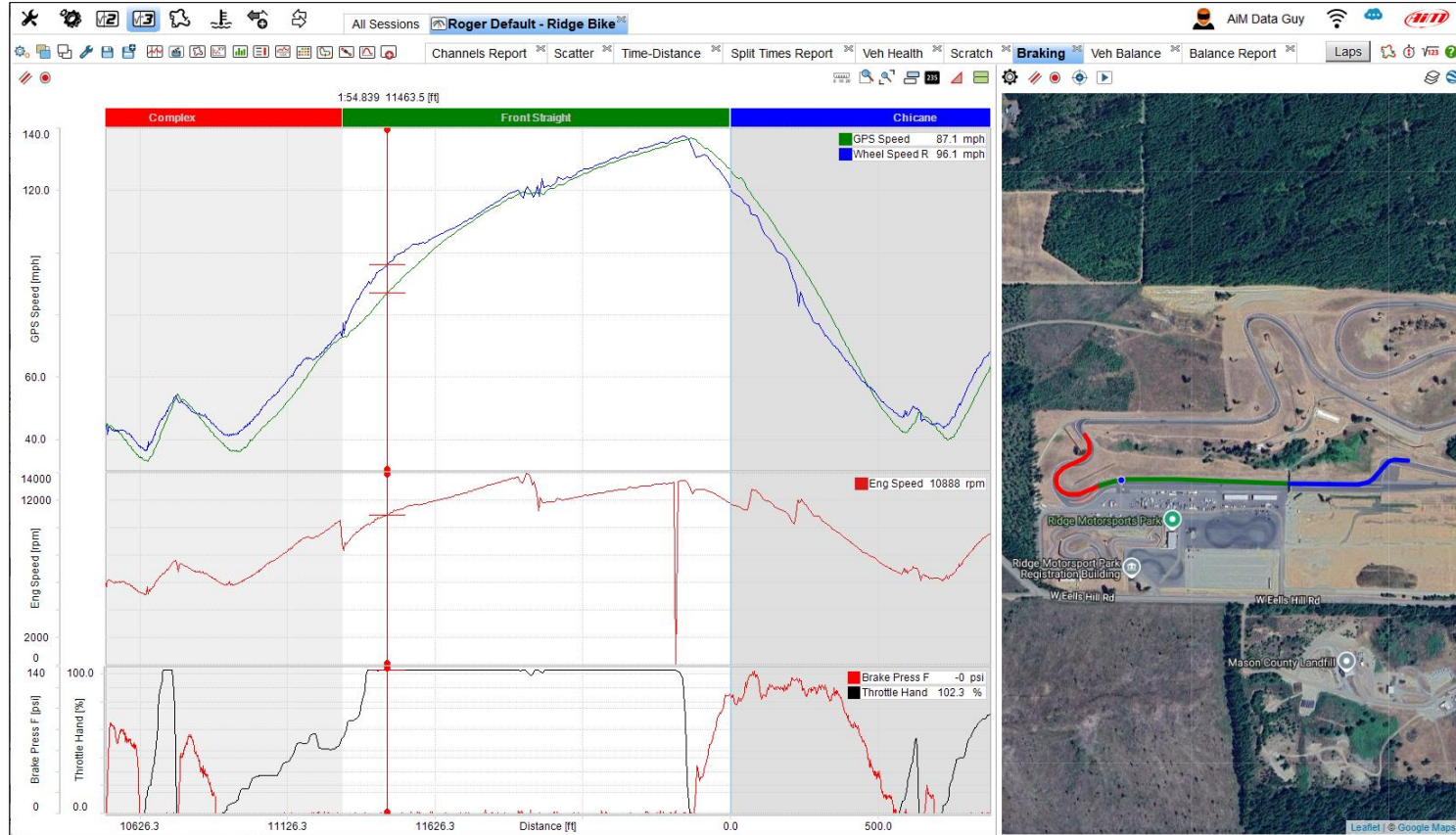
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Contact Information



Host:

Roger Caddell

AiM Sports - National Training Manager
roger@aimsports.com



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