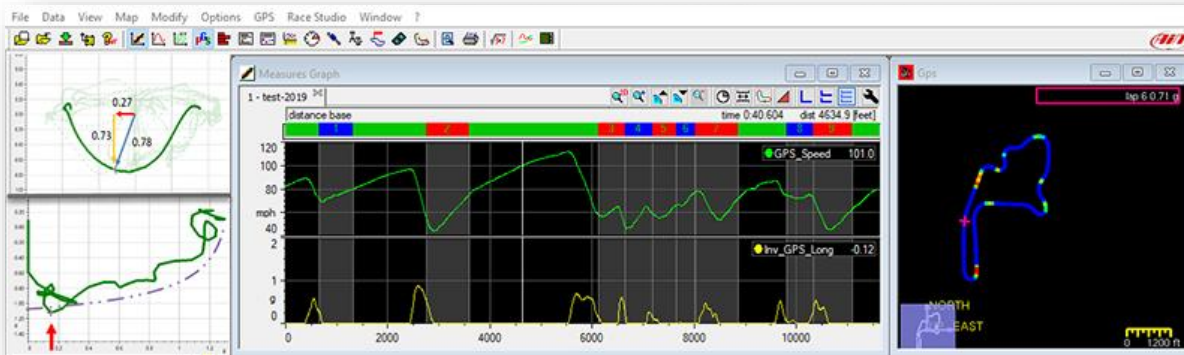




Host: Roger Caddell



Co-Host: Jeremy Lucas

Webinar Series

Bringing Data Support and Training to You

Braking Analysis
with GPS Based Data and Math Channels

April 30rd, 2020

www.aimsports.com



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Jeremy Lucas
Jeremy@fasttechlimited.com
Central Ohio (East Liberty)
614-467-0033
www.FASTtechLimited.com



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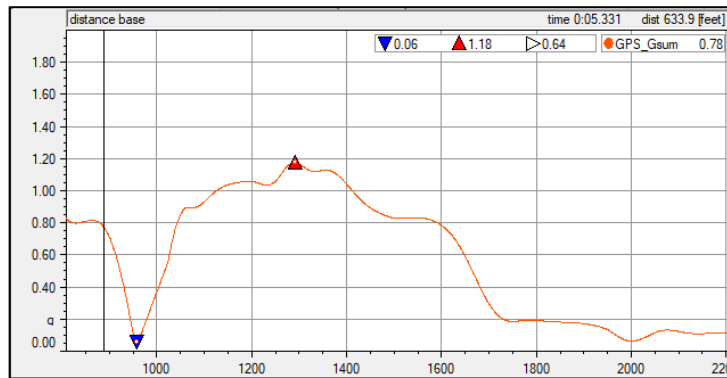
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Math Channel Definitions



GPS_Gsum

Textbook Formula:

$$Gsum = \sqrt{G_{long}^2 + G_{lat}^2}$$

AIM Formula Using GPS variables:

$$\text{sqrt}((\text{GPS_LonAcc}^2) + (\text{GPS_LatAcc}^2))$$

Green = Math Formula, Blue = Measured Value, Red = Constant

Math channels

General 1 - DriverA-Toyo 2 - DriverB-Toyo

Delete Insert

Channel parameters

Name: GPS_Gsum

Unit of measure: 9

Full scale: 2

Zero scale: 0

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel

☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Formula

sqrt((GPS_LonAcc^2)+(GPS_LatAcc^2))

Test channel

Formule construction

Constants:

KM2MI

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Internal Battery

RPM

InlineAcc

LateralAcc

VerticalAcc

RollRate

PitchRate

YawRate

GPS_Speed

GPS_Nsat

Symbols & operators

+ - * / ^

Functions:

sqrt exp log ln sin cos tan asin atan abs deriv integ

Import set

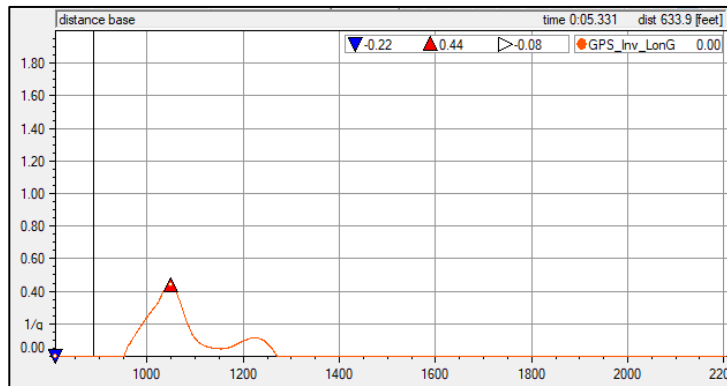
Export set

Default AIM set

Cancel

OK

Math Channel Definitions



GPS_Inv_LonG

Textbook formula:

$$\text{Inv } G_{long} = -G_{long}$$

AIM formula using GPS variables:

-GPS_LonAcc

Green = math formula, Blue = measured value, Red = constant

Math channels

General 1 - DriverA-Toyo 2 - DriverB-Toyo

Delete Insert

Channel parameters

Name: GPS_Inv_LonG

Unit of measure: 1/g

Full scale: 2

Zero scale: 0

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel

☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Formula

-GPS_LonAcc

Test channel

Formule construction

Constants:

KM2MI

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Internal Battery

RPM

InlineAcc

LateralAcc

VerticalAcc

RollRate

PitchRate

YawRate

GPS_Speed

GPS_Nsat

Symbols & operators

+

-

*

/

^

'

(

)

Functions:

sqrt

exp

log

ln

sin

cos

tan

asin

acos

atan

abs

deriv

integ

ln, integ

Import set

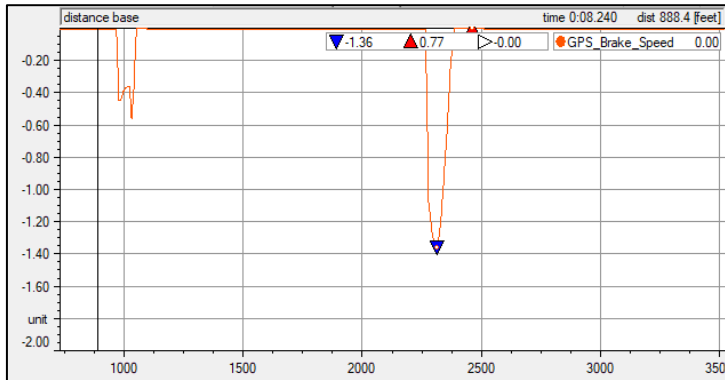
Export set

Default AIM set

Cancel

OK

Math Channel Definitions



GPS_Brake_Speed (or Braking Aggressiveness)

Textbook formula:

$$\text{Brake Speed} = \frac{d(\text{LongG})}{d(\text{time})}$$

= Derivative of
LongG over Time

AIM formula using GPS variables,
& only when LongG is less than -0.15:

IF(LT(GPS_LonAcc,-0.15),deriv(GPS_LonAcc),0)

Green = math formula, Blue = measured value, Red = constant

Math channels

General 1 - DriverA-Toyo 2 - DriverB-Toyo

Delete Insert

Channel parameters

Name: GPS_Brake_Speed

Unit of measure: unit

Full scale: 0

Zero scale: -2

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Formula

IF(LT(GPS_LonAcc,-0.15),deriv(GPS_LonAcc),0)

Test channel

Formule construction

Constants:

KM2MI

MM2IN

MI2KM

KMH2MS

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Internal Battery

RPM

InlineAcc

LateralAcc

VerticalAcc

RollRate

PitchRate

YawRate

GPS_Speed

GPS_Nsat

Symbols & operators

+ - * / ^ ()

Functions:

sqrt exp log ln sin cos tan asin acos atan abs deriv integ

Import set

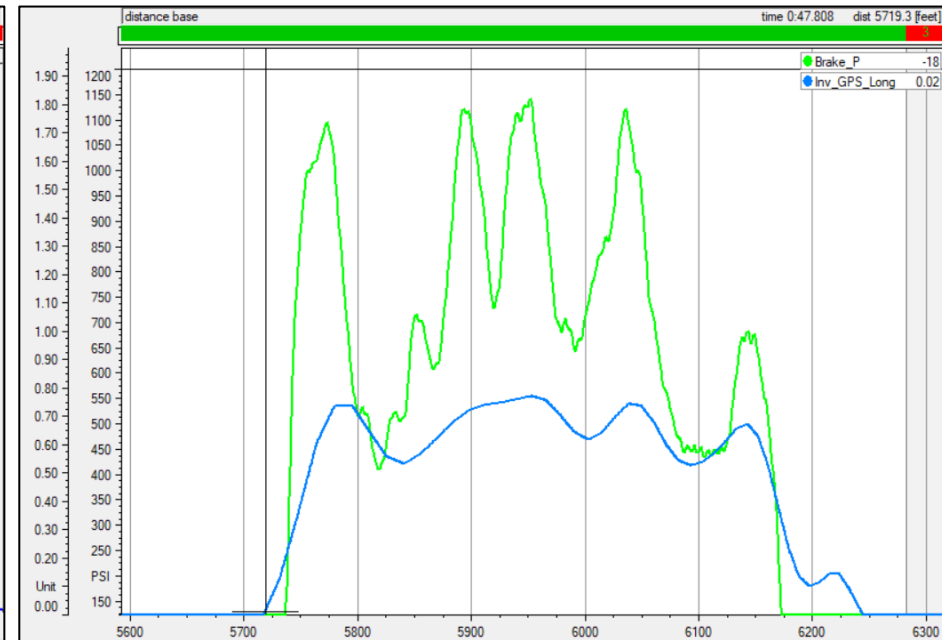
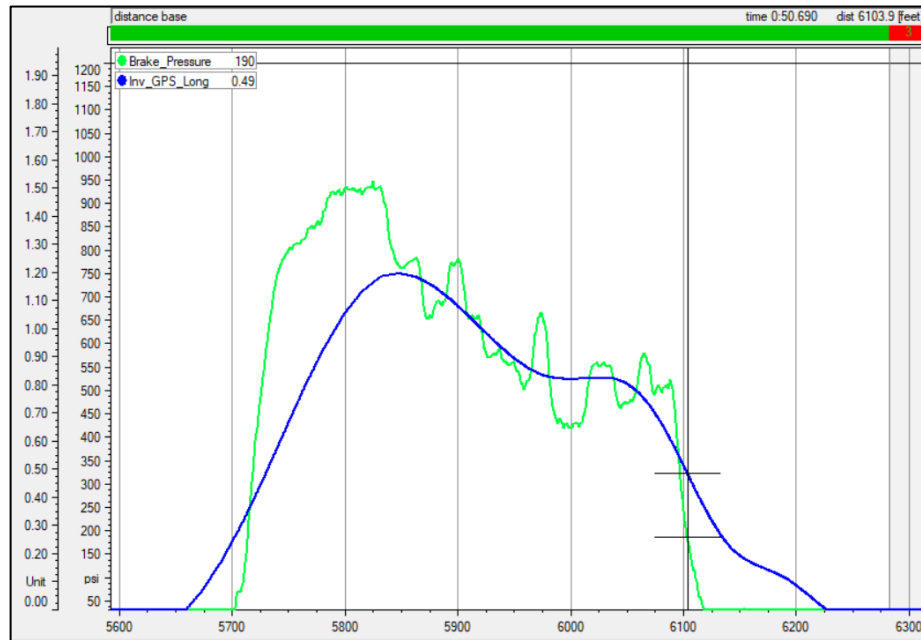
Export set

Default AIM set

Cancel

OK

GPS_Inv_LonG vs Brake Pressure



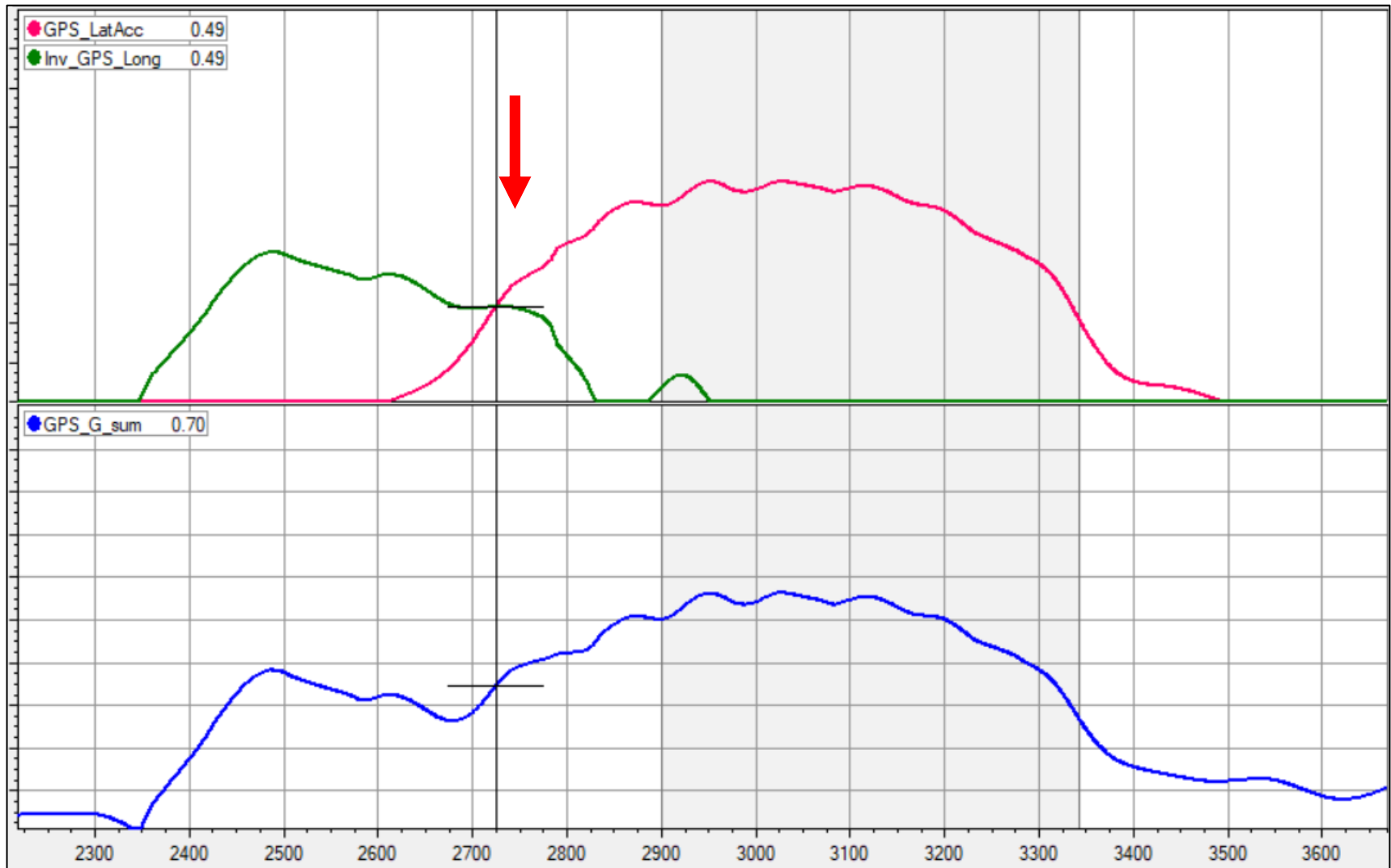
Driver A: on Hoosiers, 126mph at Braking Initiation

Better Modulation Control

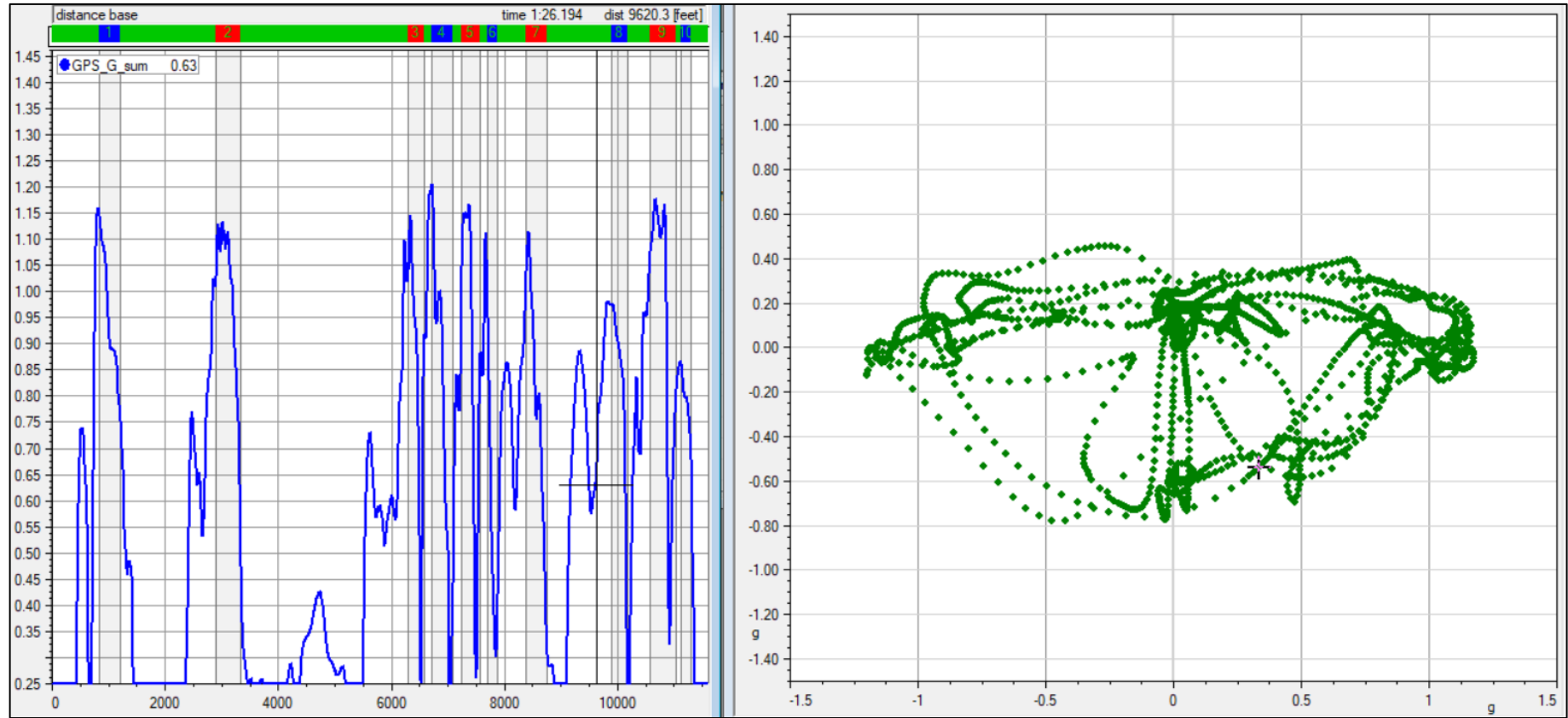
Driver B: on Toyo RR, 111mph at Braking Initiation

Lots of Hunting for the Limit

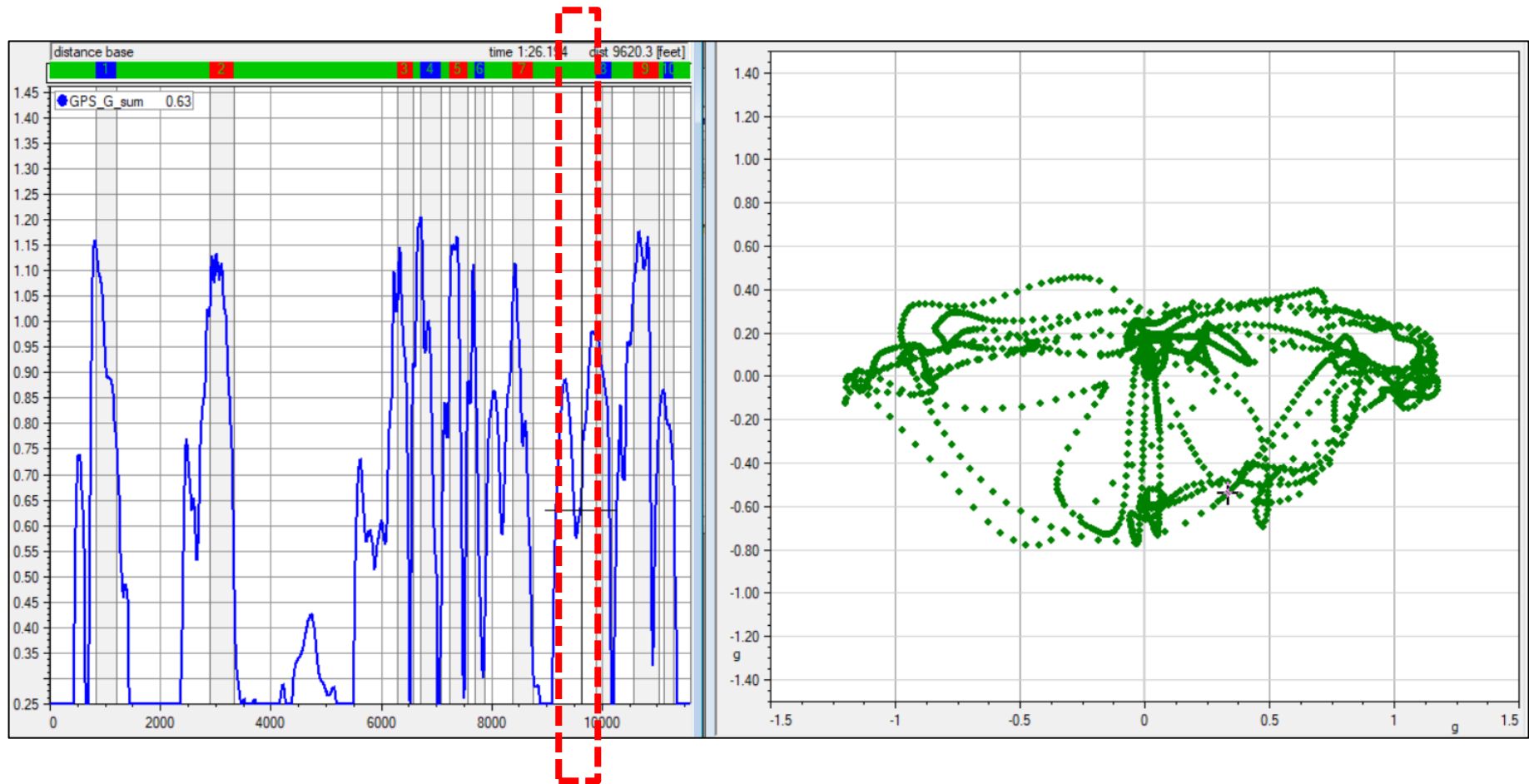
GPS_Gsum vs GPS_LatAcc & GPS_Inv_LonG



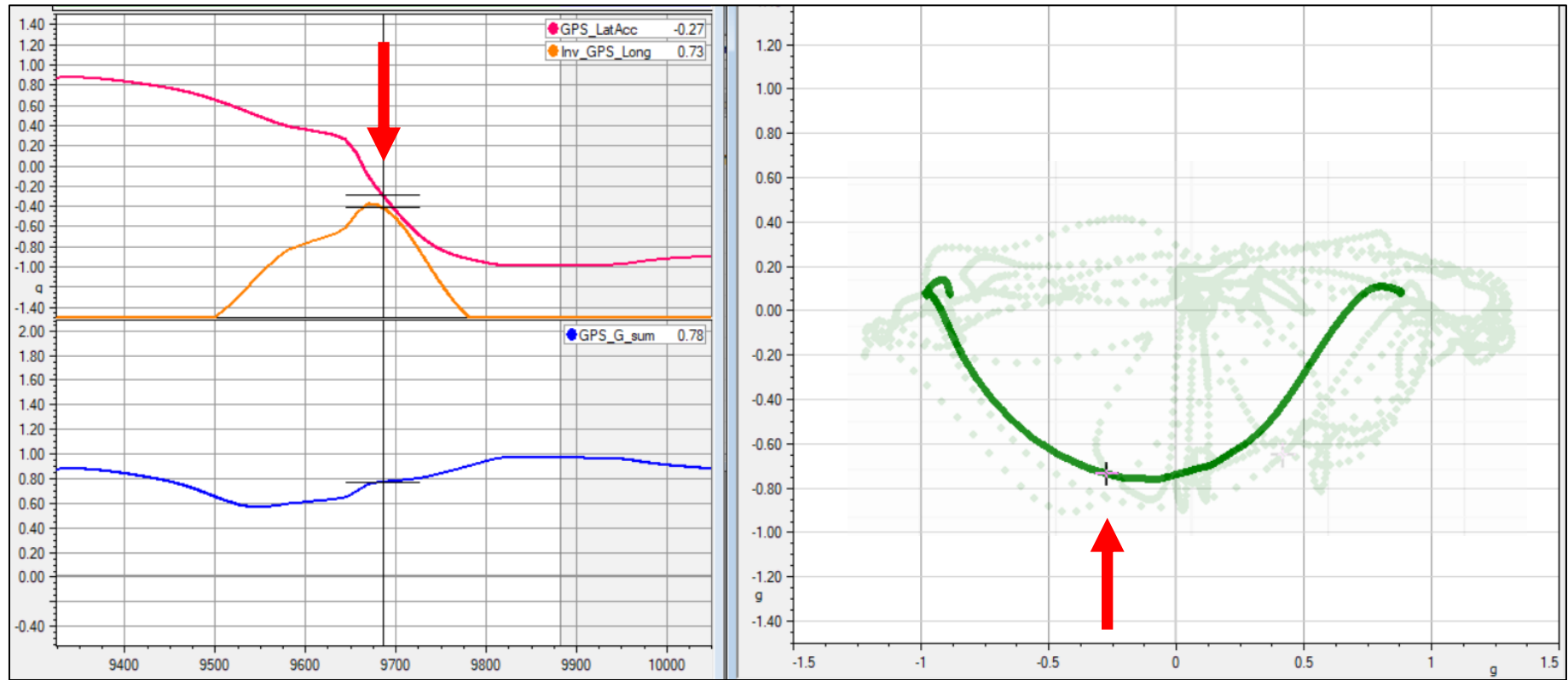
GPS_Gsum vs Friction Circle



GPS_Gsum vs Friction Circle

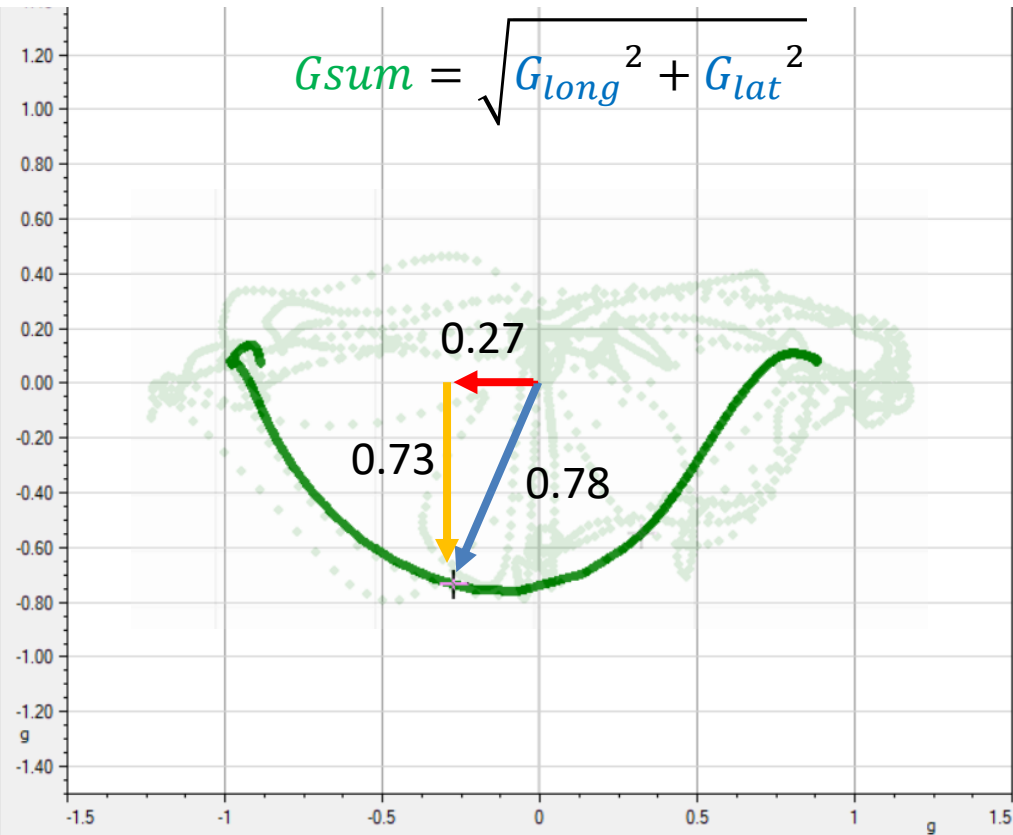
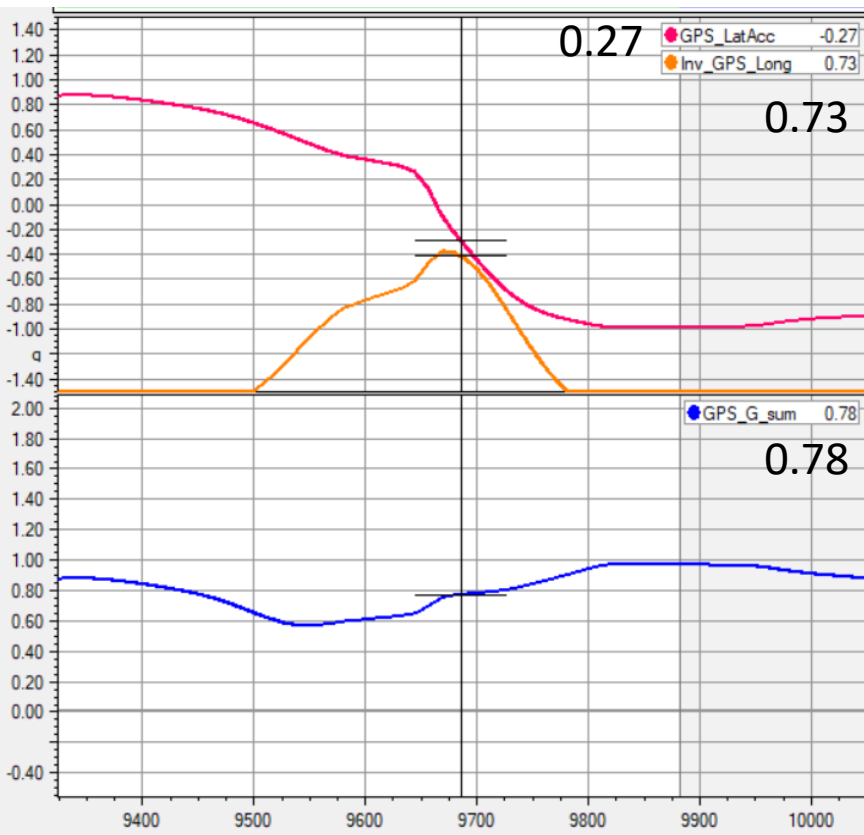


GPS_Gsum vs Friction Circle

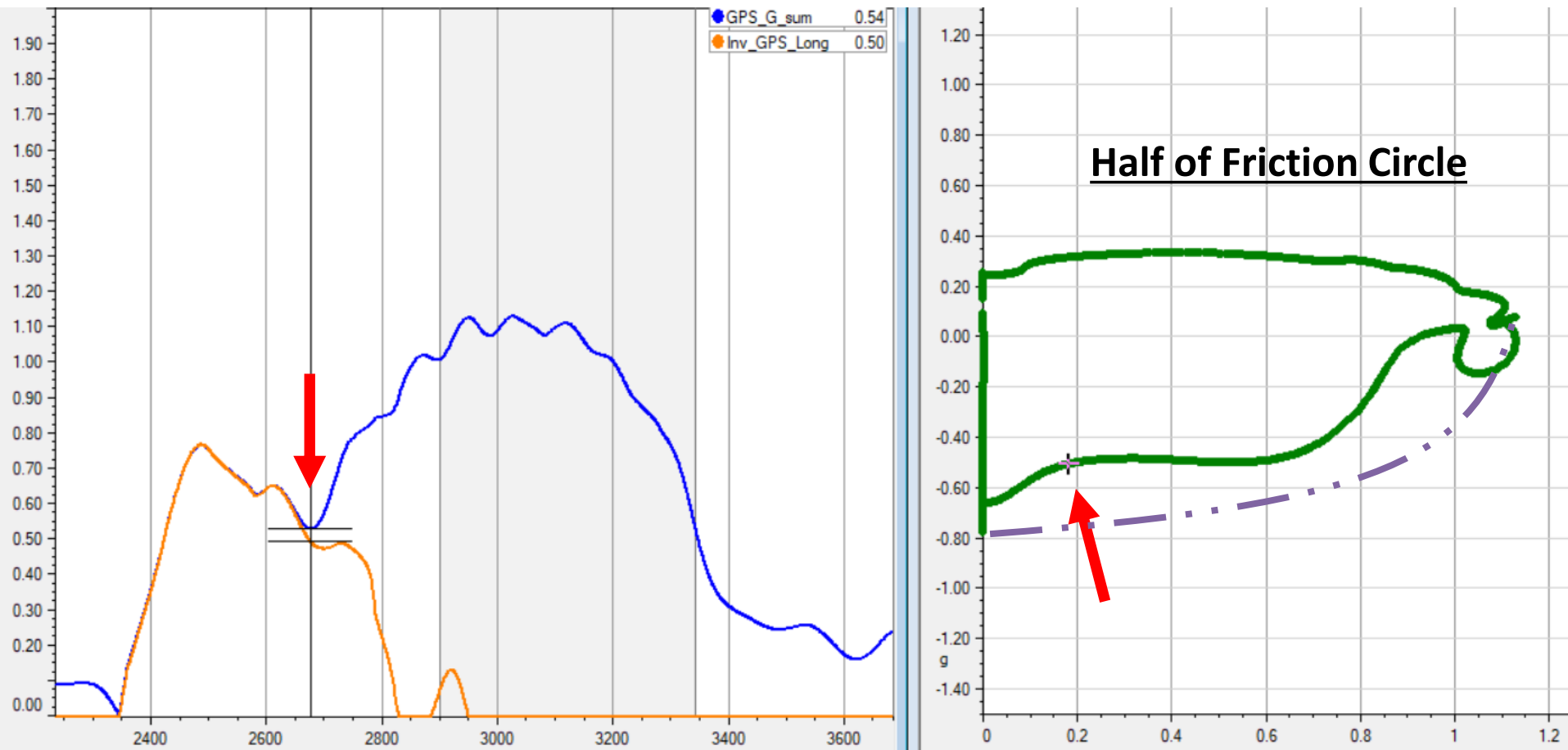


GPS_Gsum vs Friction Circle

$$a^2 + b^2 = c^2$$



Putting the Pieces Together

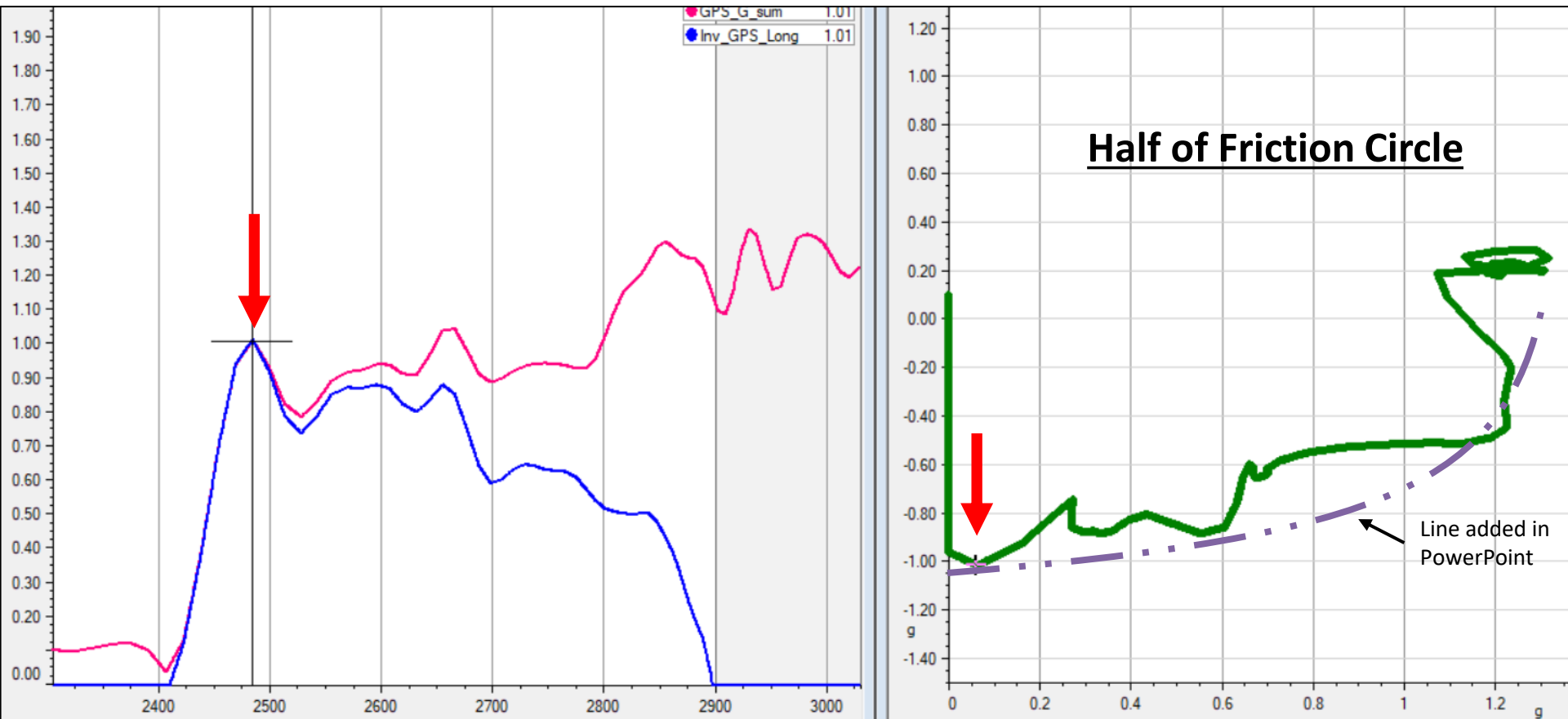


Driver C: Keyhole at MidOhio, Giving up Available Tire Usage

→ Typically This Means he Could Have Braked Later

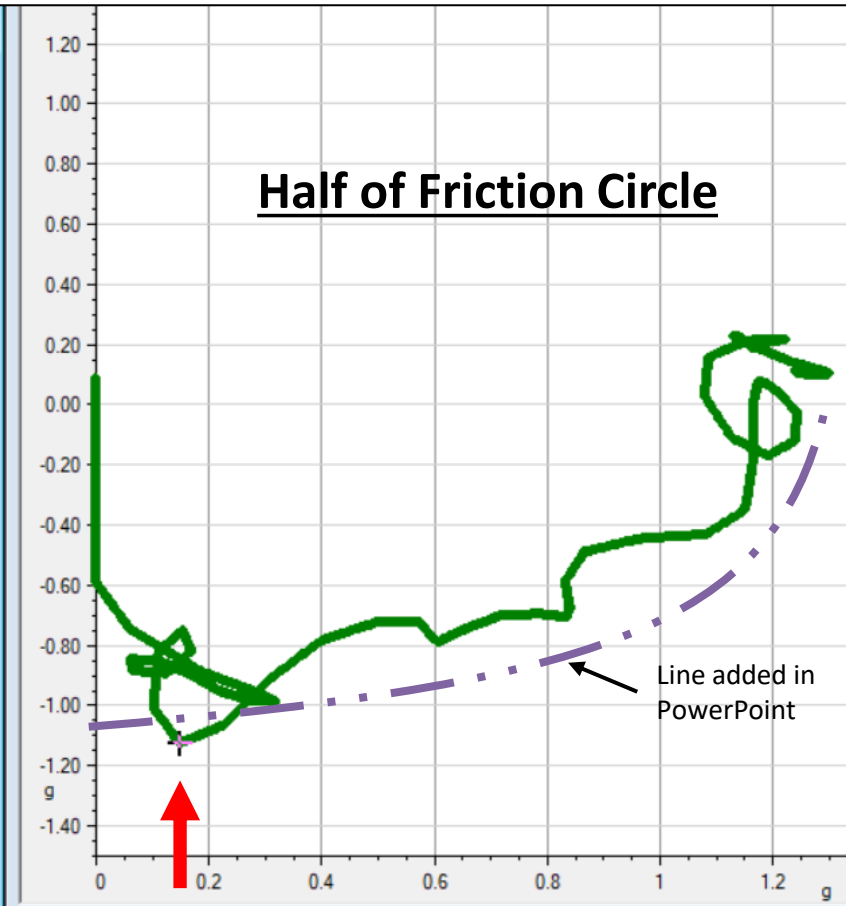
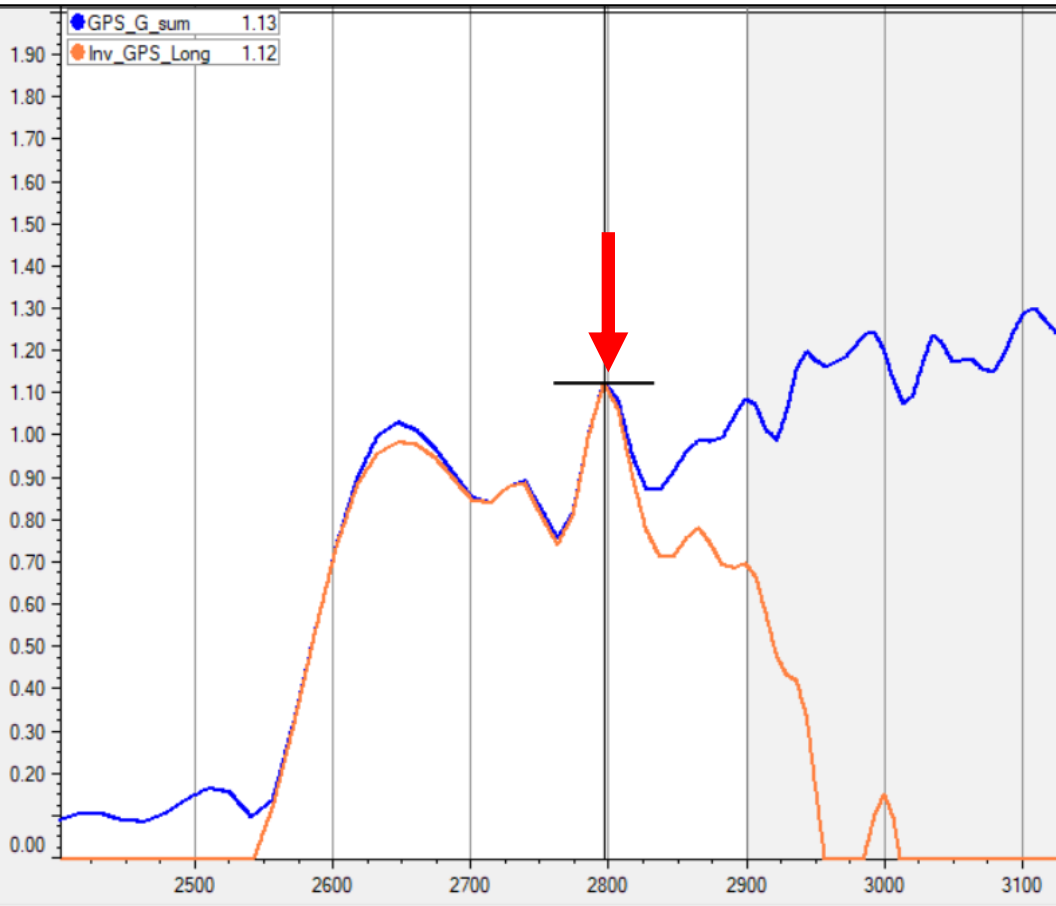
→ However in This Case it was in the Rain!!! (Be Careful of the Assumptions You Make)

Putting the Pieces Together



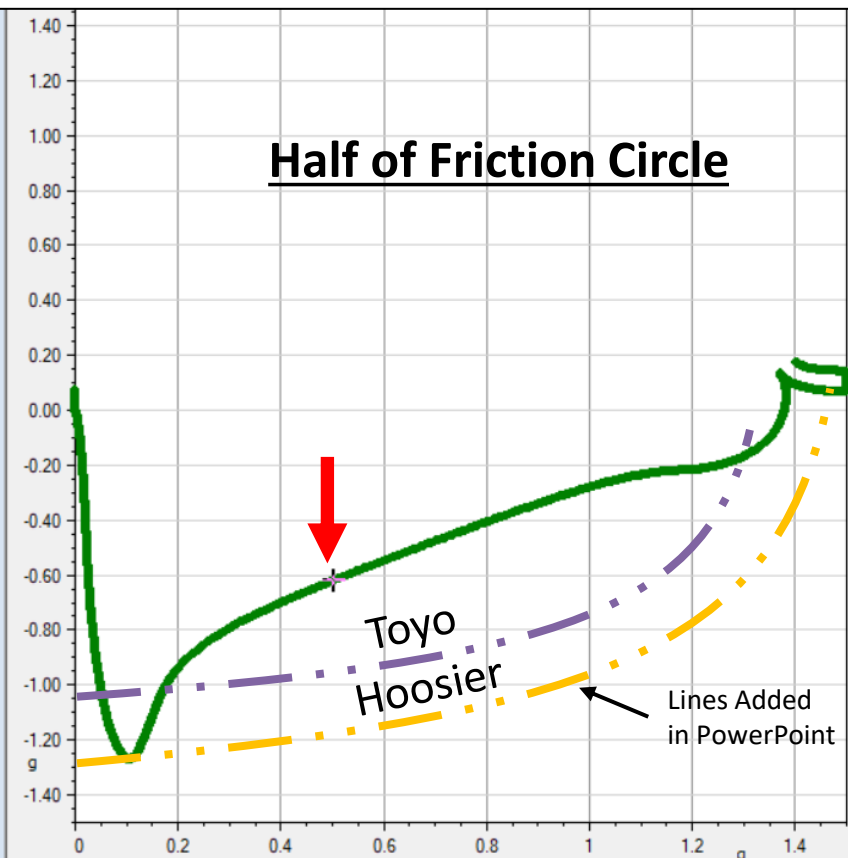
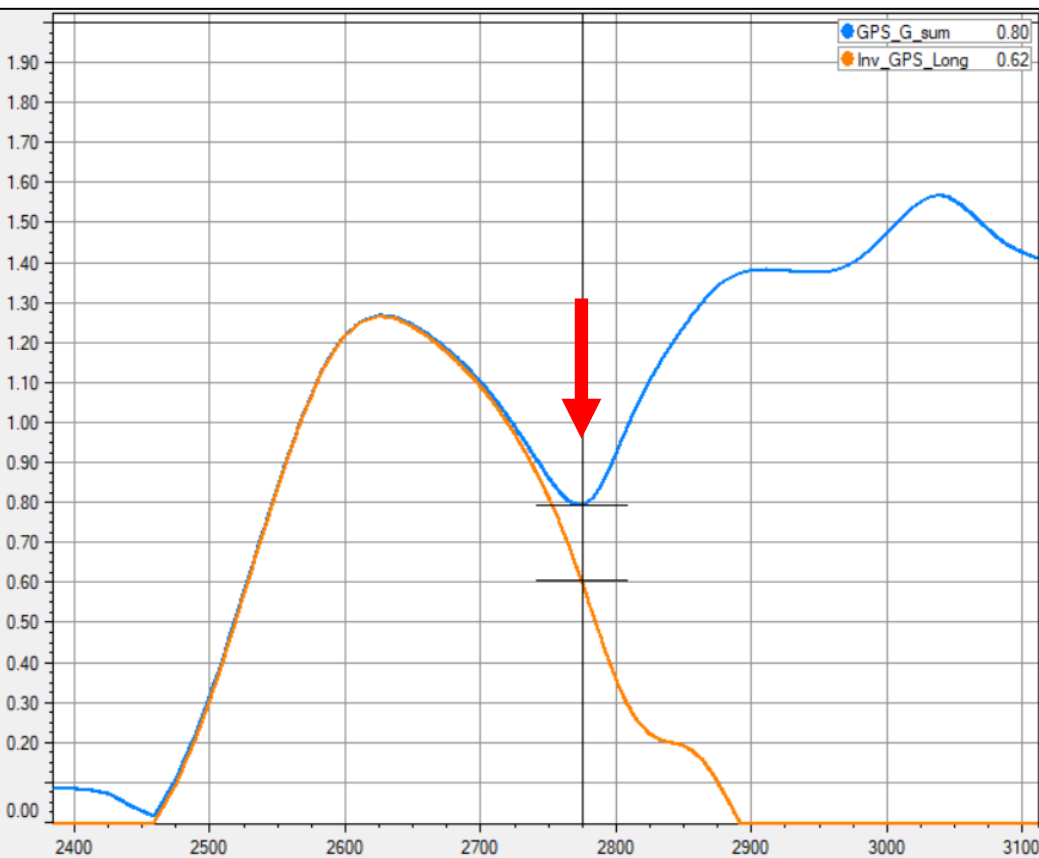
Driver C: on Toyo RRs at the Keyhole at MidOhio, not in the Rain

Putting the Pieces Together



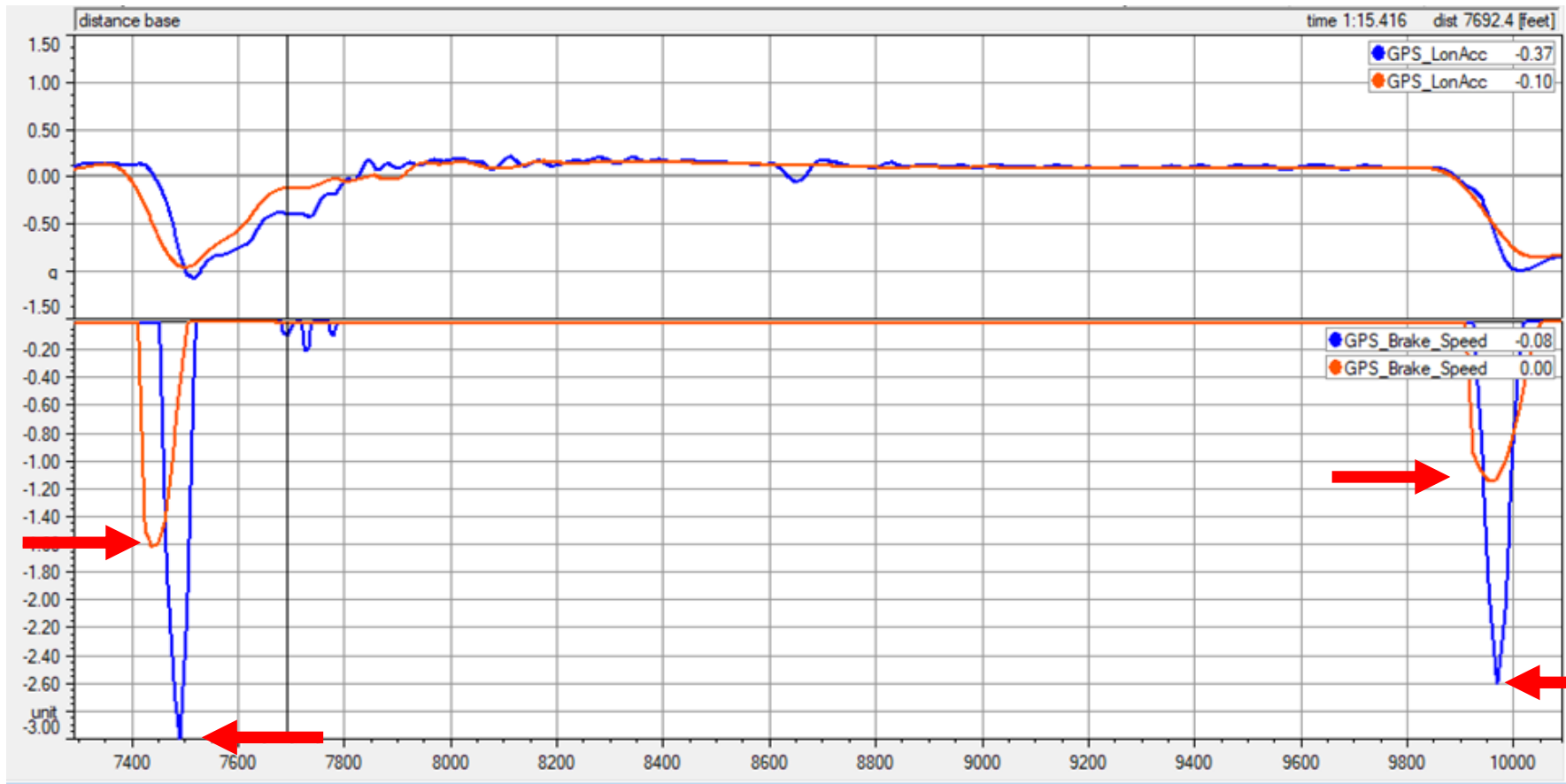
Driver D: Same Car as C, Keyhole at MidOhio
→ Kept the Same Purple Outline Trace

Putting the Pieces Together



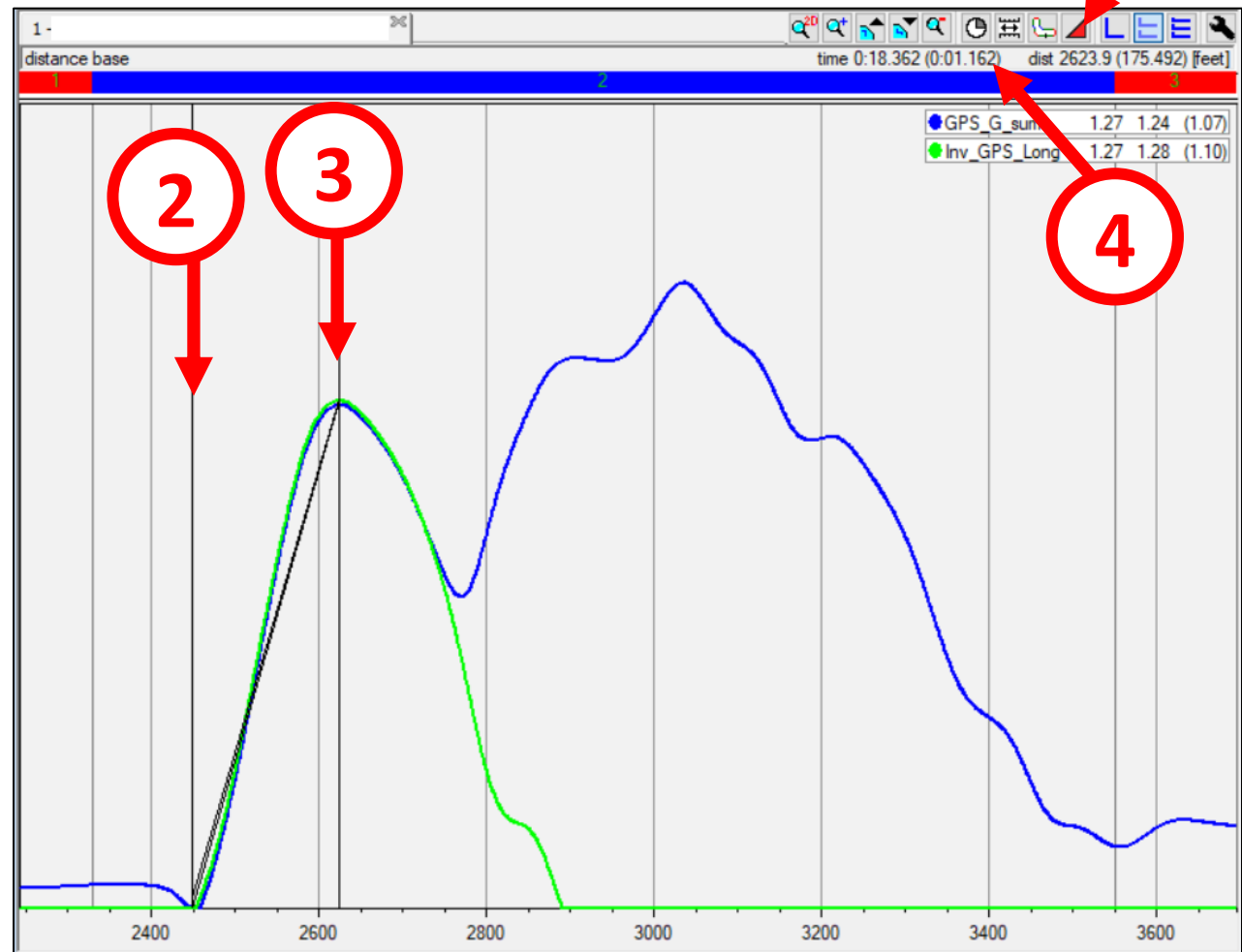
Driver A: on Hoosiers, Keyhole at MidOhio
→ Kept the Same Purple Outline Trace

GPS_Brake_Speed (Brake Aggression)



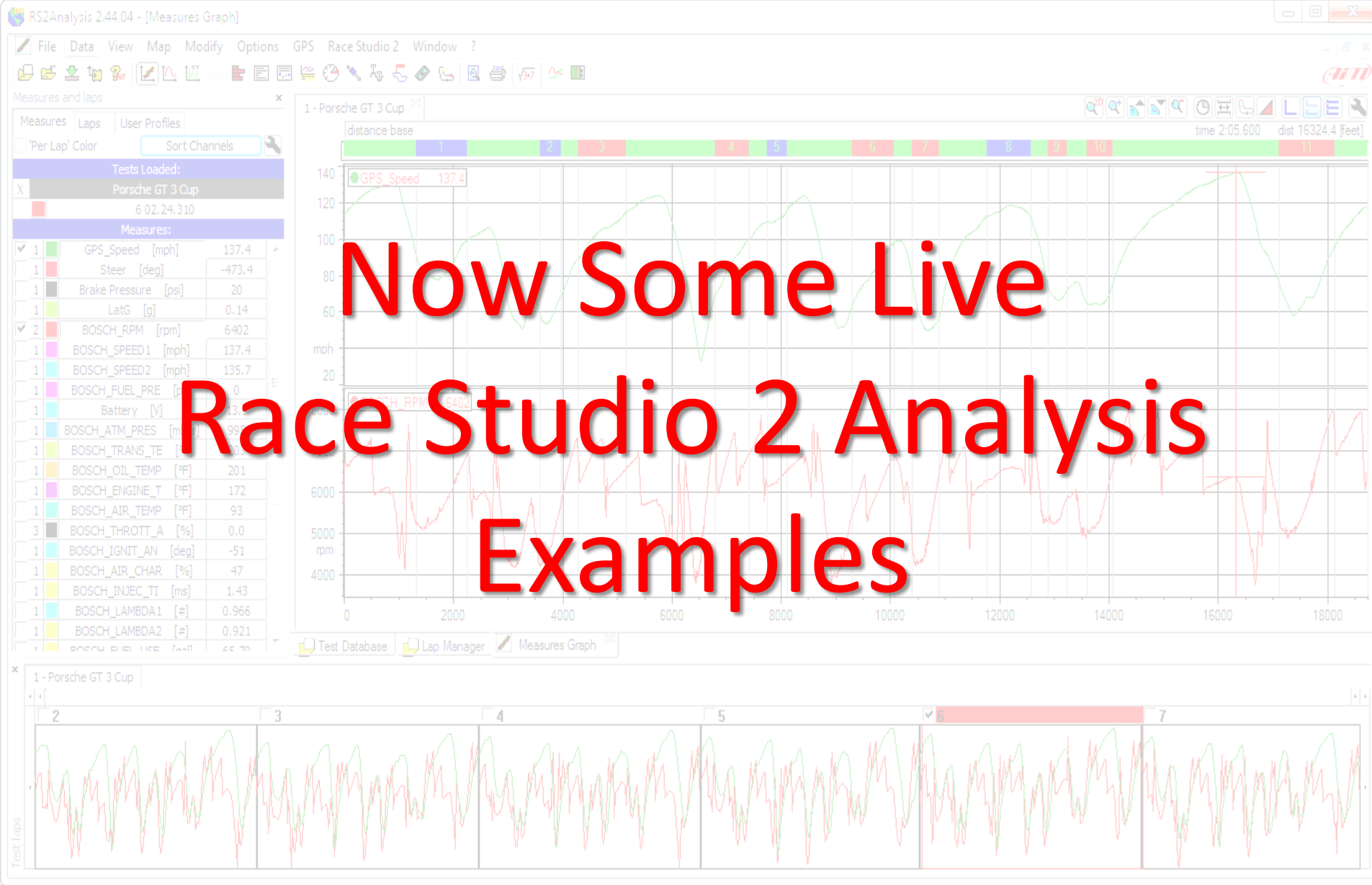
Unitless Measure of How Fast GPS_Long Builds Up
Comparative Between Similar Circumstances

Time To Full Brake?

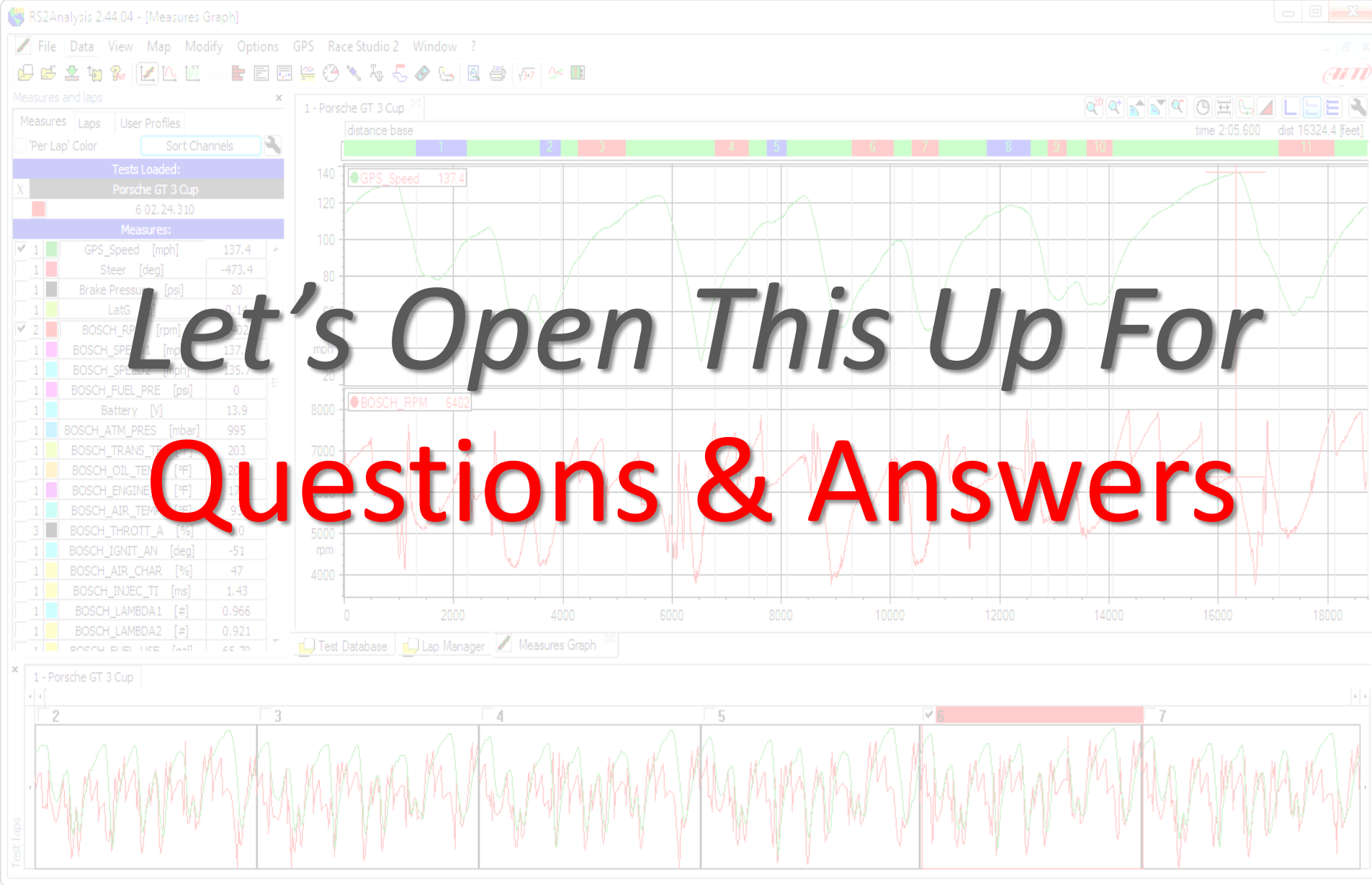


Can be Measured Using the Delta Function on the Measures Graph.
0.5 seconds is FAST!

- 1) Click Delta
- 2) Click Start Point
- 3) Click End Point
- 4) Time Delta in (xx)



Now Some Live Race Studio 2 Analysis Examples



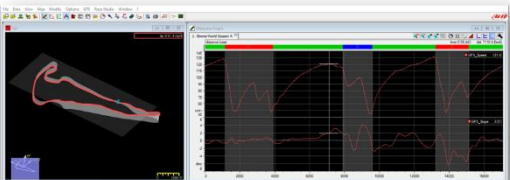
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bimmerworld
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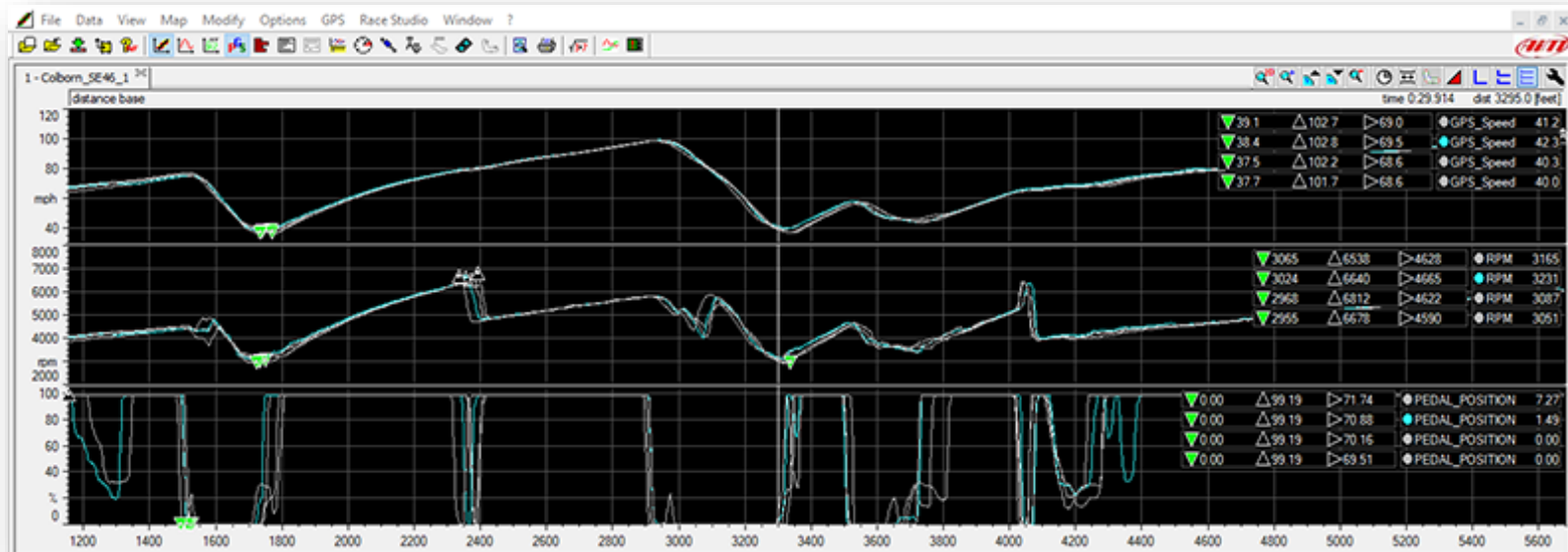
Tuesday May 5th, 2020

10:00am Pac / 1:00pm East

Co-Host: James Colborn

www.jamescolborn.com

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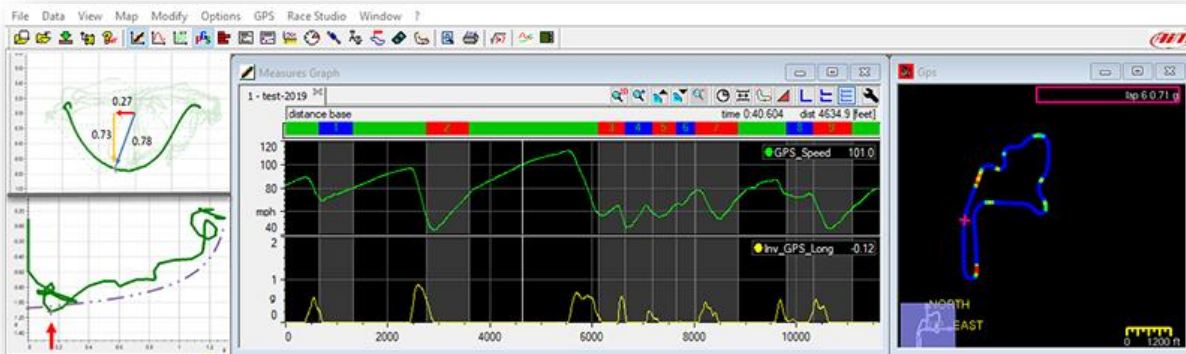


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