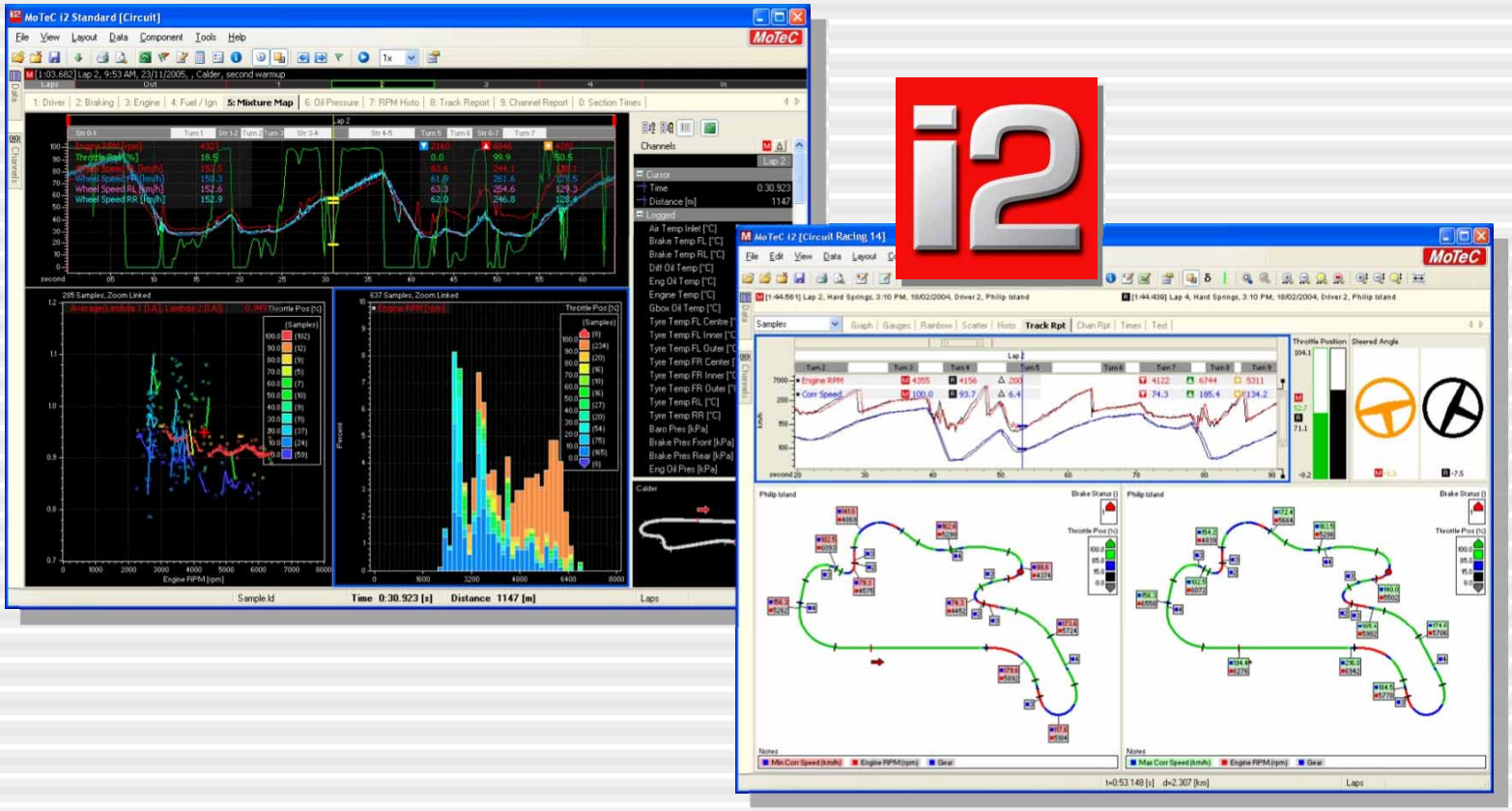
MoTeC

i2 Data Analysis Seminar



Topics

- About MoTeC
- Introduction to *i2*
- Displaying data
- Track editing
- Reading traces
- Evaluating Driver Performance
- Evaluating Chassis Performance
- Data Maintenance
- Any Questions?

MoTeC the Company

- Since 1987
- Australian owned
- Motorsport focus
- Over 200 dealers
- 40+ Staff on site

Meet the Team

Support Engineers at MoTeC's Research Centre in Australia

Darren Reynolds

Mark McCoy

Peter Swinney

David Chandler

Omar Khan

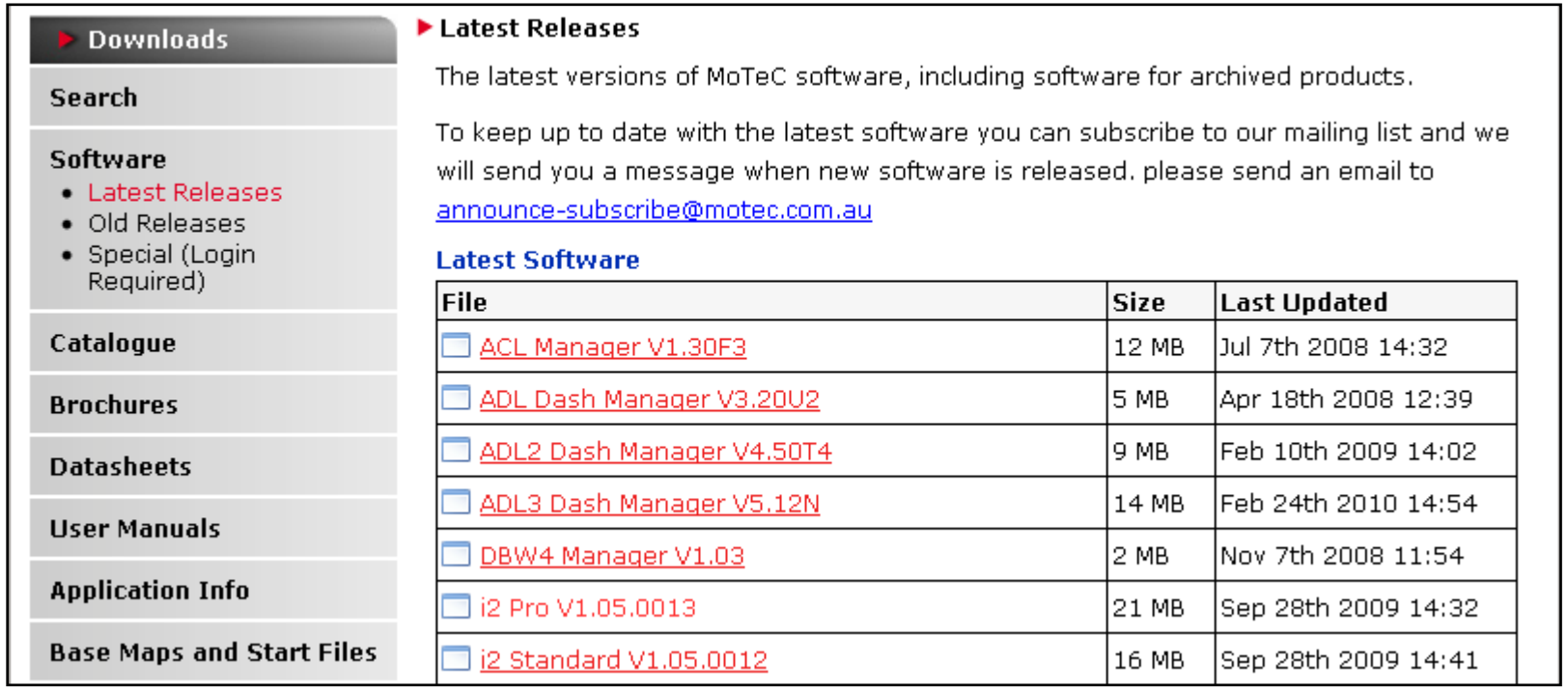
Duane Mitchell

Ross Buckingham

Software Download/Installation

- MoTeC software is available for download from the website at:

  http://www.motec.com.au/software/latestreleases



Downloads

Search

Software
- Latest Releases
- Old Releases
- Special (Login Required)

Catalogue

Brochures

Datasheets

User Manuals

Application Info

Base Maps and Start Files

Latest Releases

The latest versions of MoTeC software, including software for archived products.

To keep up to date with the latest software you can subscribe to our mailing list and we will send you a message when new software is released. please send an email to announce-subscribe@motec.com.au

Latest Software

File	Size	Last Updated
ACL Manager V1.30F3	12 MB	Jul 7th 2008 14:32
ADL Dash Manager V3.20U2	5 MB	Apr 18th 2008 12:39
ADL2 Dash Manager V4.50T4	9 MB	Feb 10th 2009 14:02
ADL3 Dash Manager V5.12N	14 MB	Feb 24th 2010 14:54
DBW4 Manager V1.03	2 MB	Nov 7th 2008 11:54
i2 Pro V1.05.0013	21 MB	Sep 28th 2009 14:32
i2 Standard V1.05.0012	16 MB	Sep 28th 2009 14:41

i2 Standard vs i2 Pro

i2 Standard

- Single overlay lap
- Simple maths functions
  - Corrected speed / distance
  - Filter, scale and offset
  - + - * /
- 15 Worksheets
- 5 time/distance graphs
- 10 Channels per graph
- 5 Outing graphs
- 2 Histograms
- 1 Scatter plot
- 1 Mixture map
- 1 Track Report
- Section Times

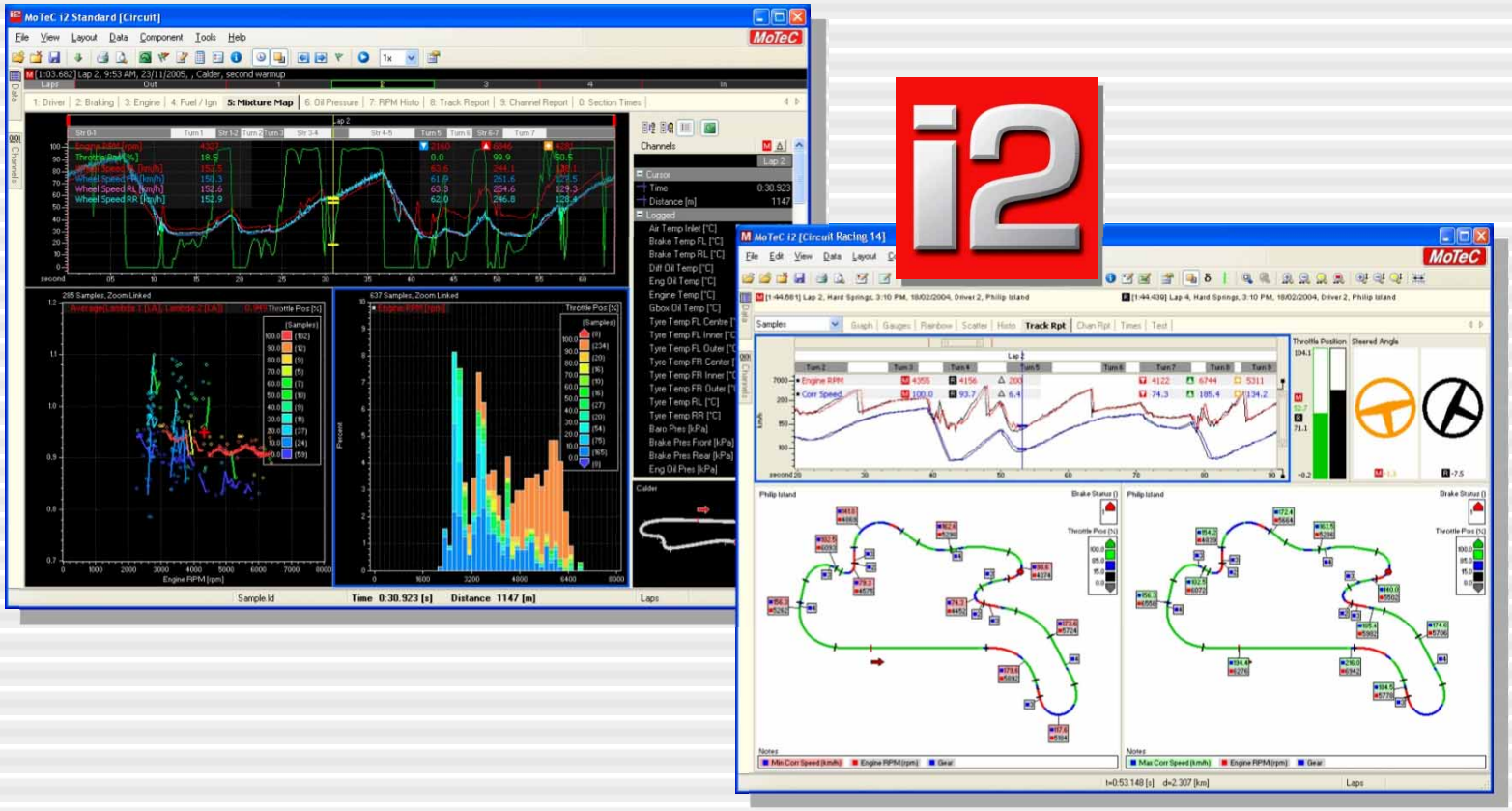
i2 Pro

- Multiple overlay laps
- Advanced mathematics
  - user maths
  - global maths
  - flexible Expressions
- Unlimited display components
- Unlimited workbooks
- Unlimited worksheets
- User definable track sections/sectors
- Lap Reports
- Statistics zoom
- Suspension Analysis
- Video
- Multiple projects

i2 Standard is included, while i2 Pro requires the optional Pro Analysis upgrade.

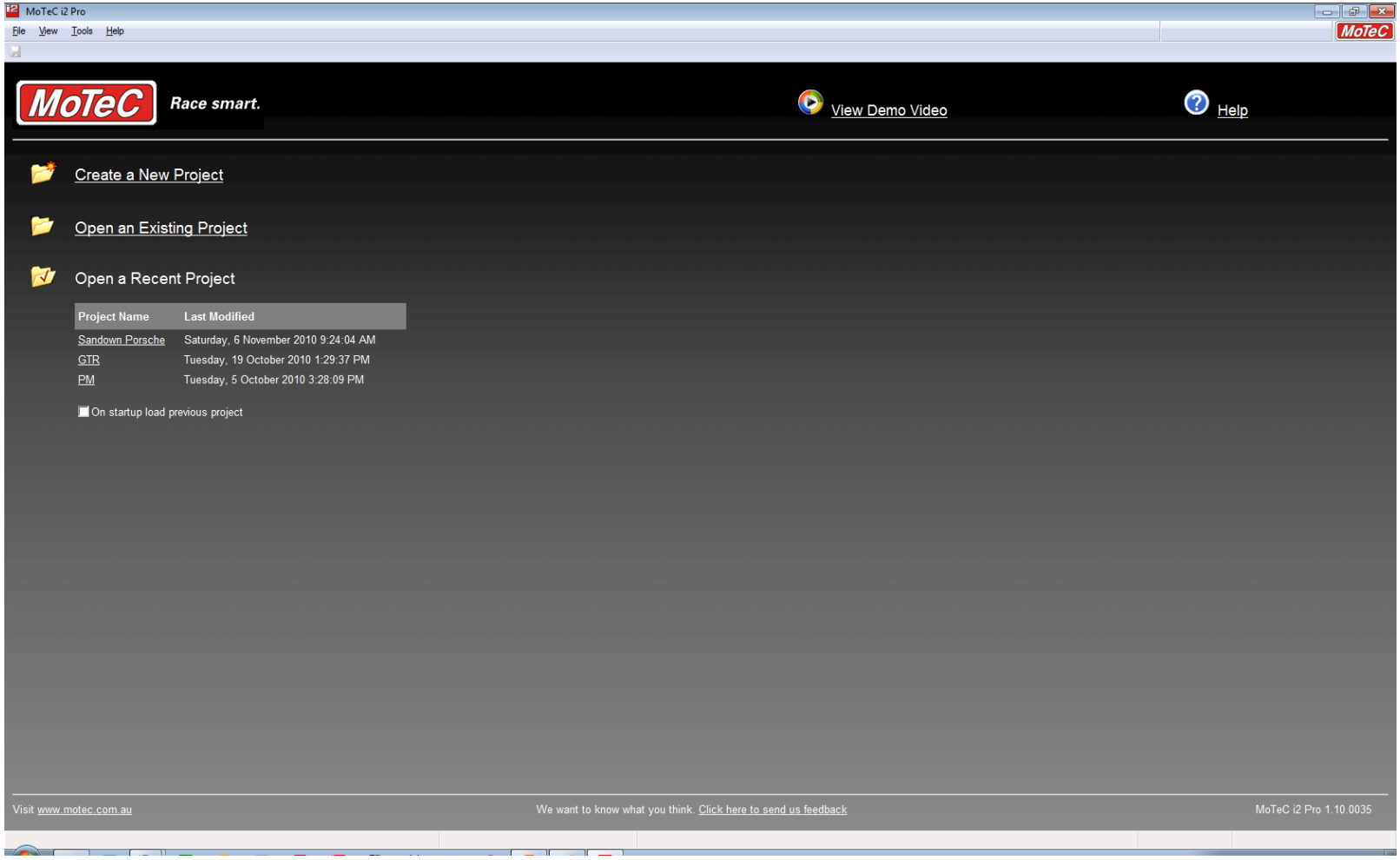
MoTeC

i2 Introduction

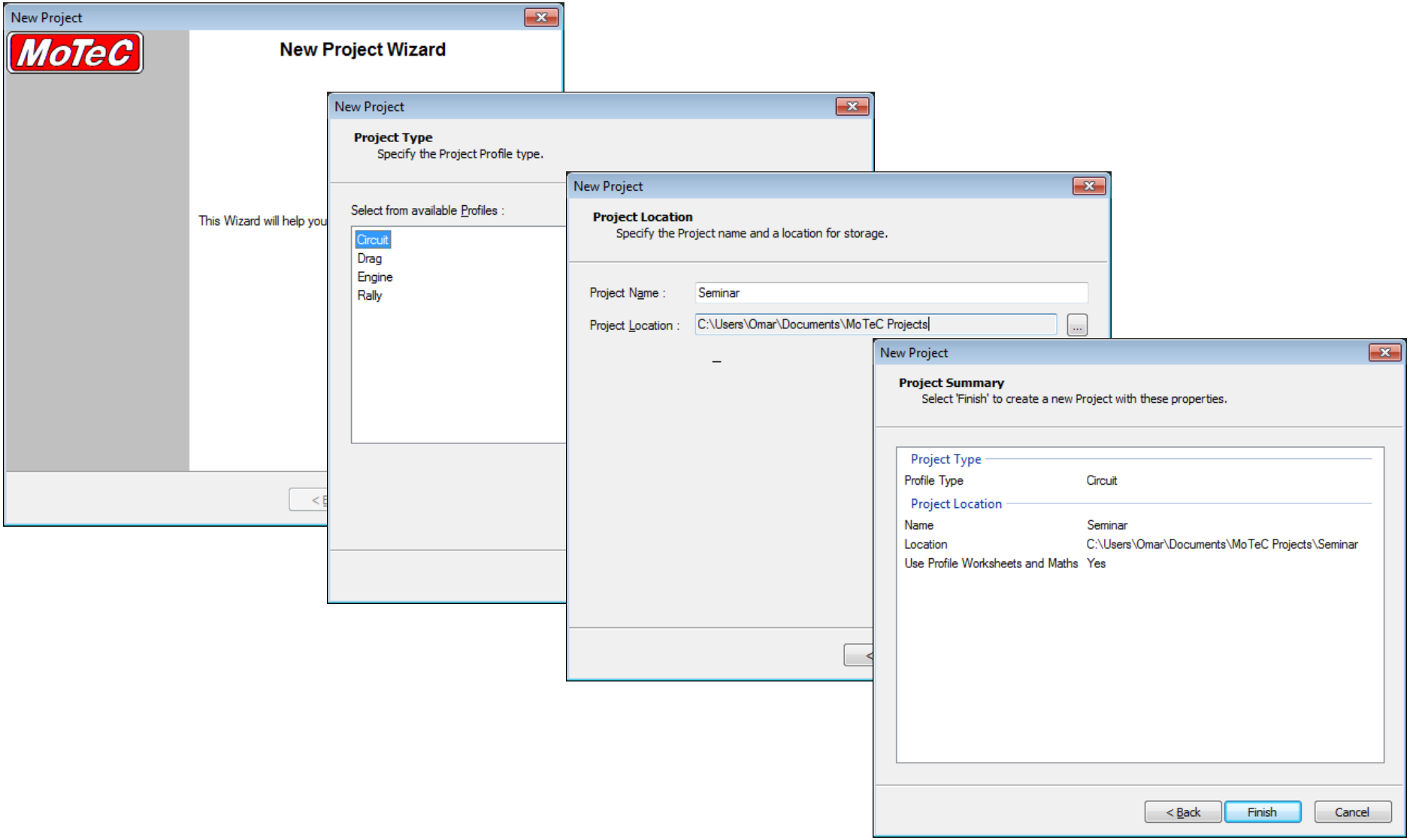


Getting Started

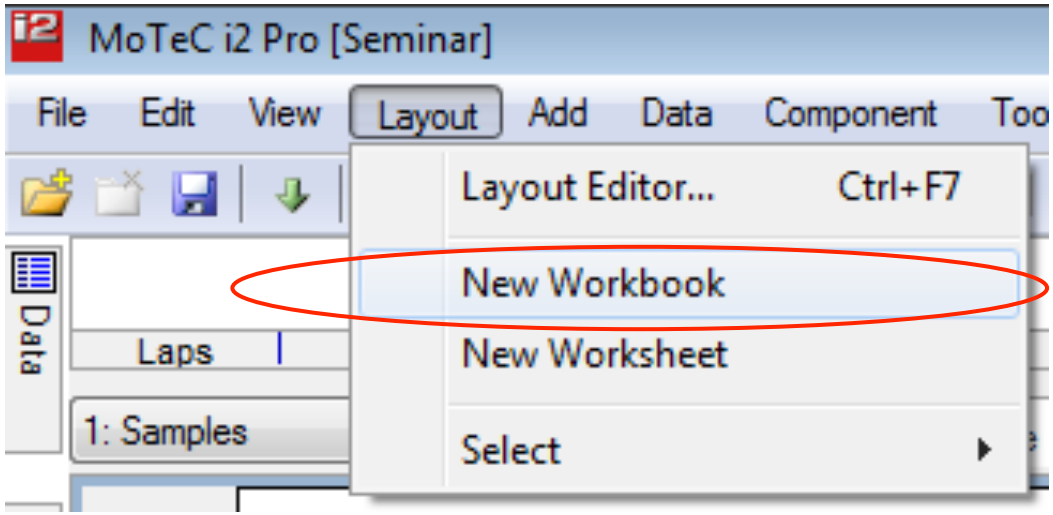
- Double Left click on the MoTeC ***i2 Pro*** Icon on your desktop to start the software

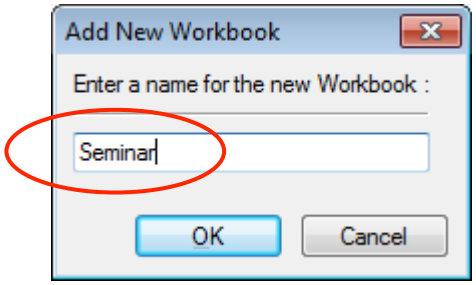


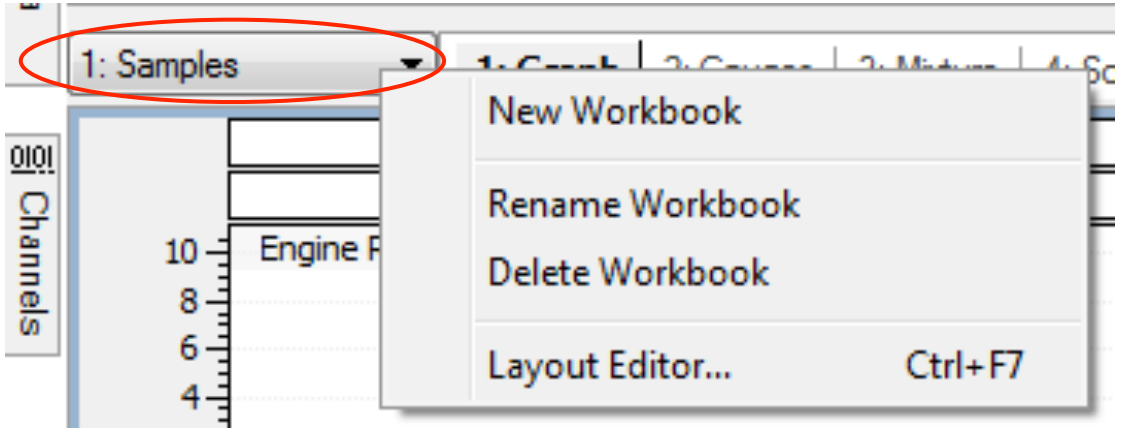
New Project Wizard



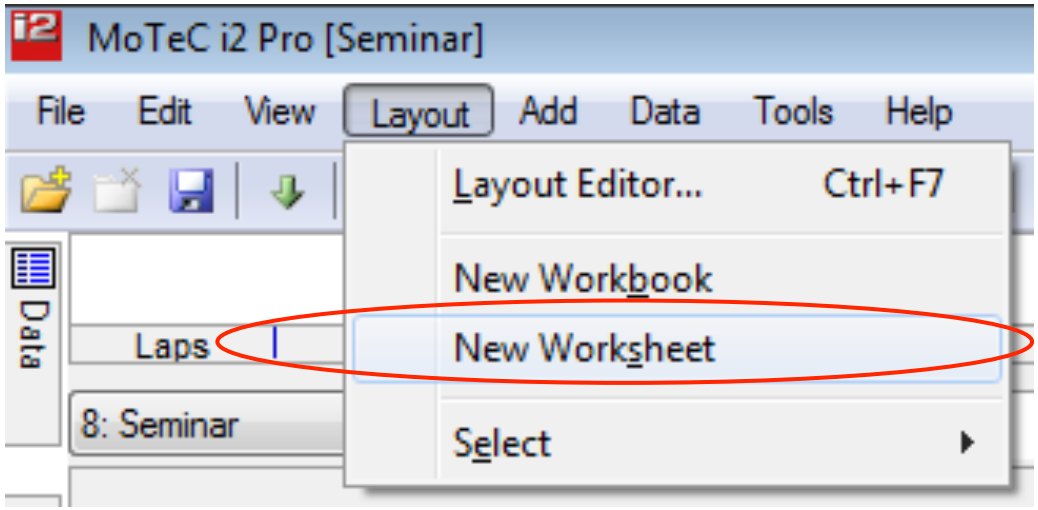
New Workbook

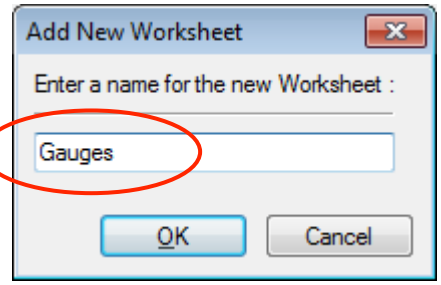


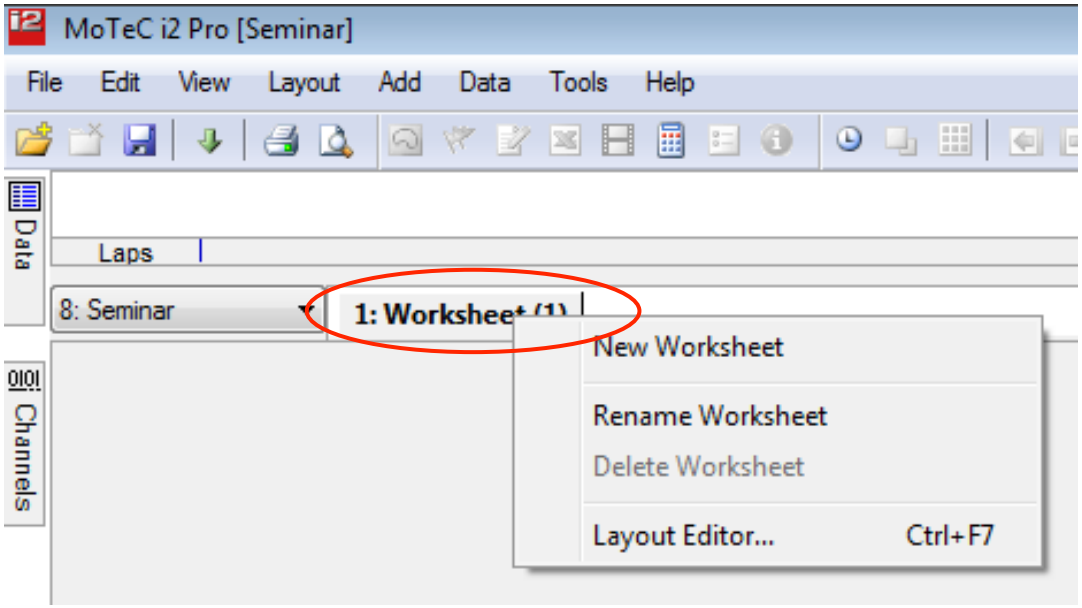




New Worksheet

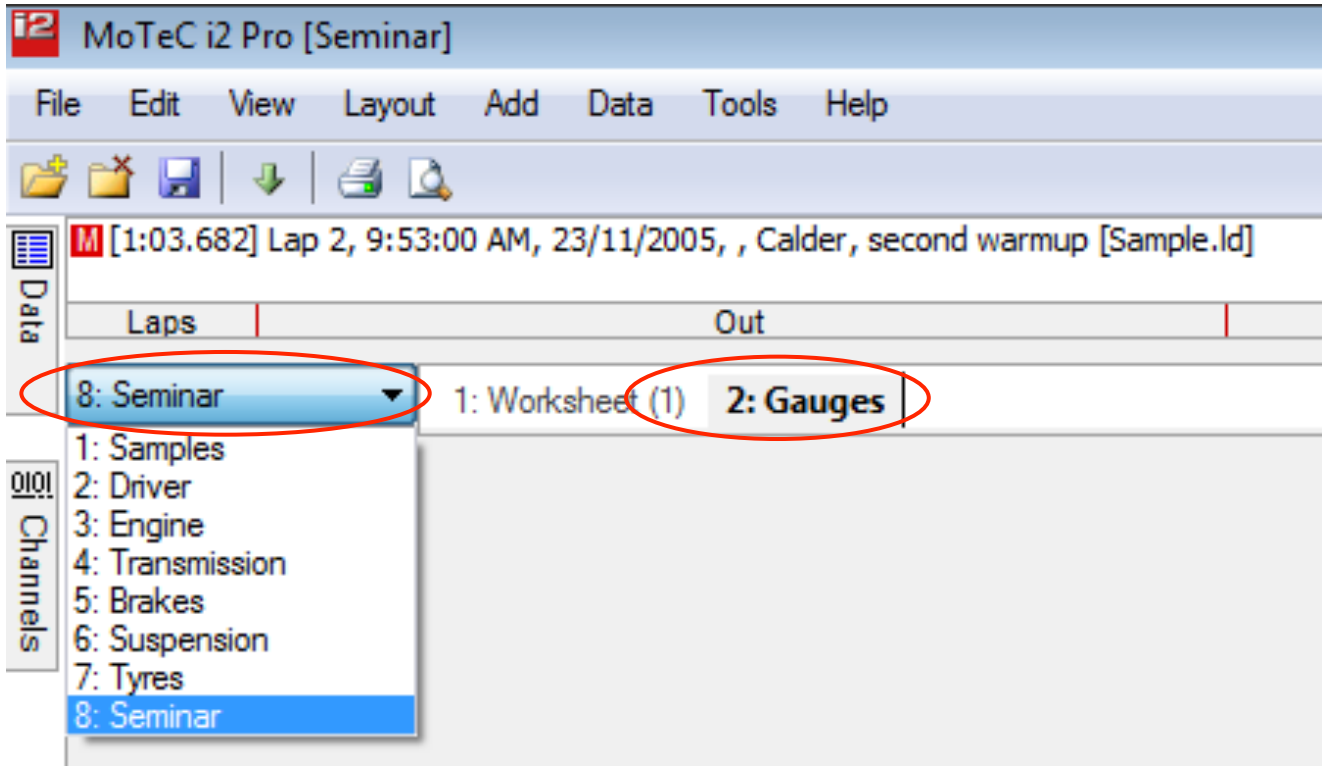




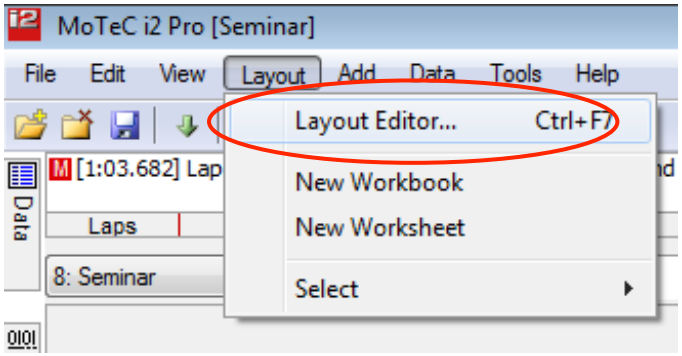


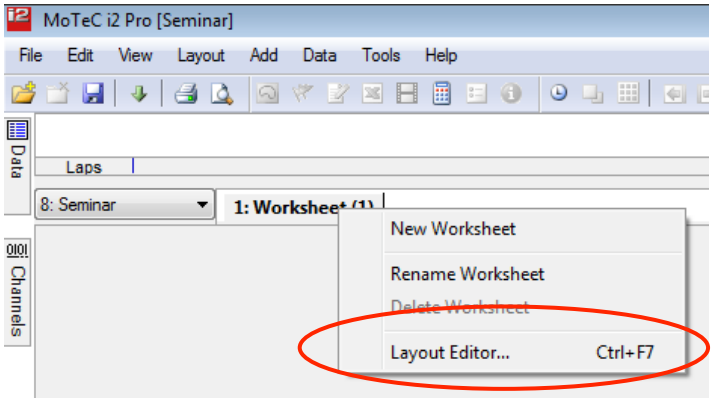
Workbook/Worksheet Setup

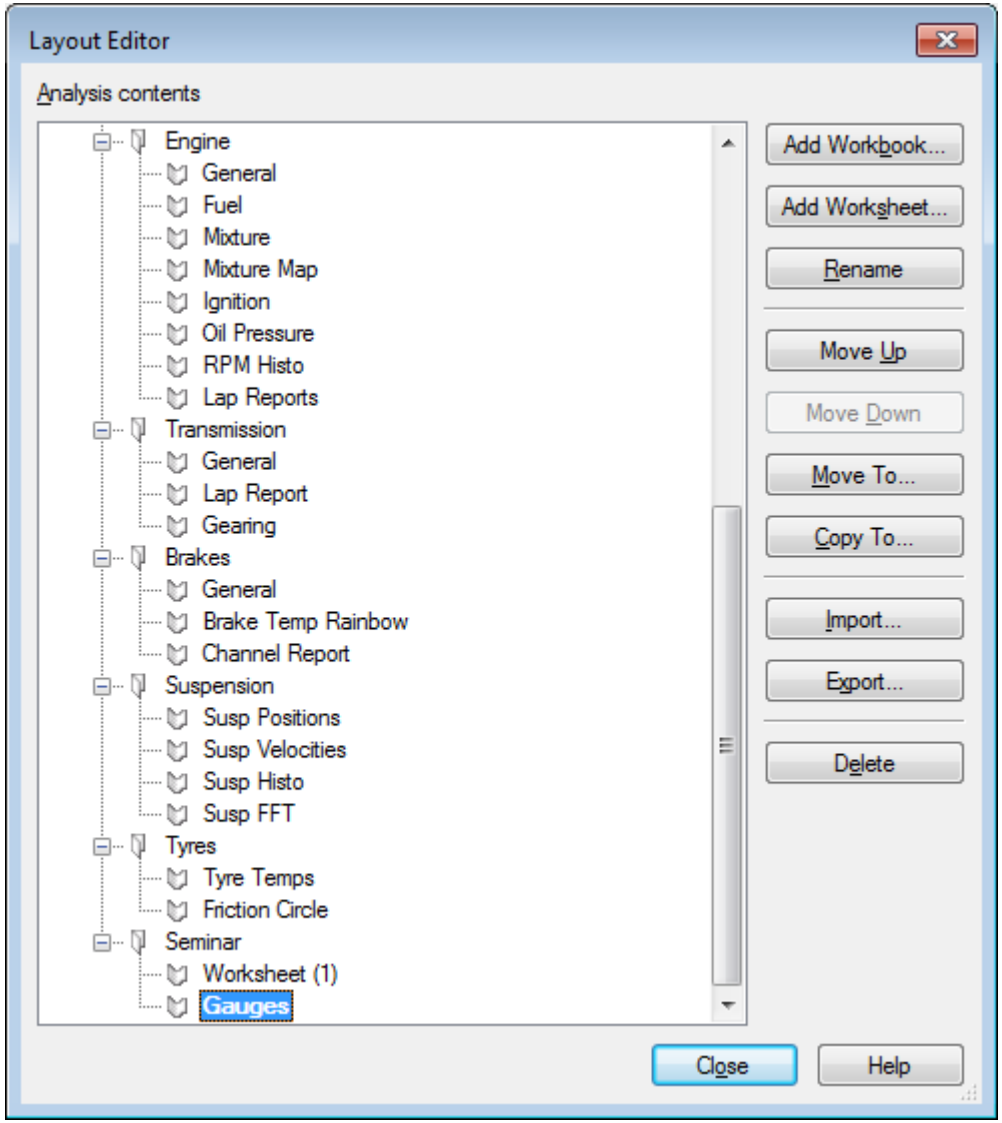
Worksheets should be grouped into workbooks by their type, such as Engine, Driver, Chassis, Suspension… or they can be grouped for different people such as Engineer, Driver A, Driver B, Team Owner.



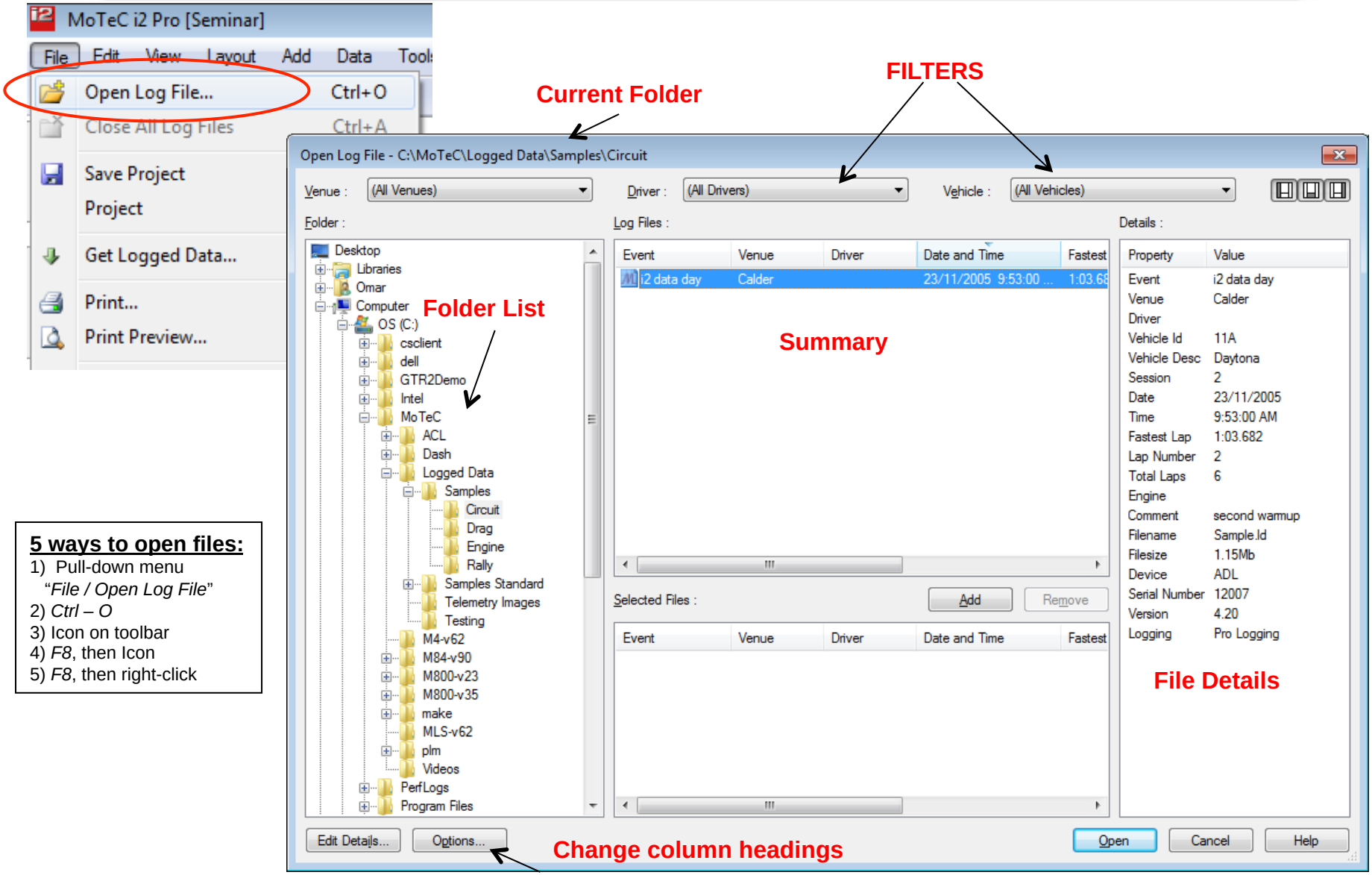
Layout Editor







Open a Log Data File

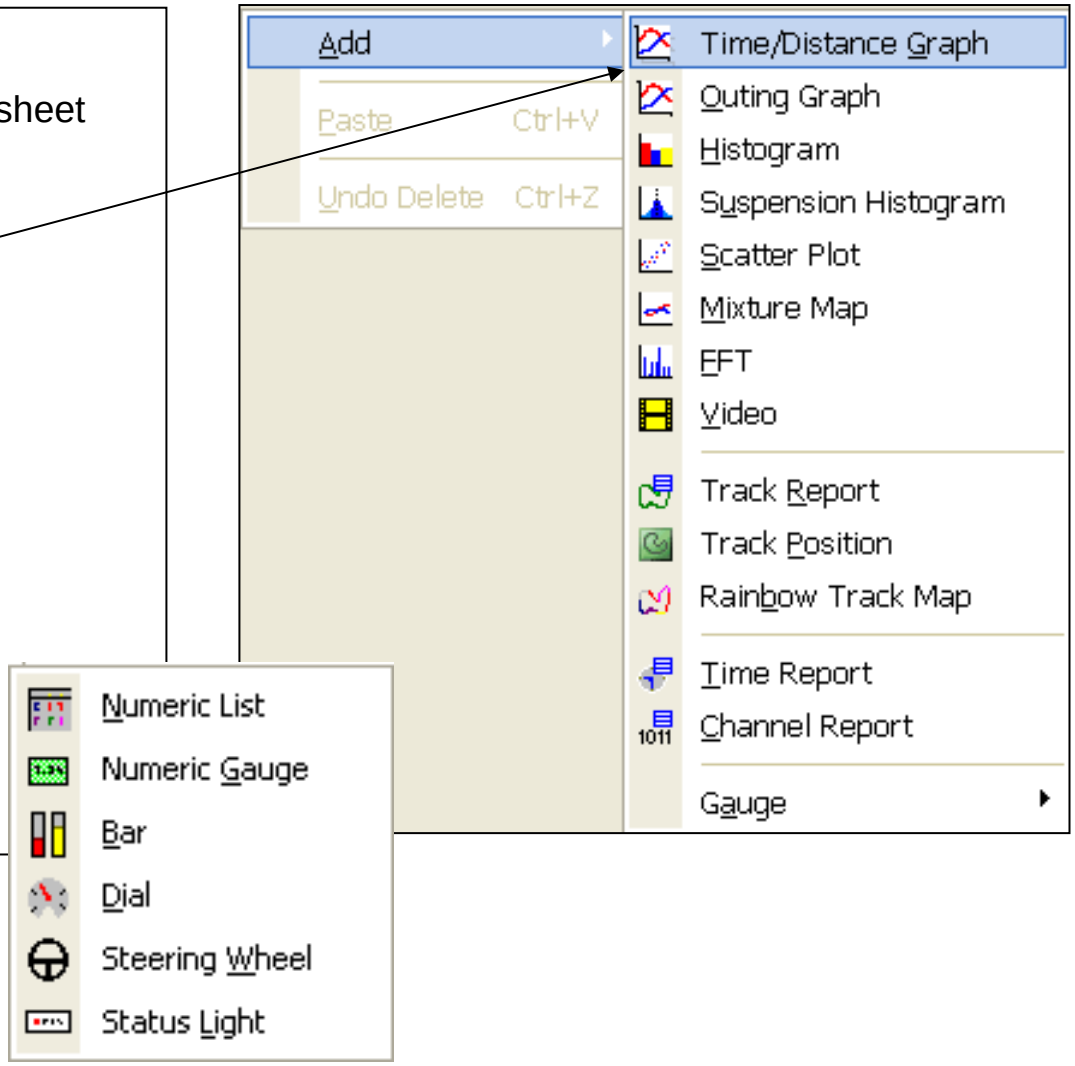


5 ways to open files:

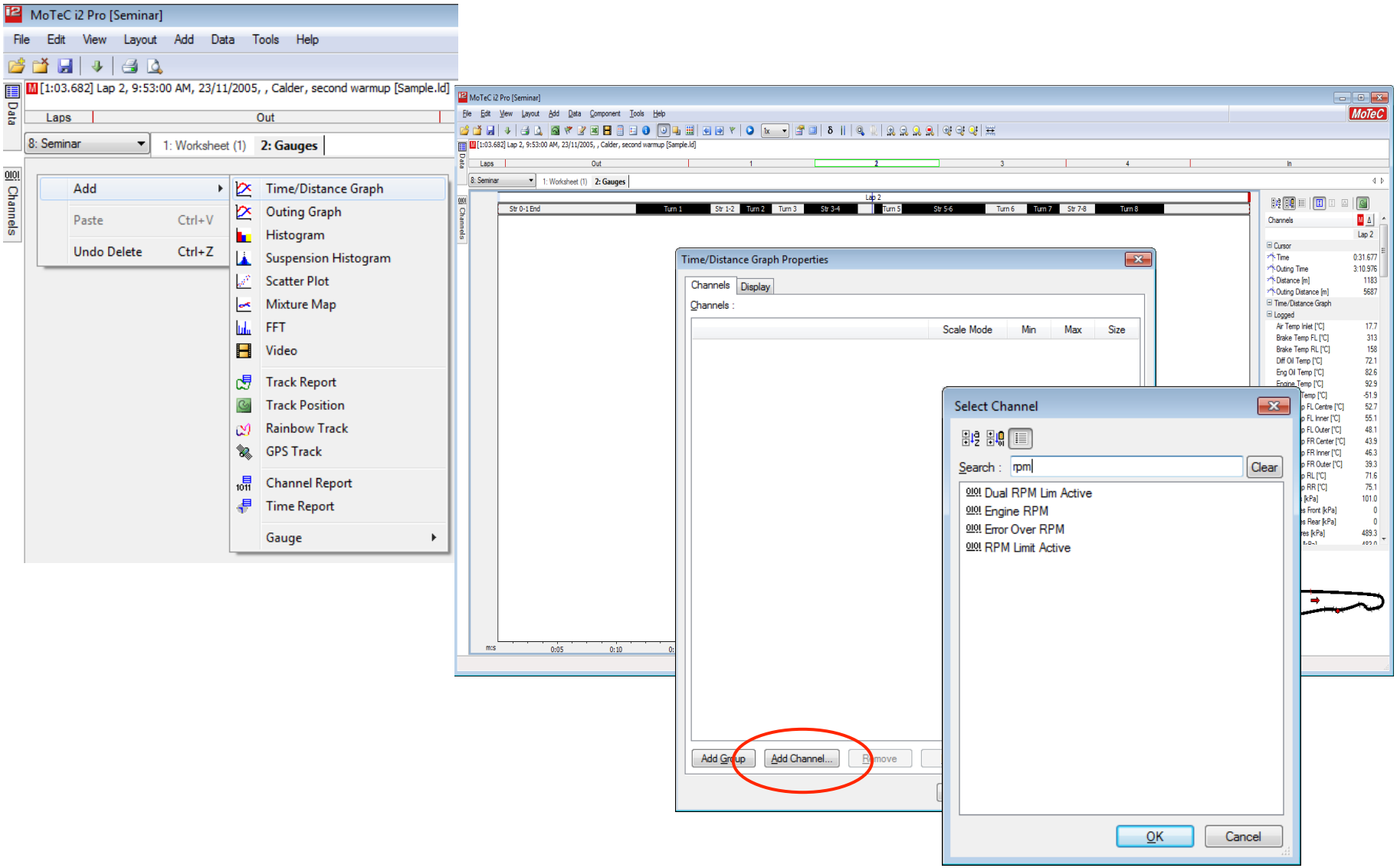
1) Pull-down menu
   "*File / Open Log File*"
2) *Ctrl – O*
3) Icon on toolbar
4) *F8*, then Icon
5) *F8*, then right-click

Adding Components

- ‘Layout – Add’ menu
- Right click on blank area of worksheet
- Available Components:
  - Time / Distance Graph
  - Outing Graph
  - Histogram
  - Suspension Histogram
  - Scatter Plot
  - Mixture Map
  - FFT
  - Video
  - Track Report
  - Track Position
  - Rainbow track map
  - Time Report
  - Channel Report
  - Gauges (various types) ->

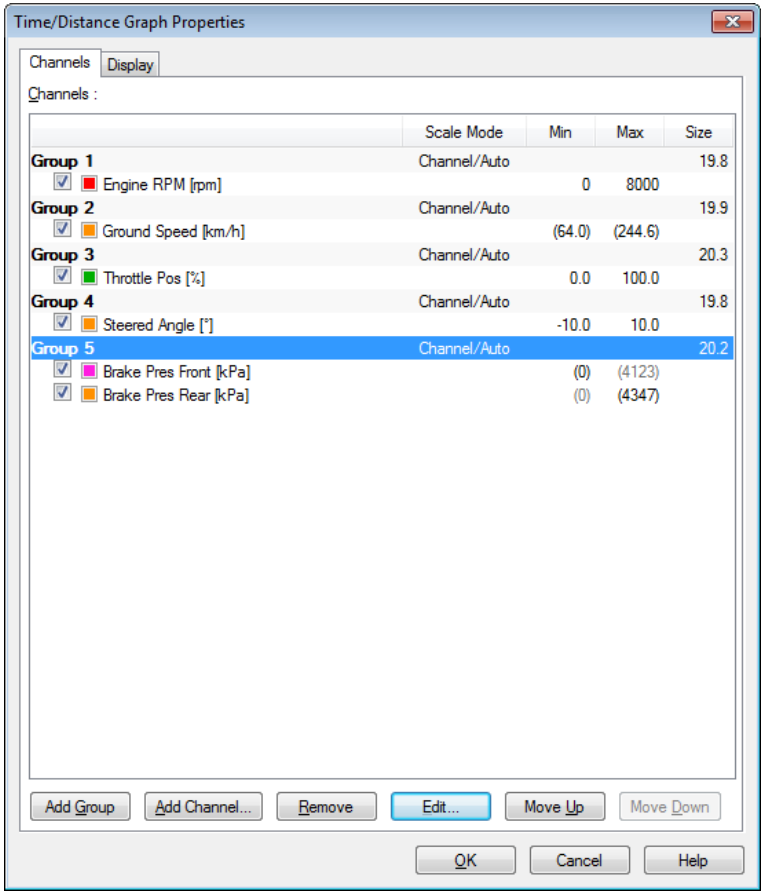


Add Time/Distance Graph



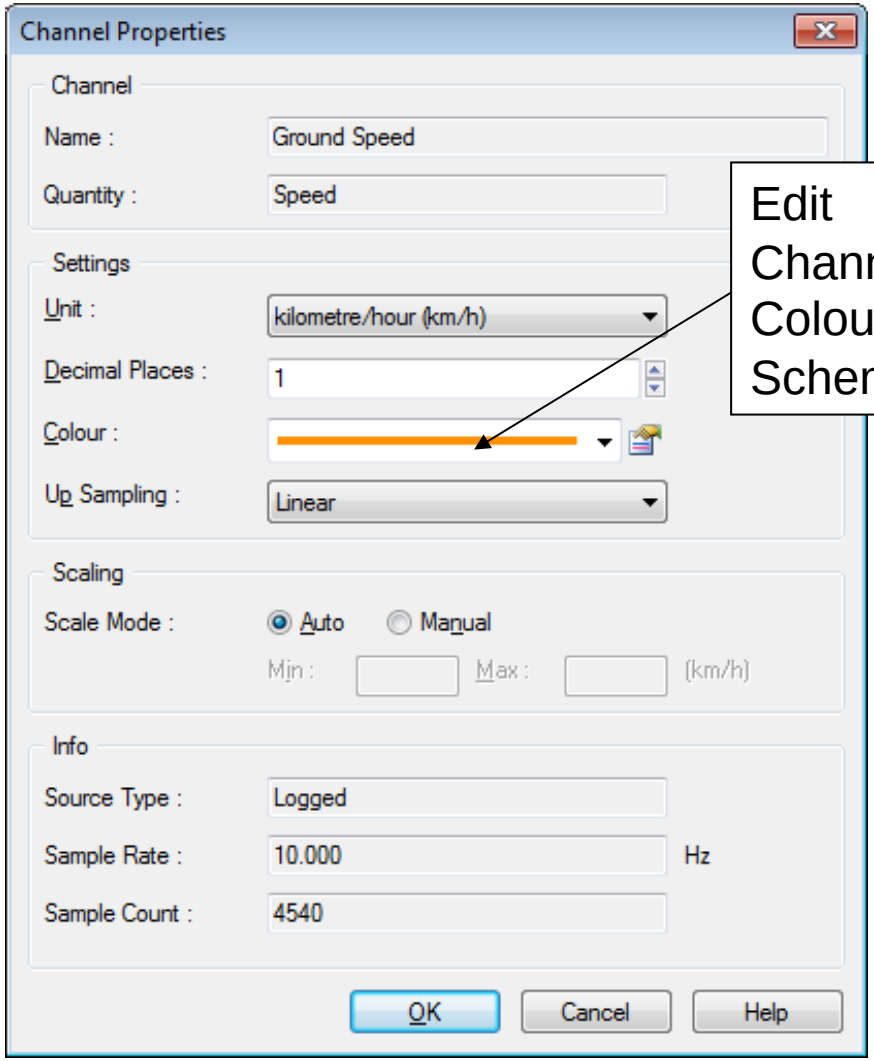
Graph Properties

- Channels
- Groups



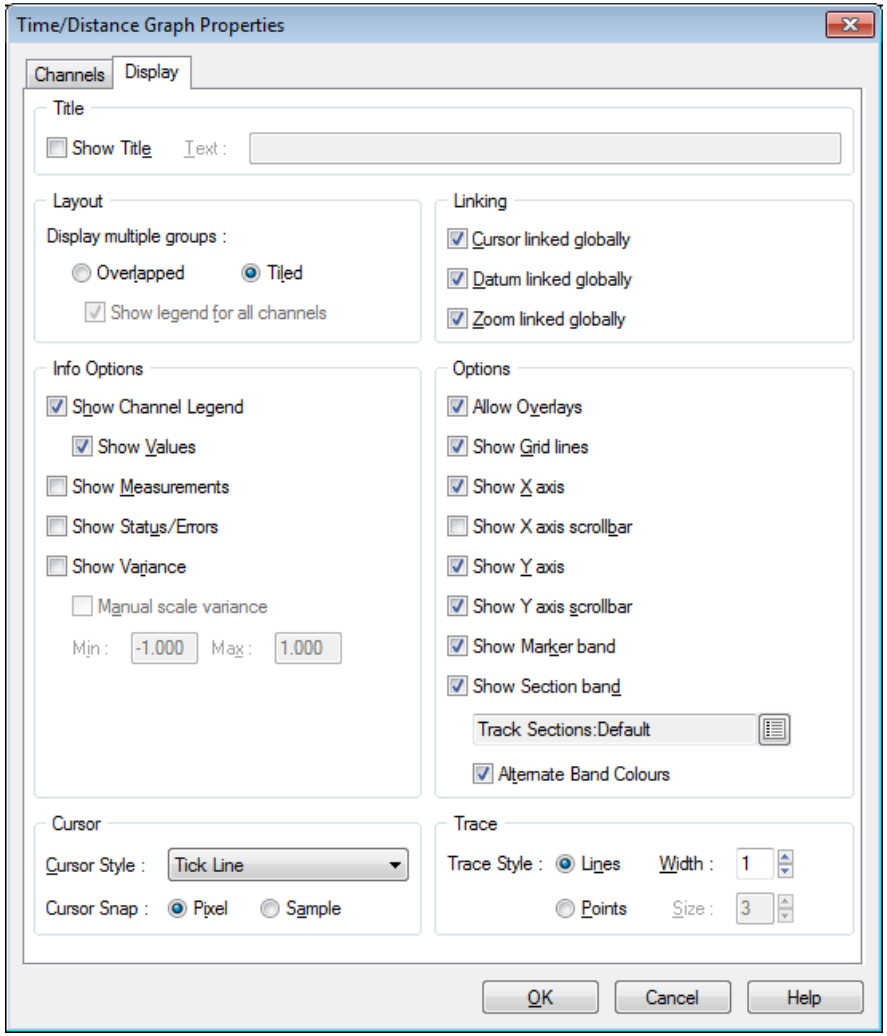
Channel Properties

- Unit
- Decimal Places
- Colour
- Up Sampling
- Scaling
- Info

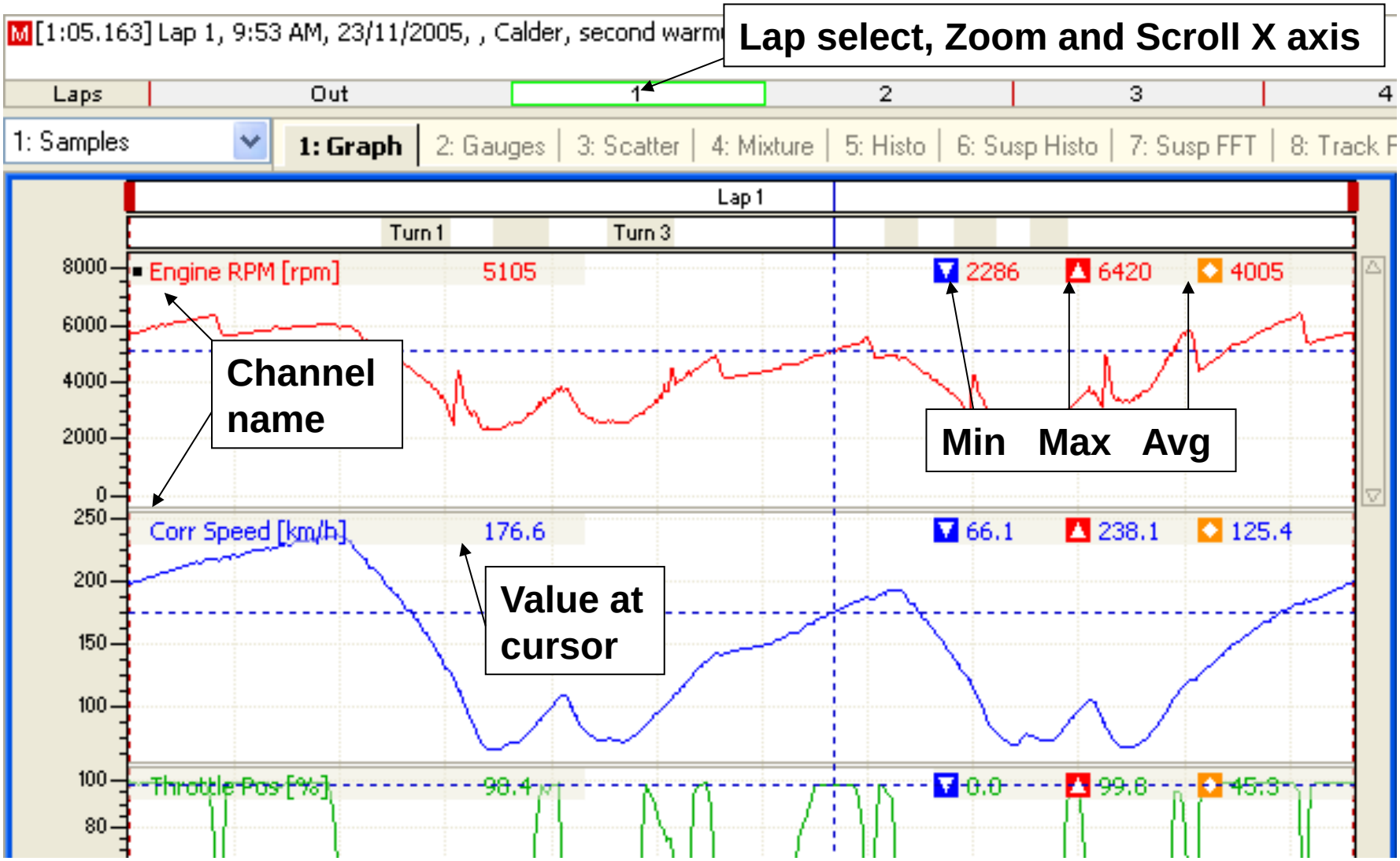


Graph Properties

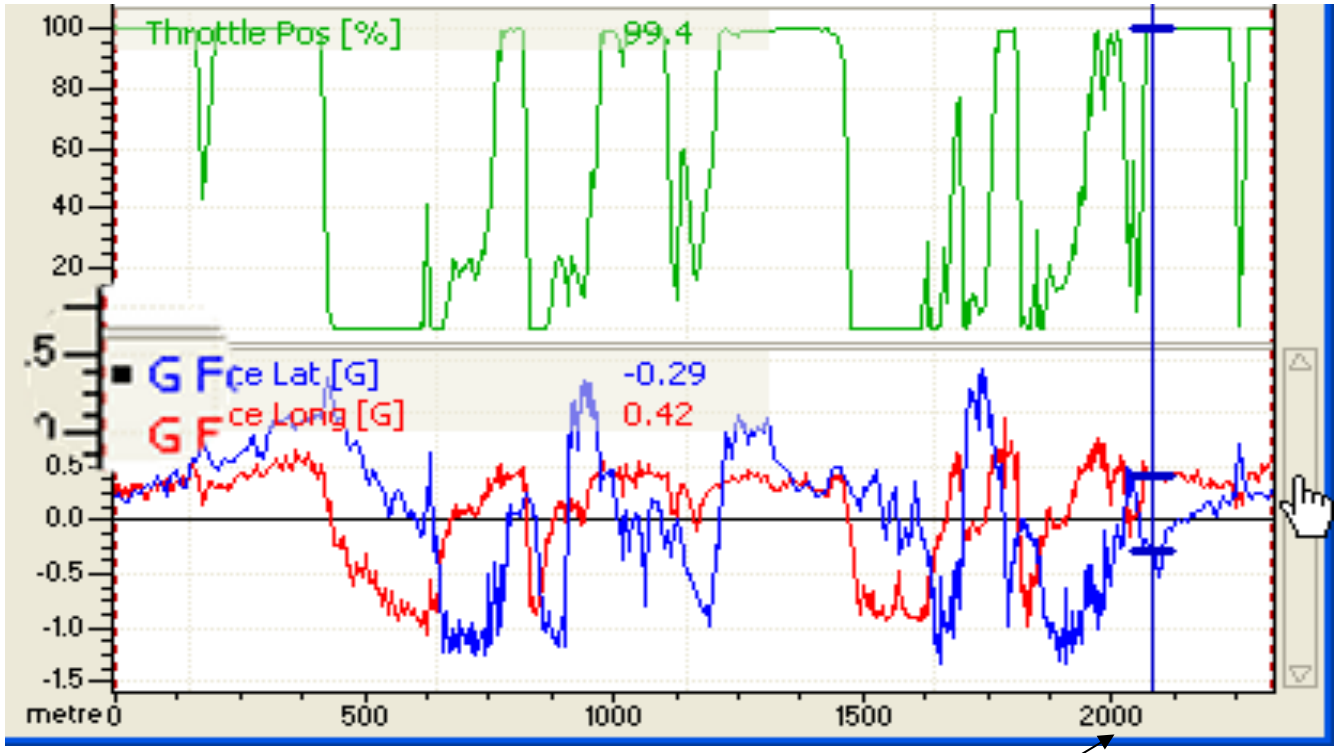
- Title
- Layout
- Info Options
- Options
- Cursor
- Trace



Time / Distance Graphs



Time / Distance Graphs



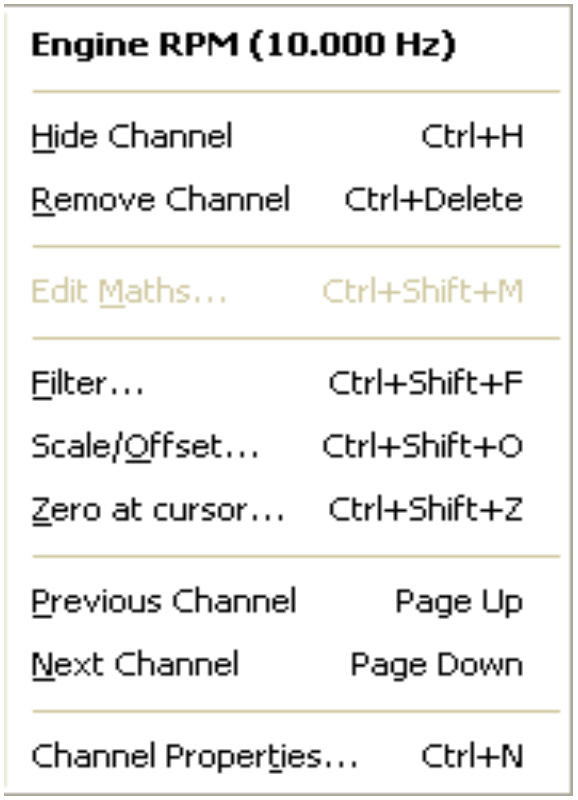
Active Channel mark

F9 toggles the Time / Distance axis

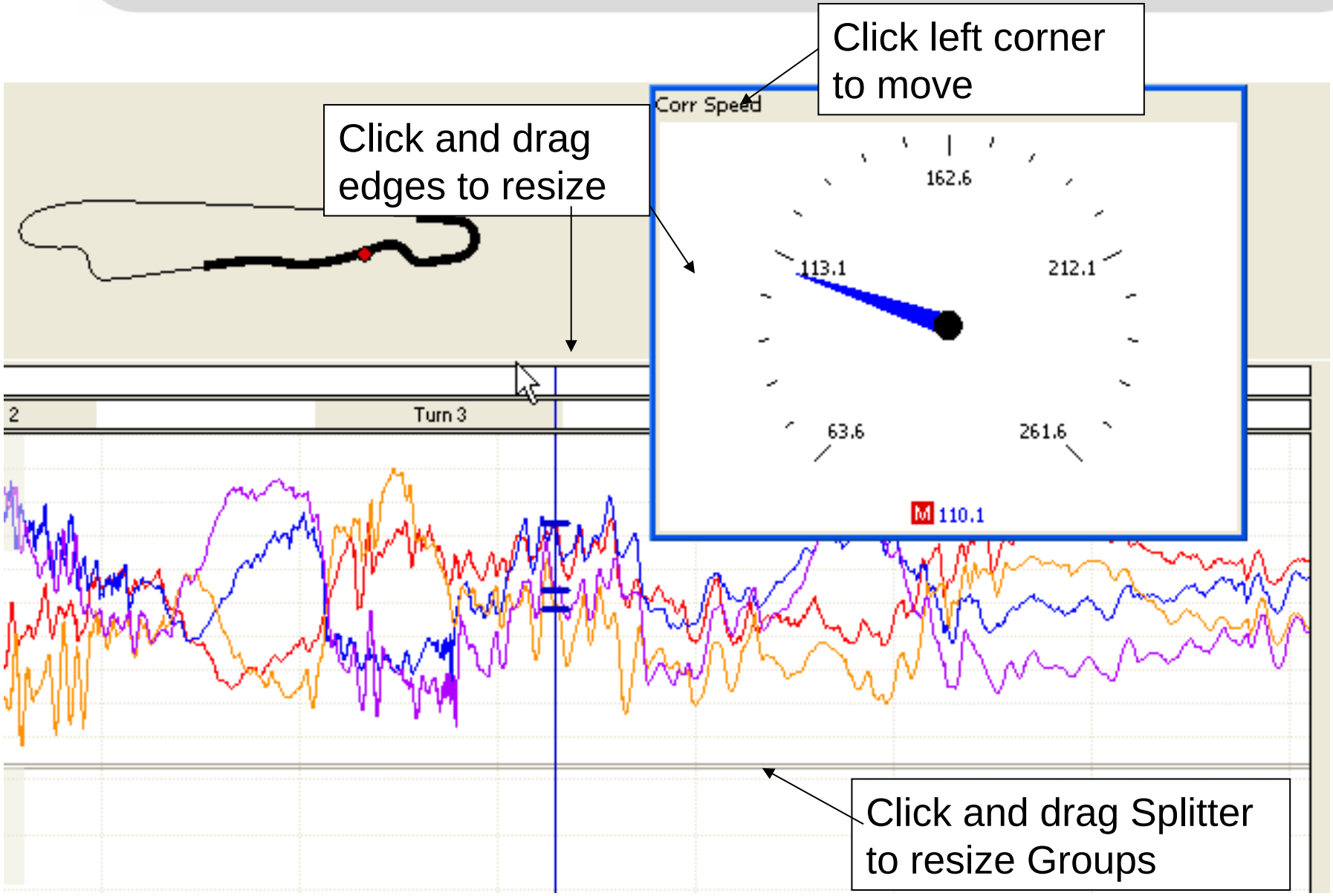
Rescale / Vertical Zoom group with active channel by dragging arrows

Channel Options on a Graph

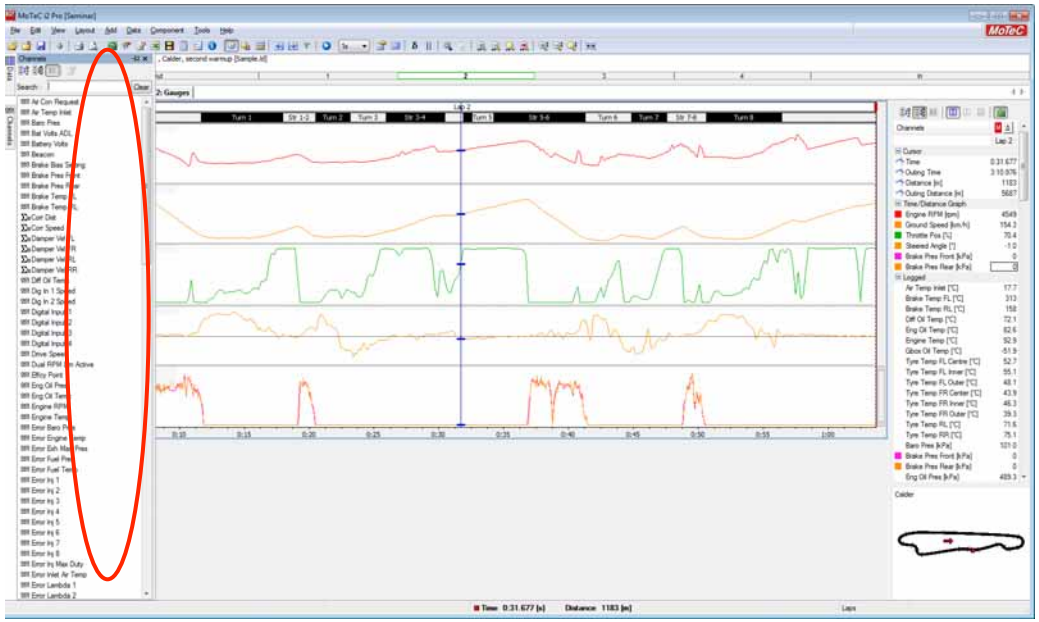
- Hide
- Remove
- Edit Maths
- Filter
- Scale / Offset
- Zero at Cursor
- Previous
- Next
- Channel Properties



Resizing and Layout

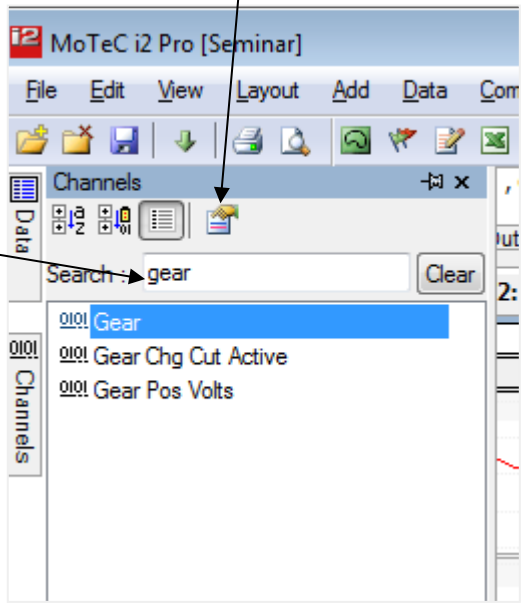


Adding Channels



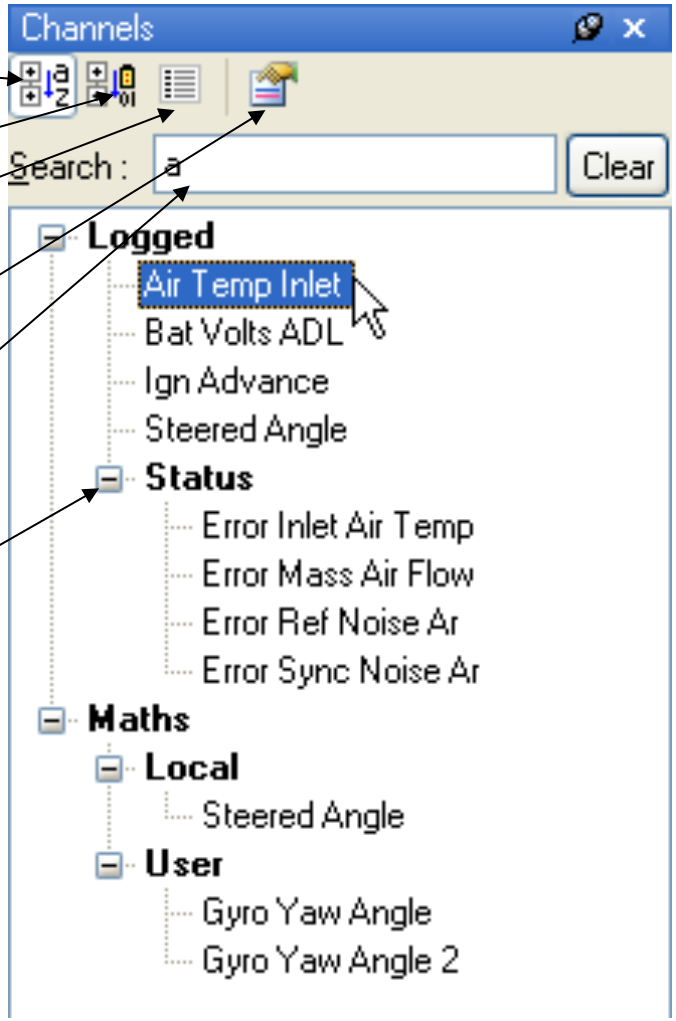
View properties of the selected channel

Search the channel list

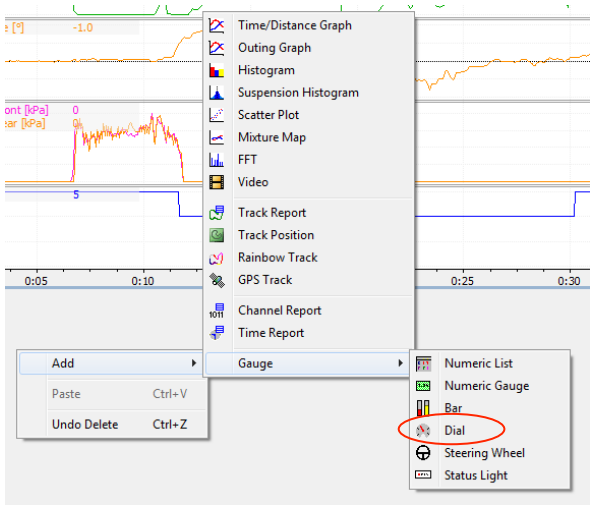


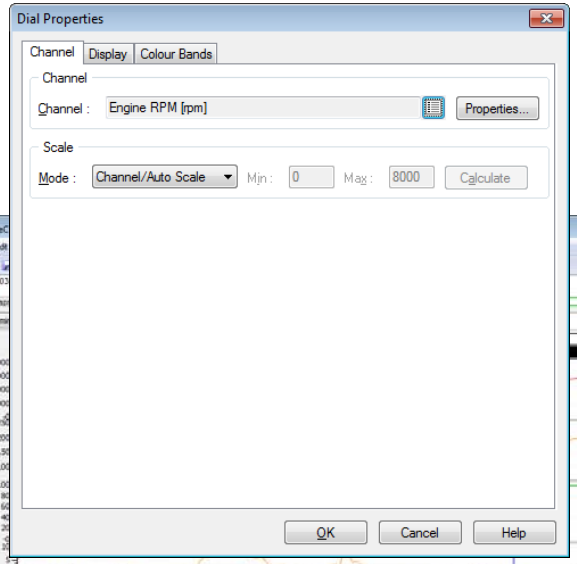
Channels Window

- Category Alphabetic Order
- Category Logged Order
- Alphabetic List
- Channel Properties
- Search Box
- Categories

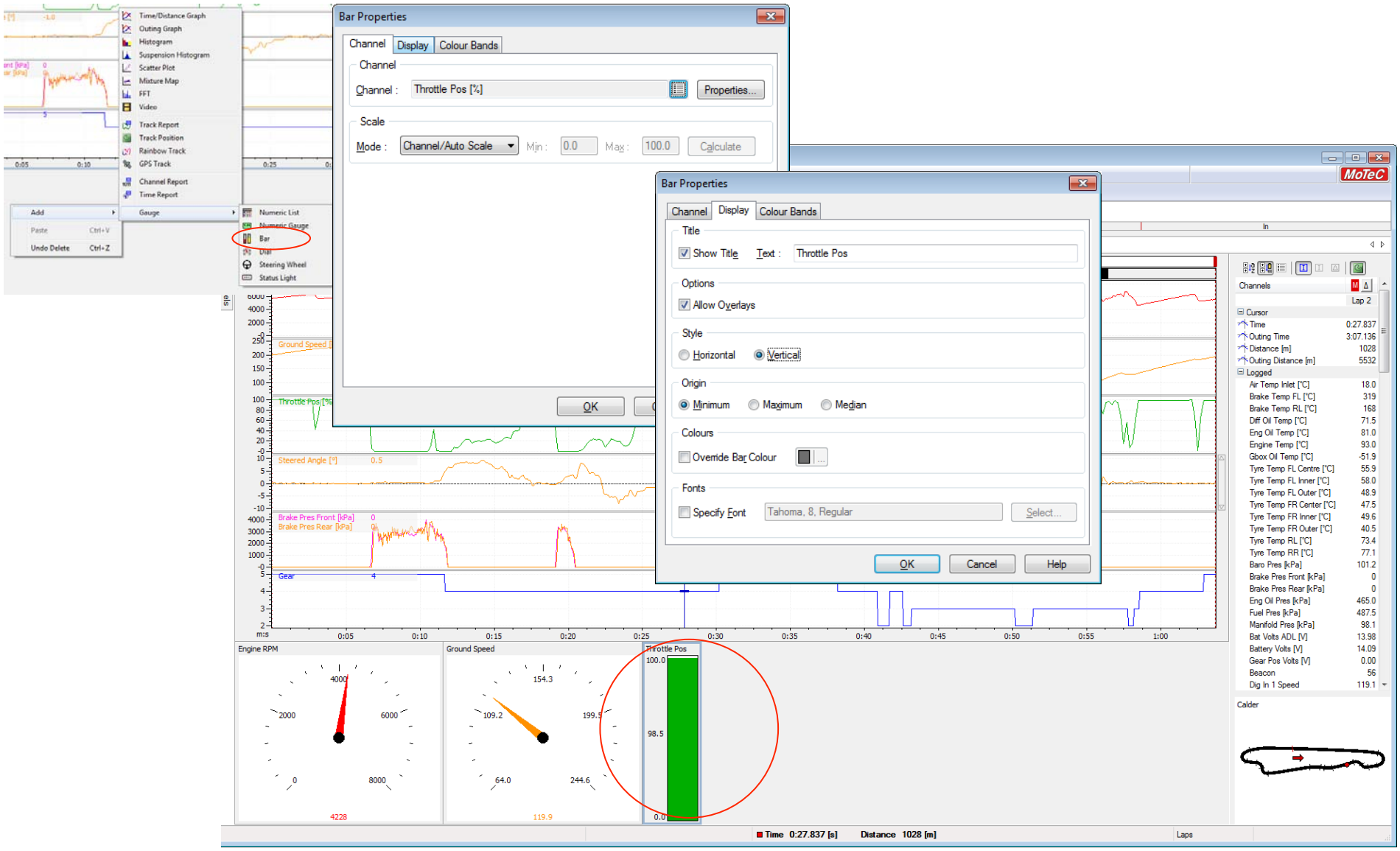


Add Gauges - Dial

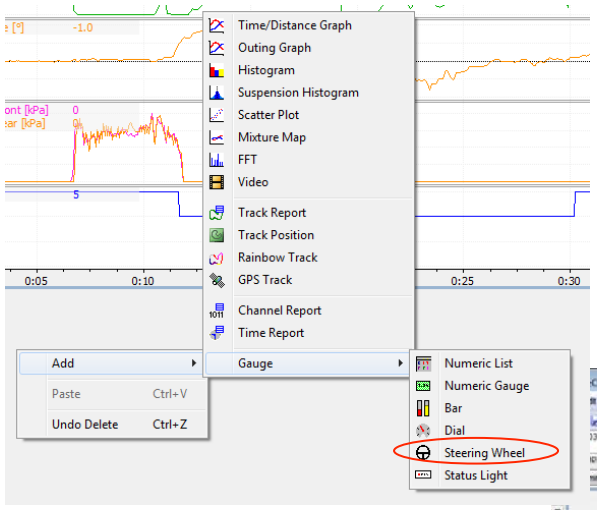


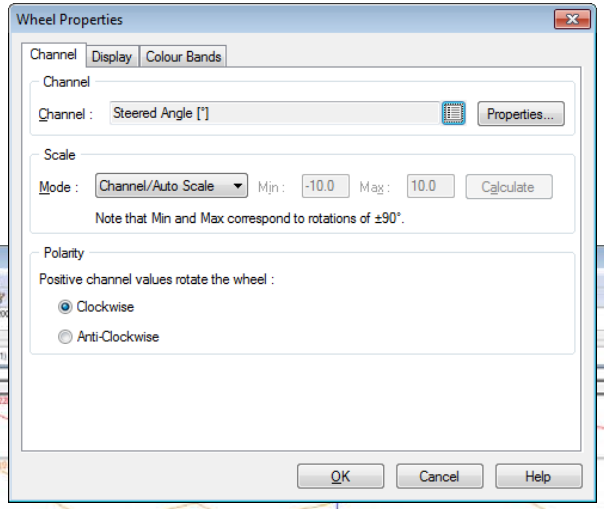


Add Gauges - Bar

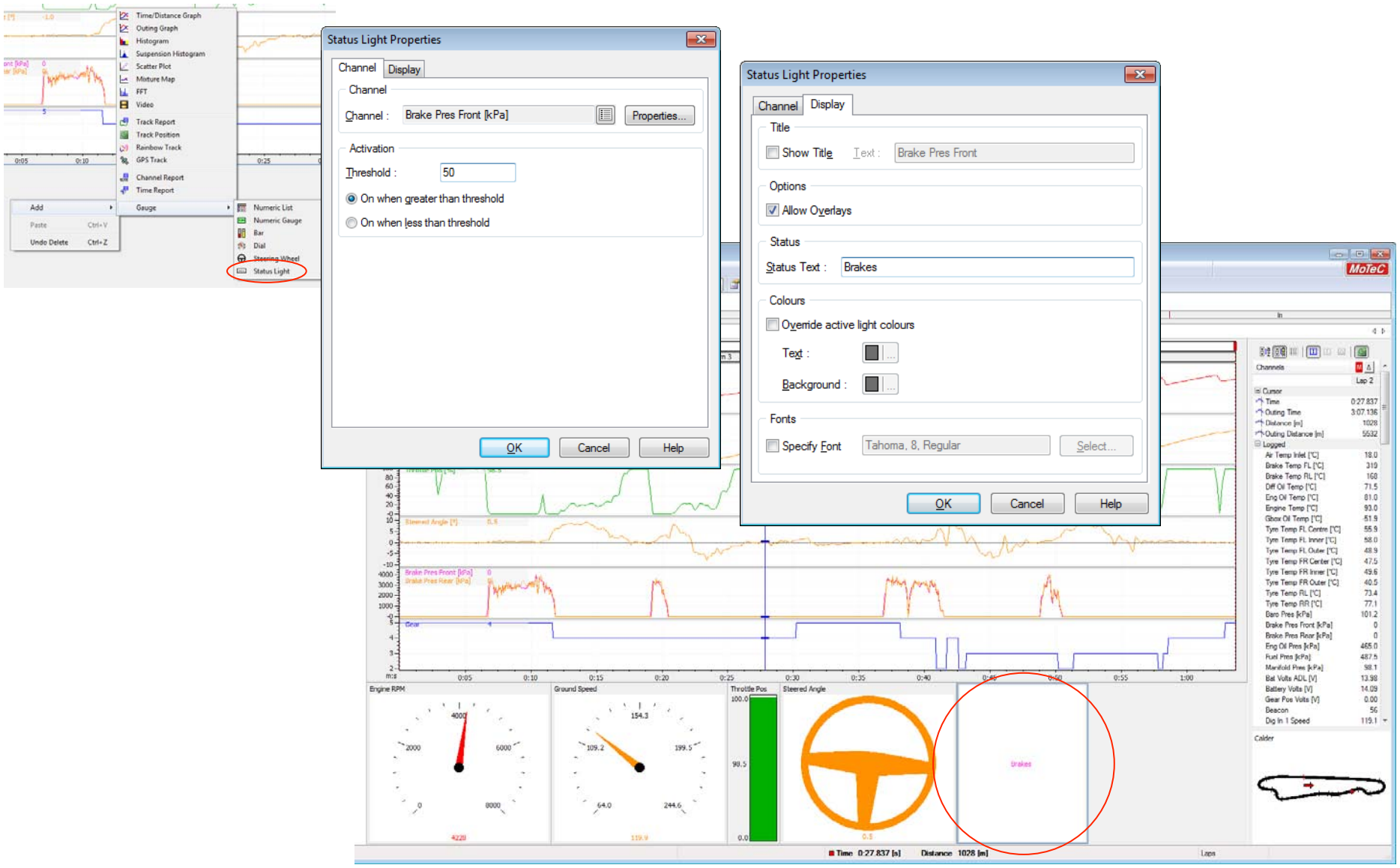


Add Gauges – Steering Wheel

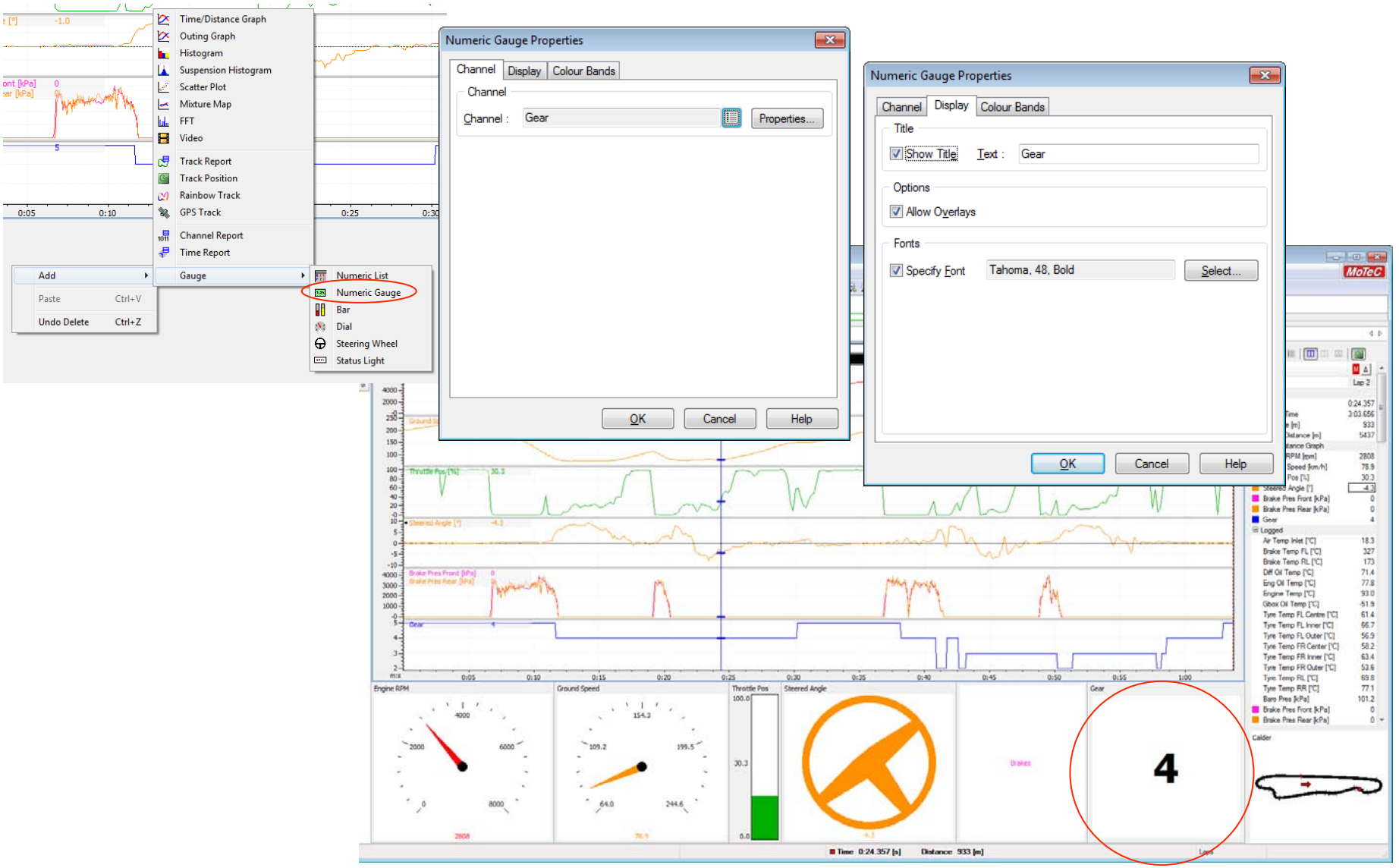




Add Gauges – Status Light

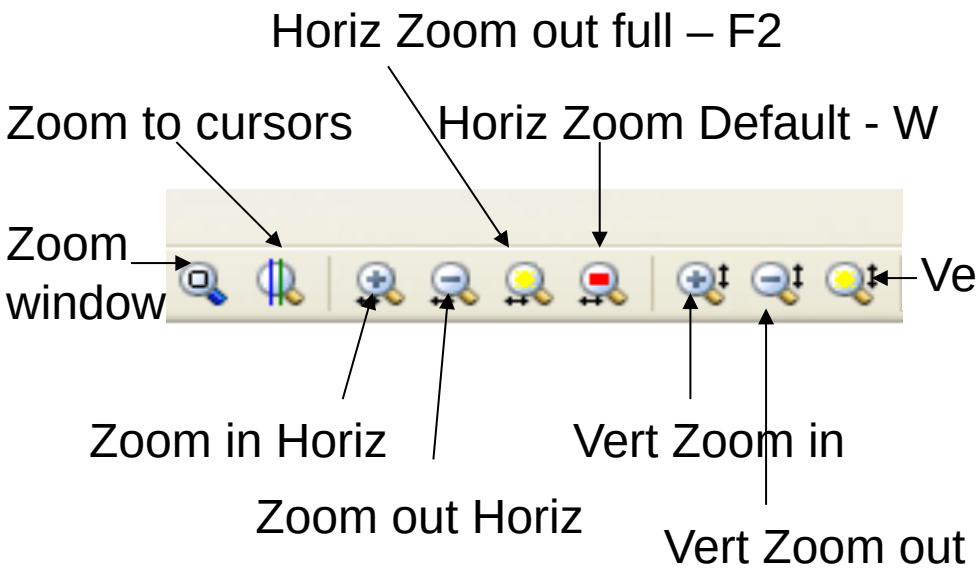


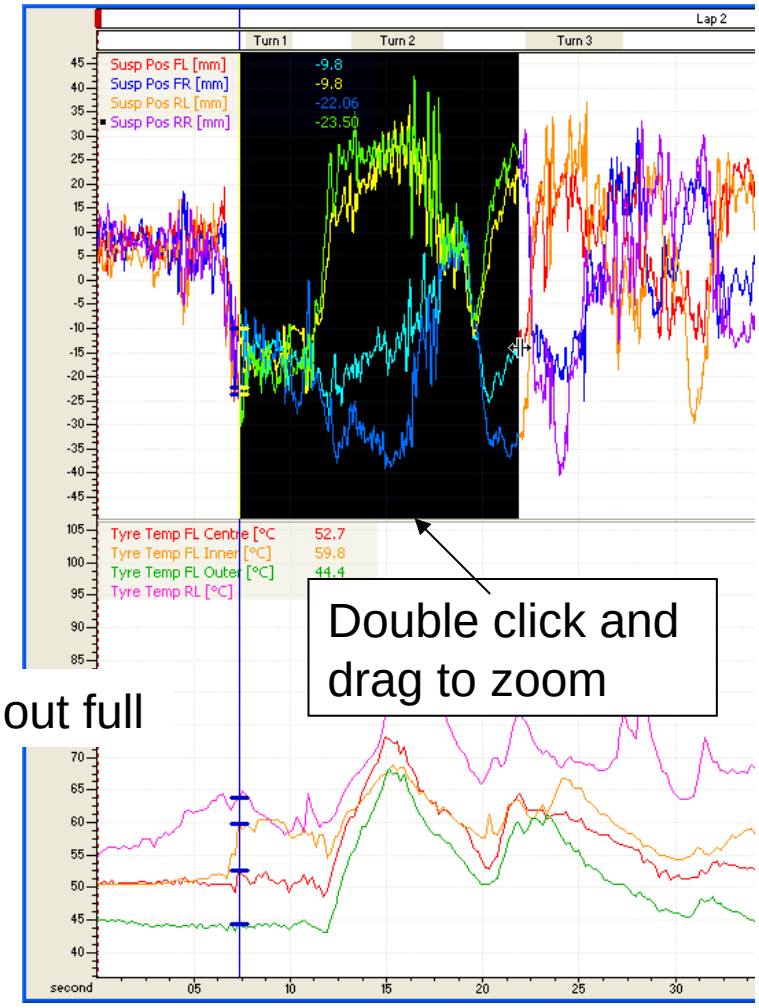
Gauges – Numeric Gauge



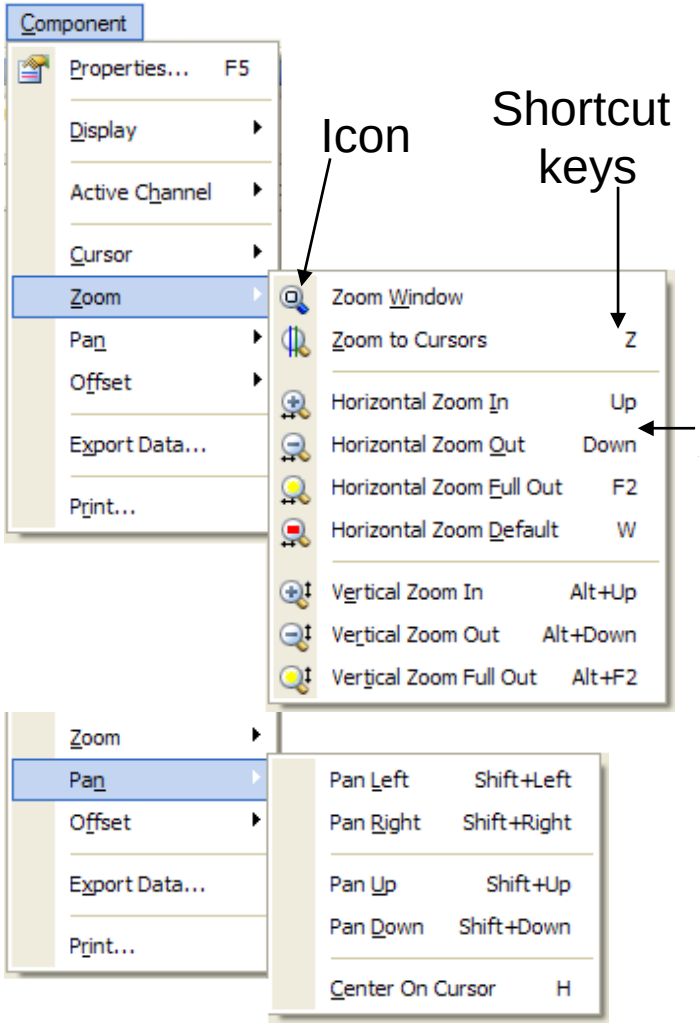
Zoom Functions

- Mouse scroll
- Keyboard shortcuts
- Scroll bars
- Zoom Icons





Zoom & Pan

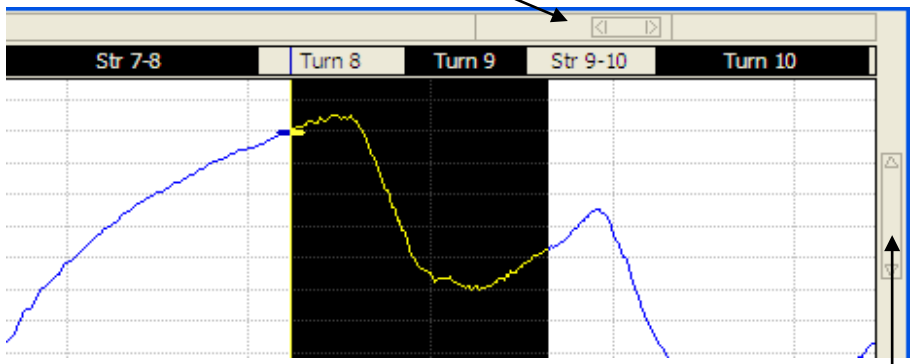


Icon

Shortcut keys

Arrow keys

Resize & Slide bar to Zoom & Pan



Double Click, Drag & Click

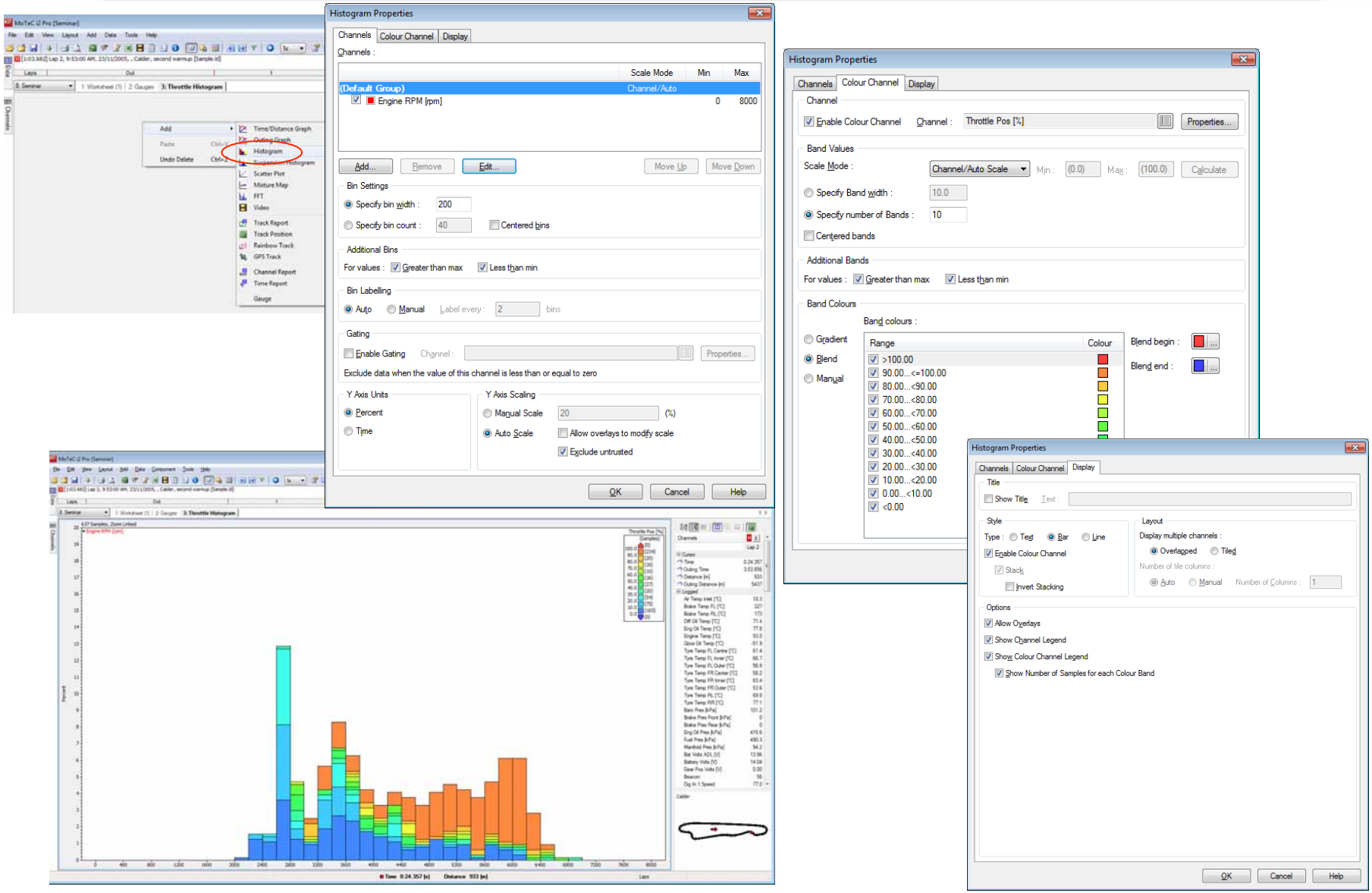
If you accidentally double click, hit “Esc” key

Double click to zoom out vertically

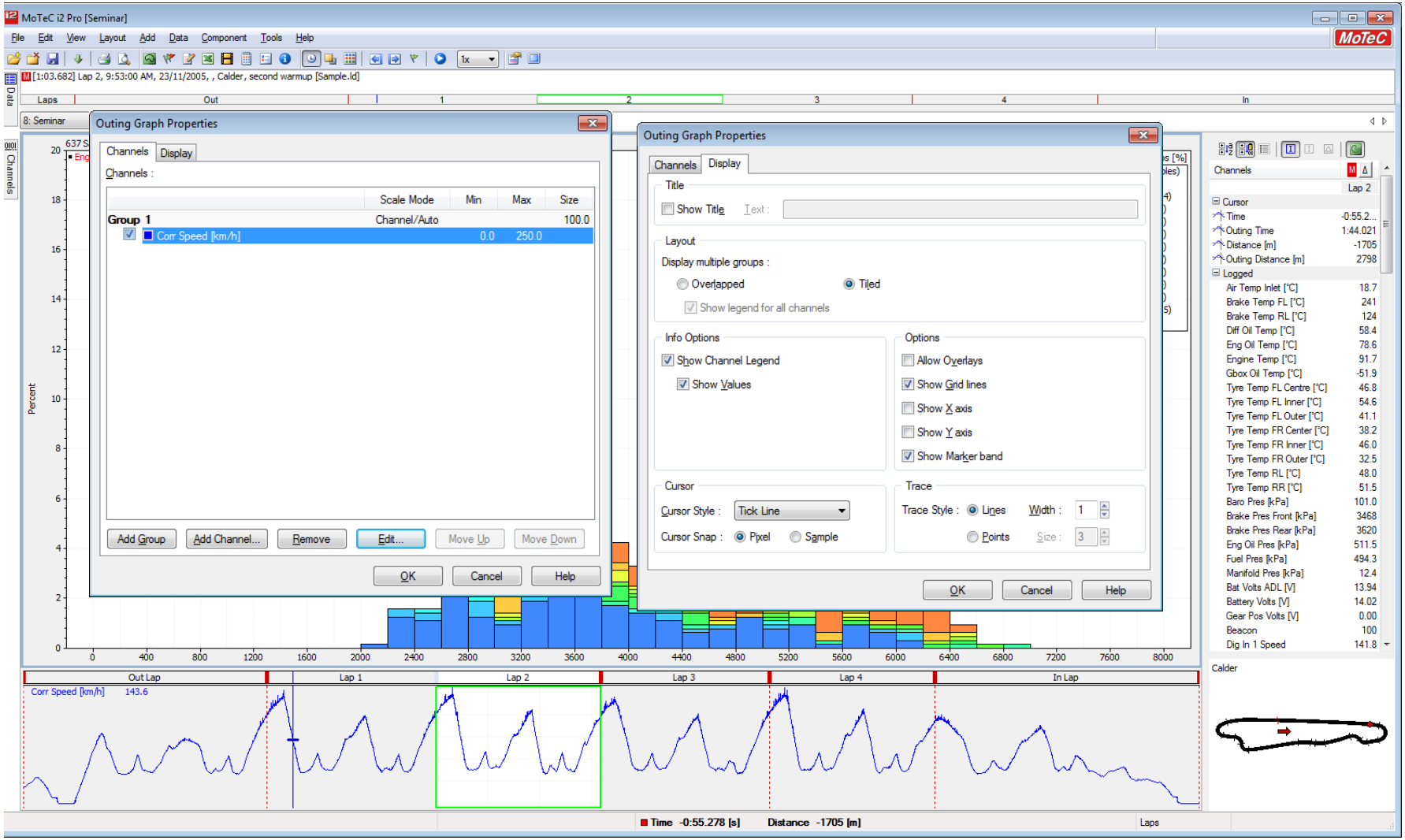
To Zoom: use scroll wheel

To Pan: slide bottom x-axis

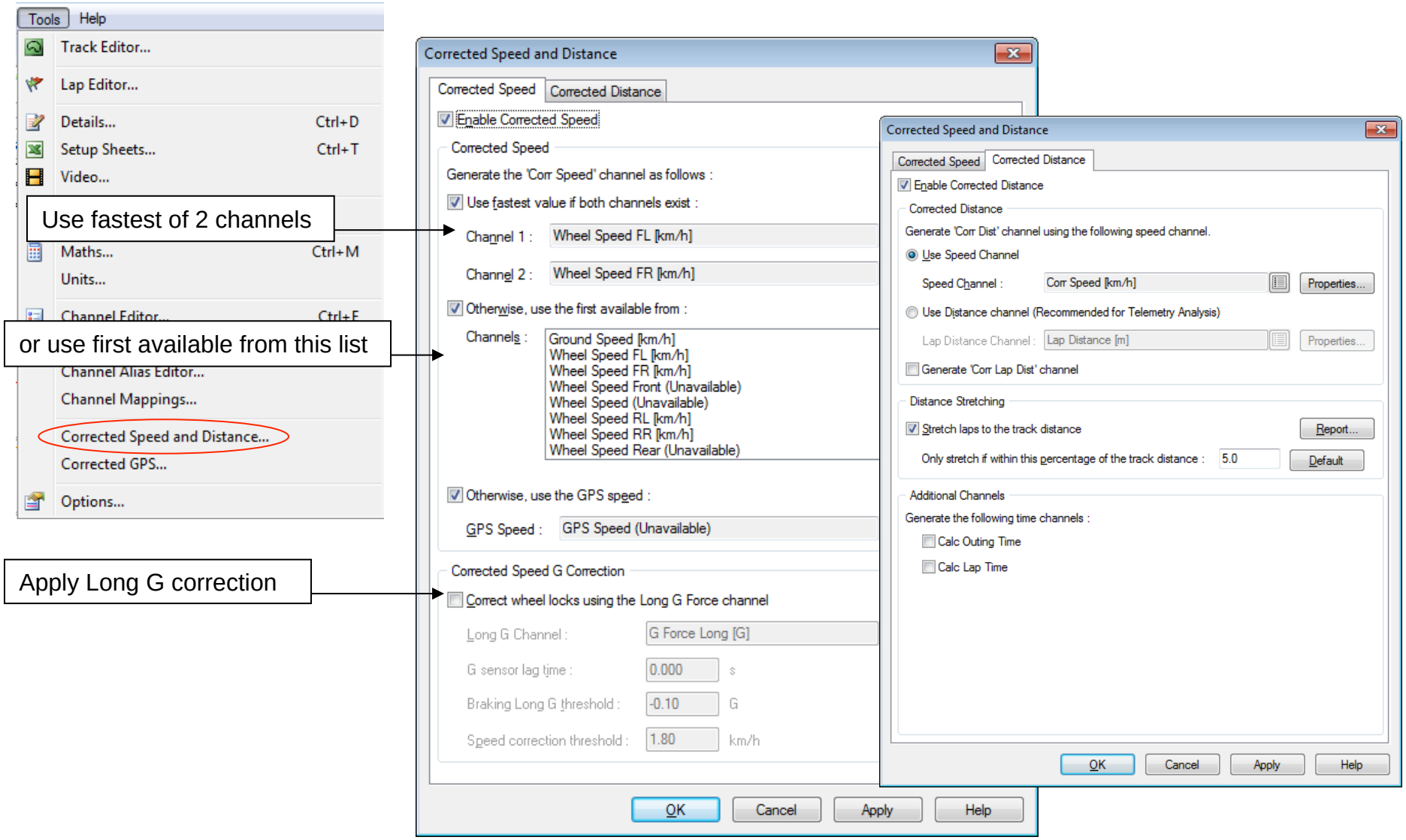
Throttle Histogram



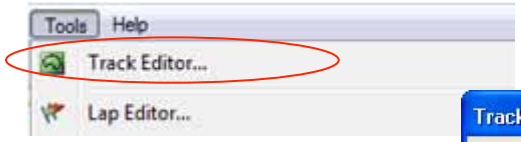
Zoom Linking



Corrected Speed & Distance

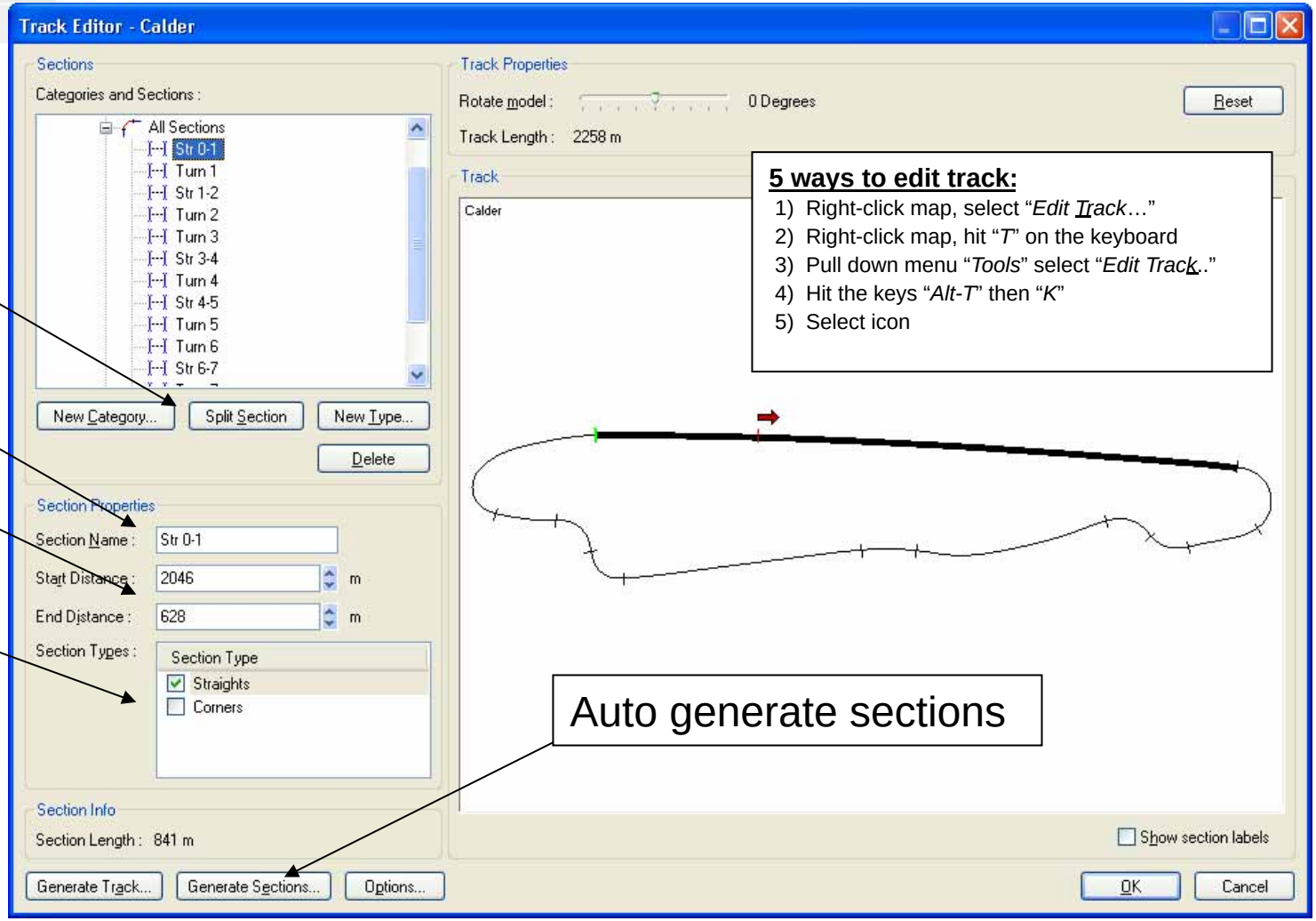


Track Editor 1



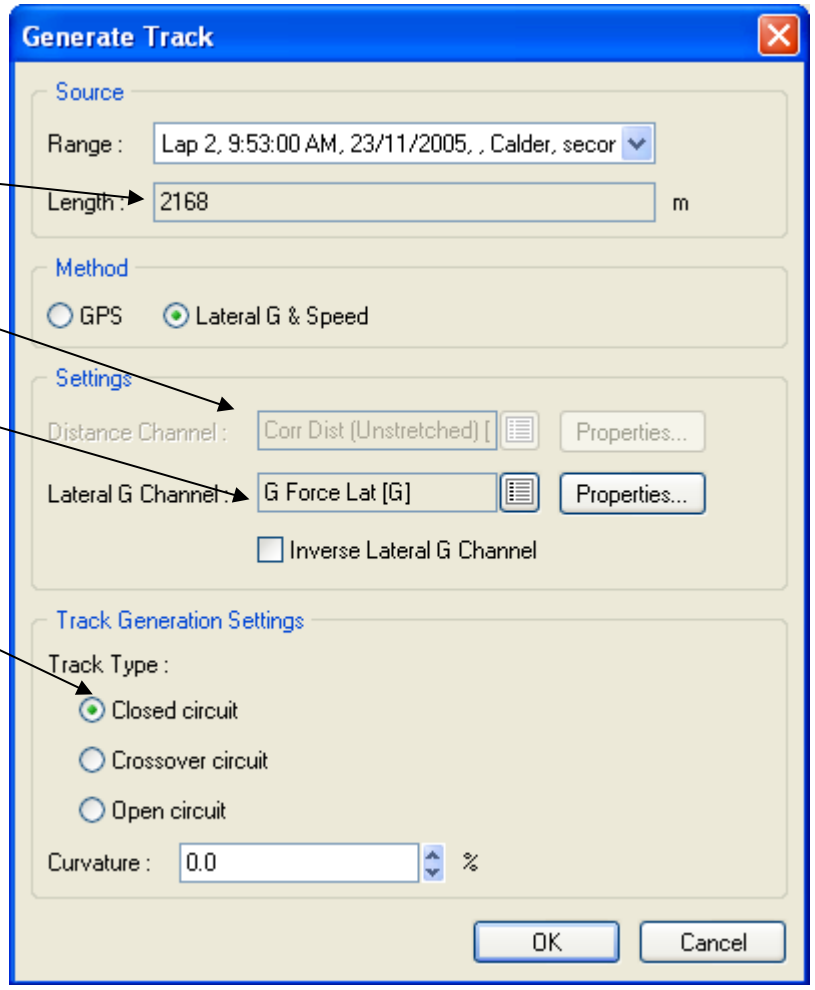
Sections

- Split
- Delete
- Section Name
- Enter Distances
- Section Type



Track Editor 2

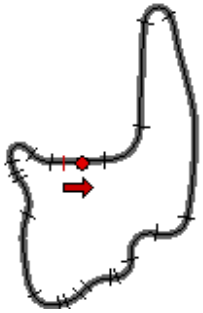
- Generate Track
  - Track Length
  - Distance Channel
  - Lateral G Channel
  - Track Type



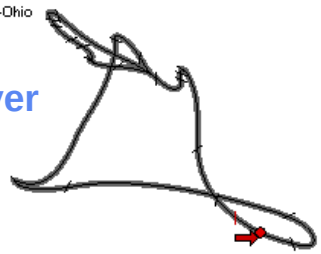
Track Mapping Troubleshooting

My map is close to the actual track, but there are still details that need to be changed.

Closed



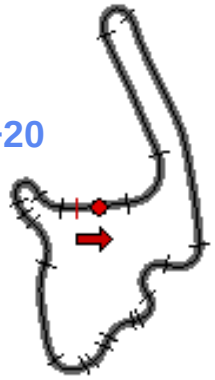
Crossover



Open

Curvature sets the tightness of all corners

+20



-20

Track Mapping Troubleshooting

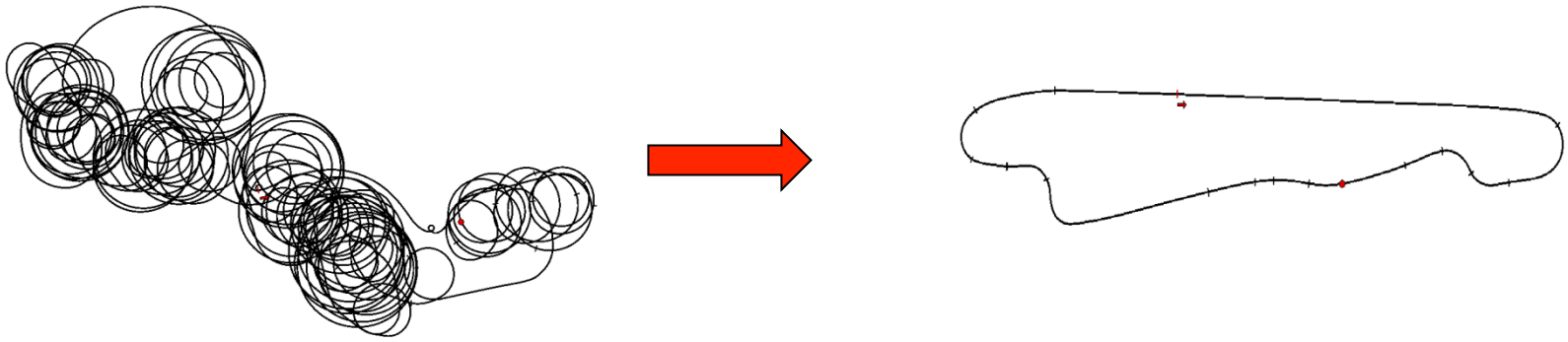
My map is totally wrong. I cannot recognize anything.

Check the lateral G trace

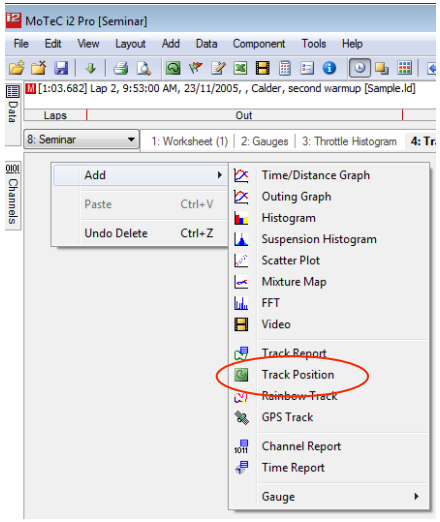
- Is there any offset in the straight line? Create a math channel to correct this offset.
- Is the maximum G Force value in the corner realistic? Create a math channel to adjust the scaling by the maximum value in the corner
- Is there excessive noise in the Lateral G trace? If so check the mounting is secure, check the wiring and connections for potential interference. A noisy trace can sometimes be improved by filtering the Lateral G channel using i2 Channel Maths.

Check the Speed

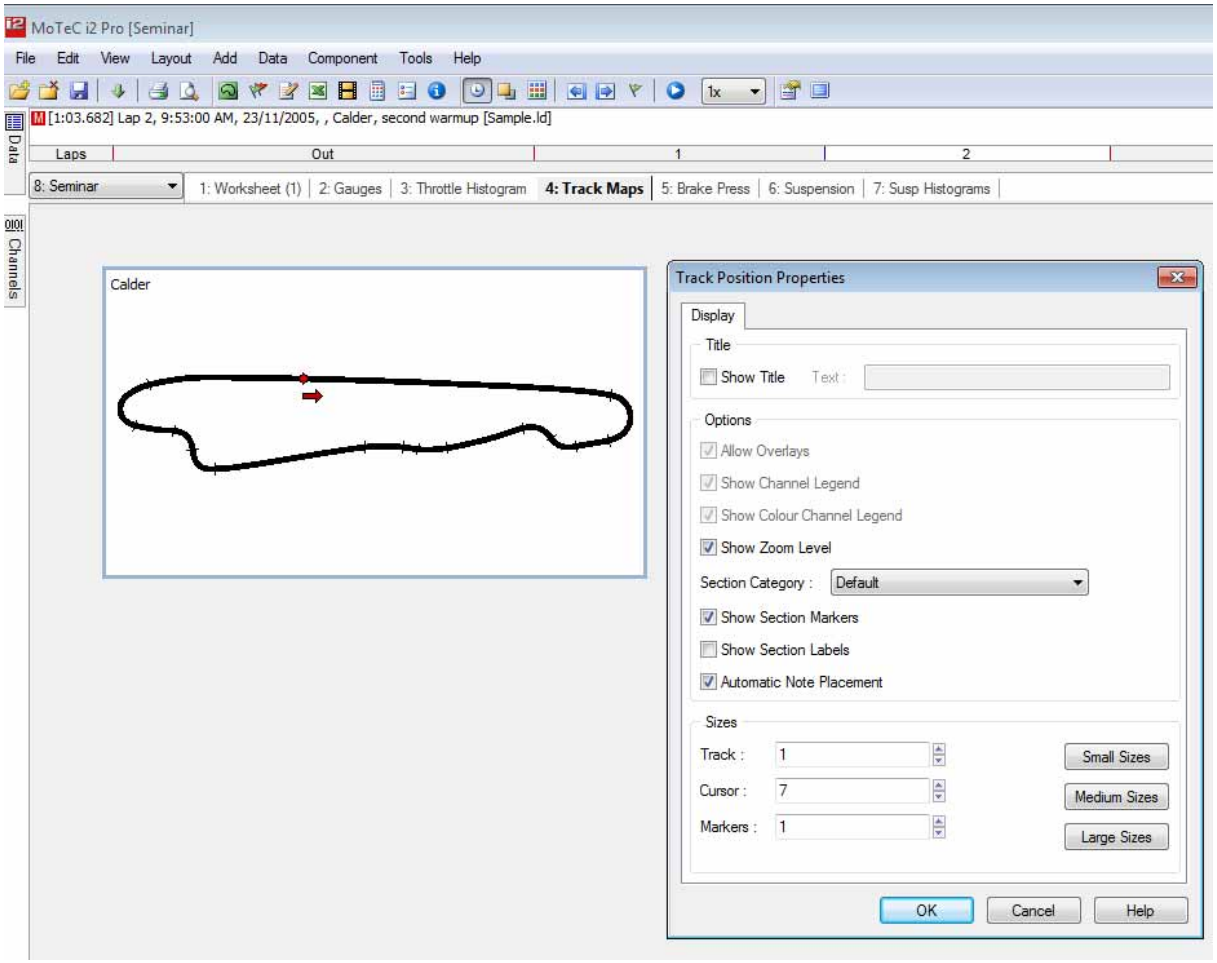
- Is the maximum speed value realistic? Check the Speed + Distance or create a math channel to scale or offset your data.
- Check the calibration of your wheel speed sensor.



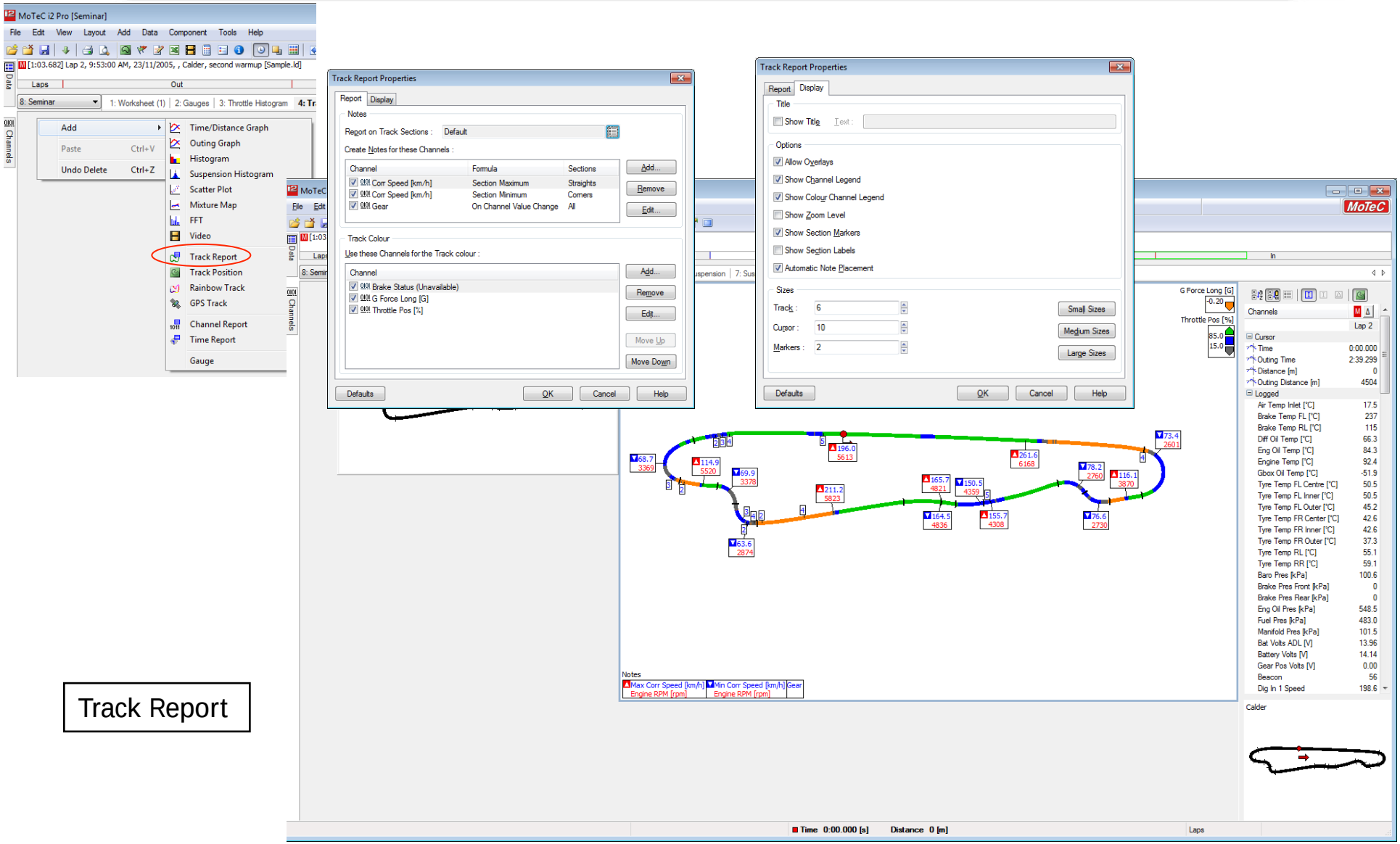
Track Mapping - Position



Track Position Map

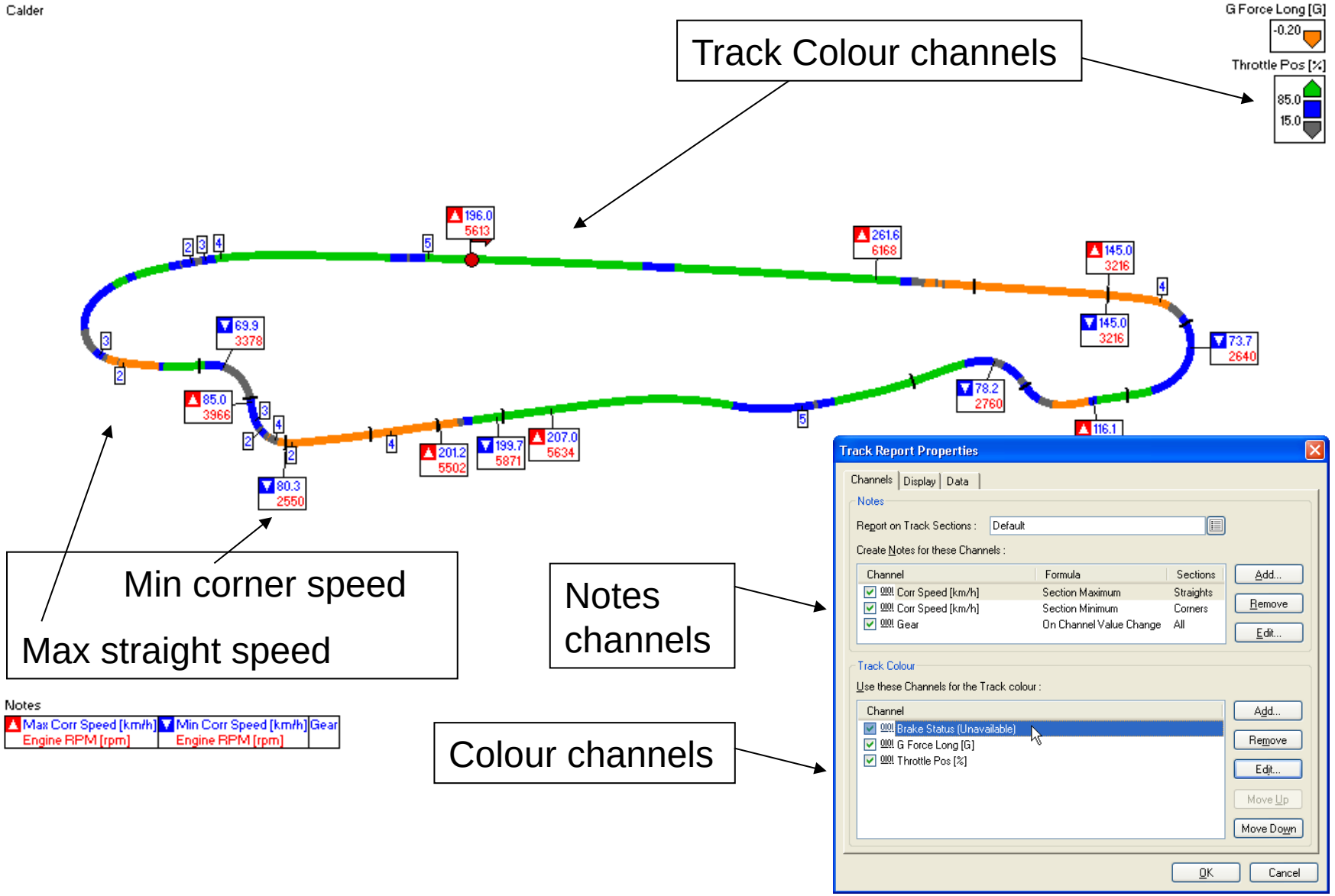


Track Mapping - Report

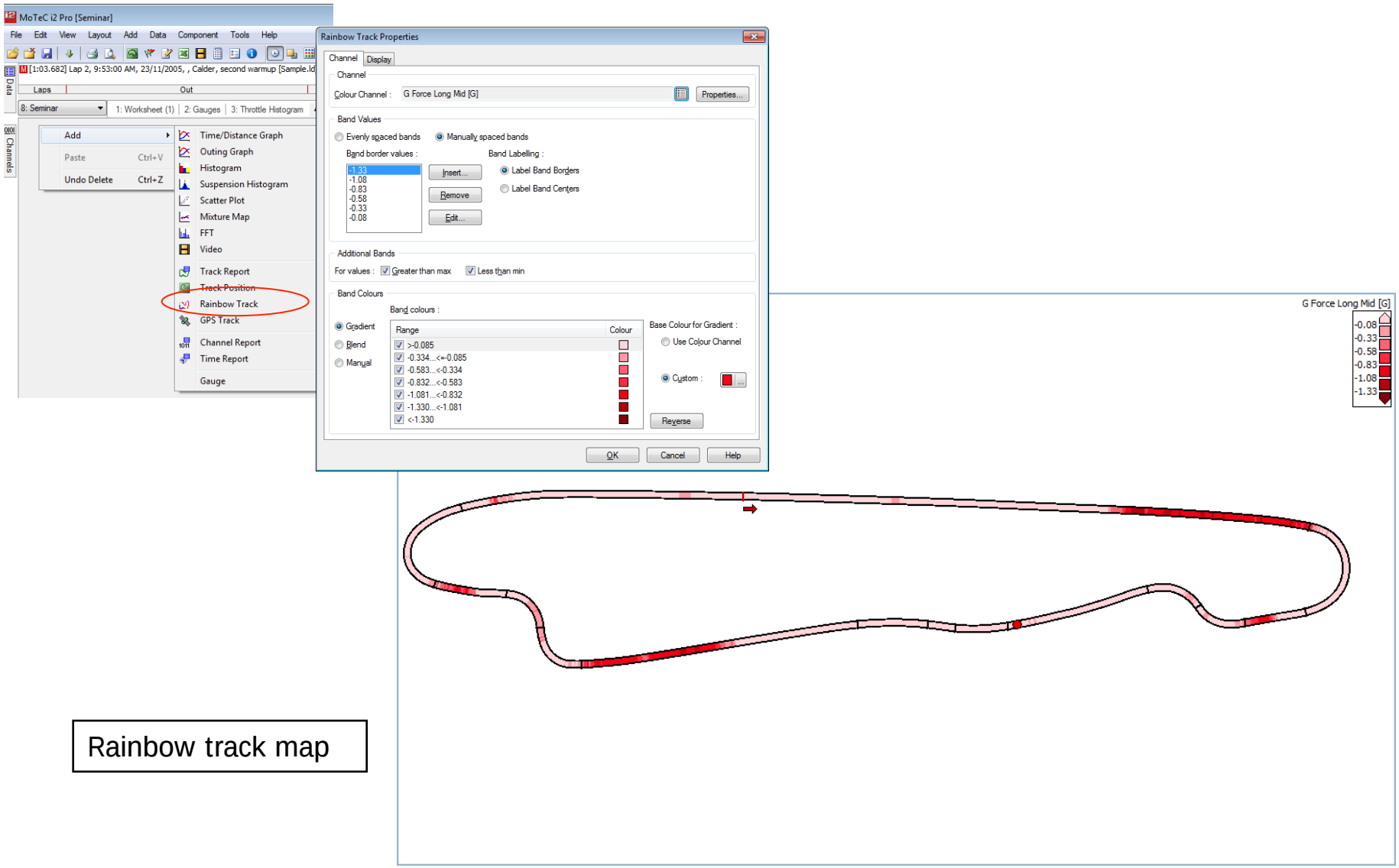


Track Report

Track Report

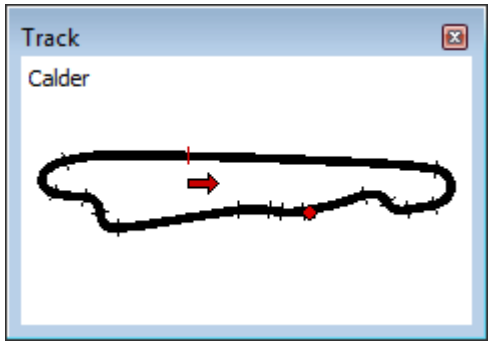


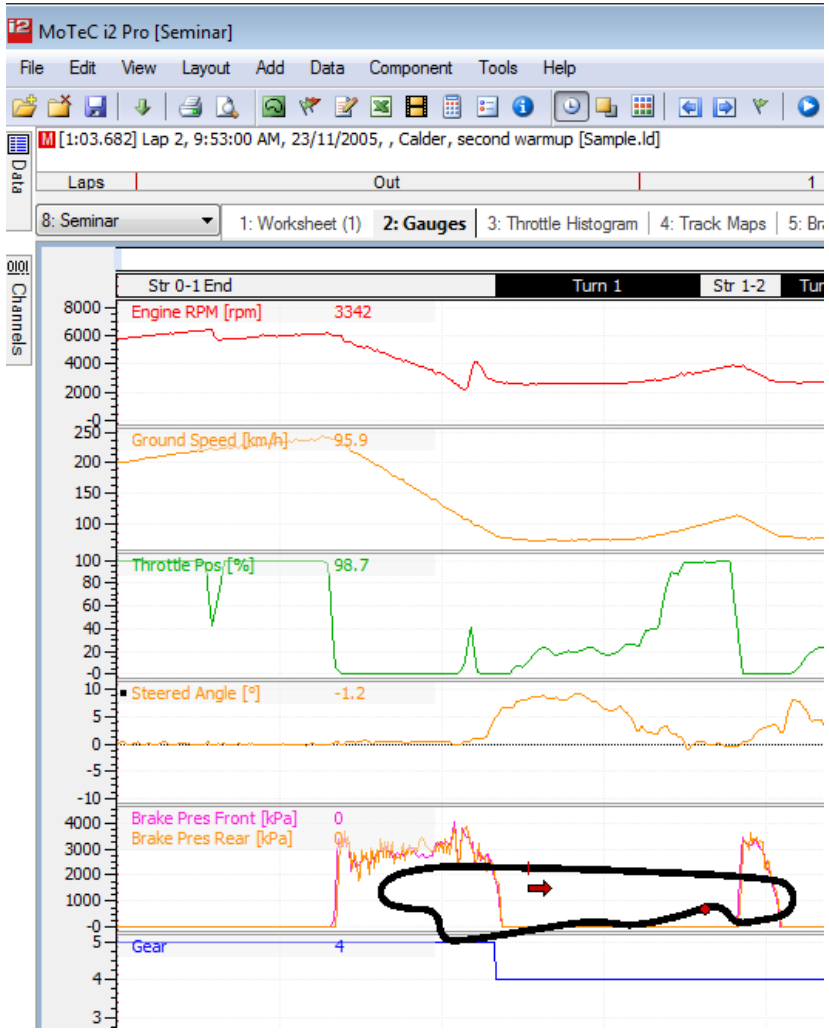
Track Mapping - Rainbow



Rainbow track map

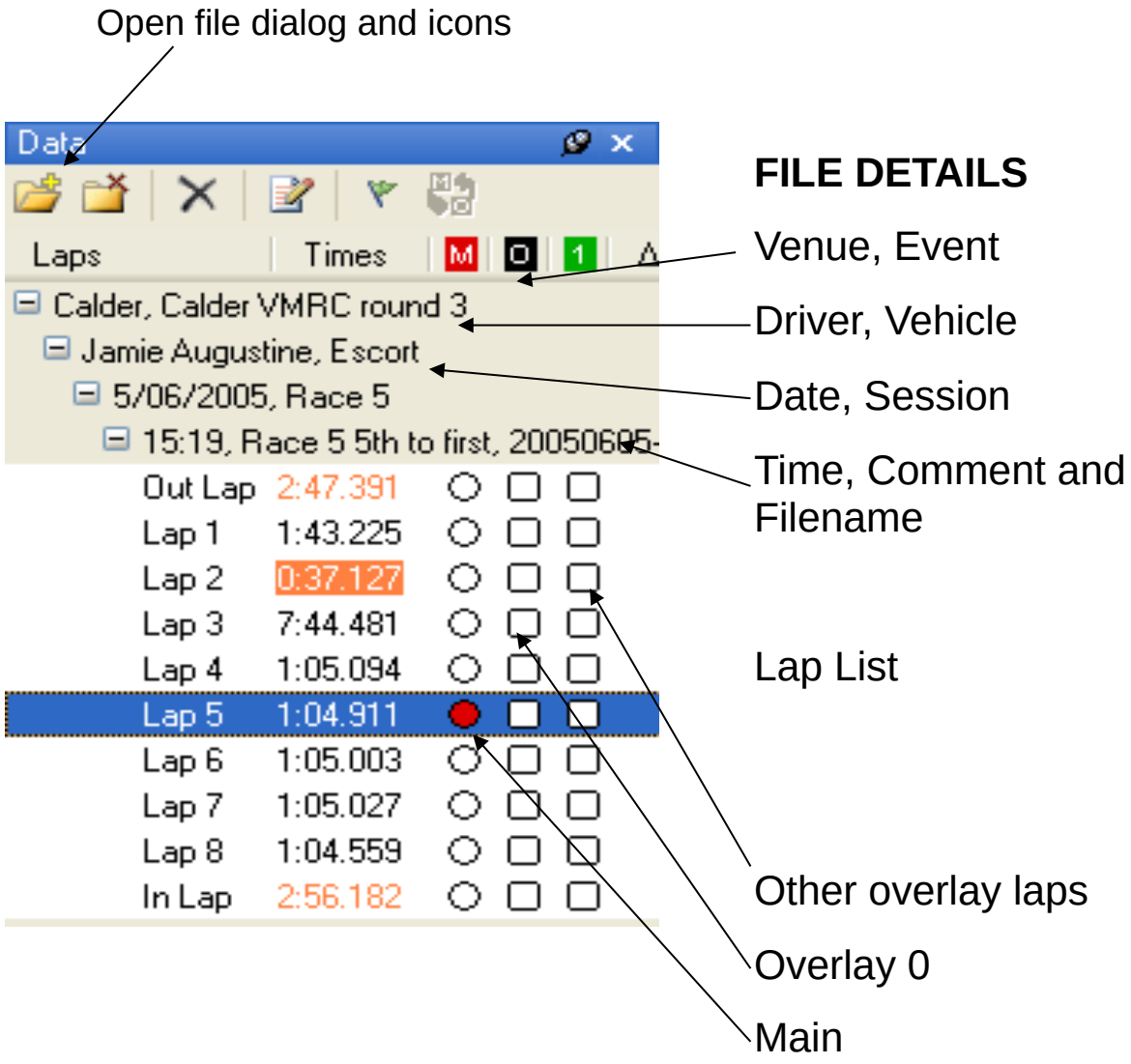
Track Mapping - Transparent





Data Window

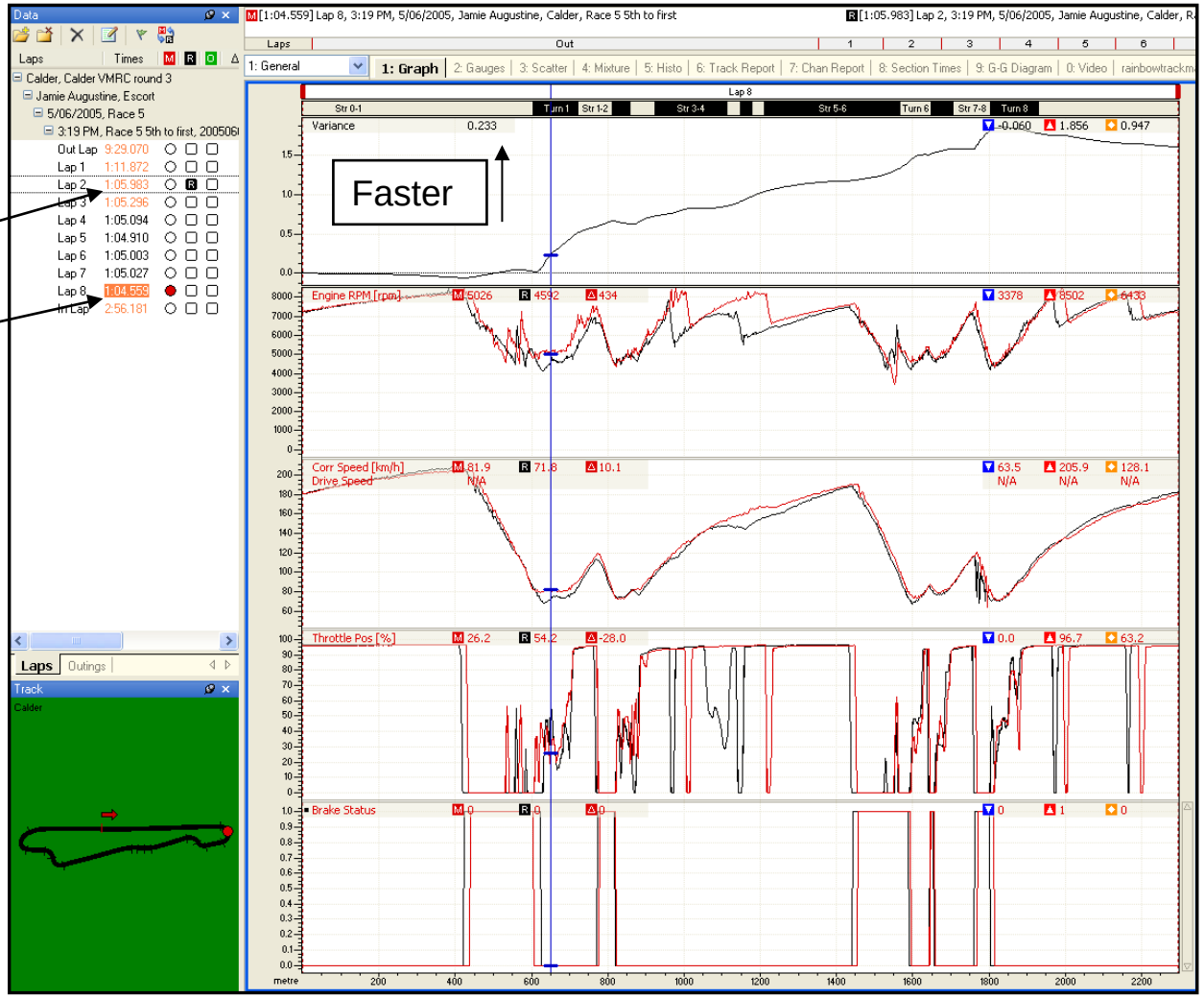
- Lap Selection
  - Main
  - Overlay
  - Other overlay laps



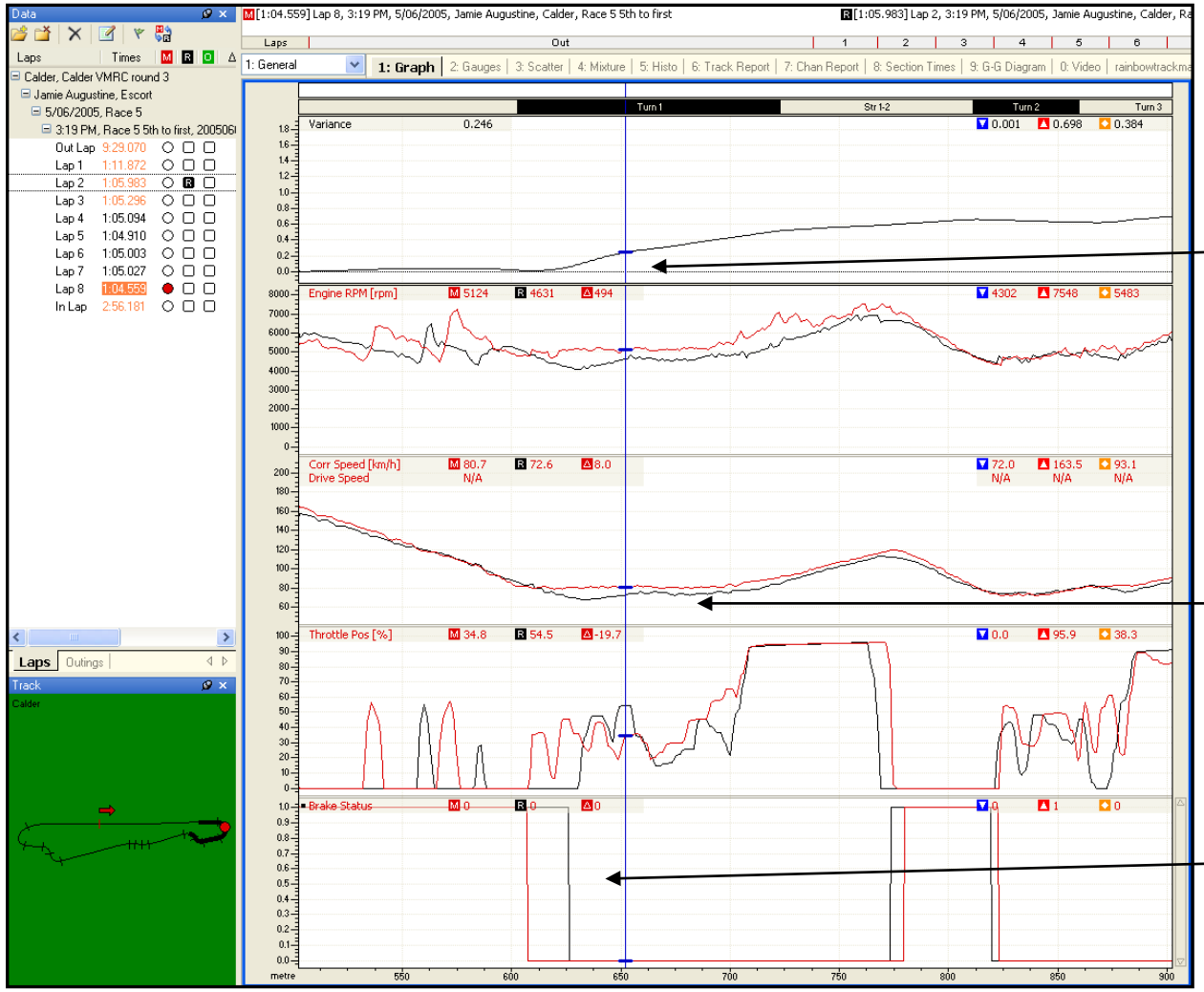
Comparing Laps - Overlays

Reference Lap (Black)

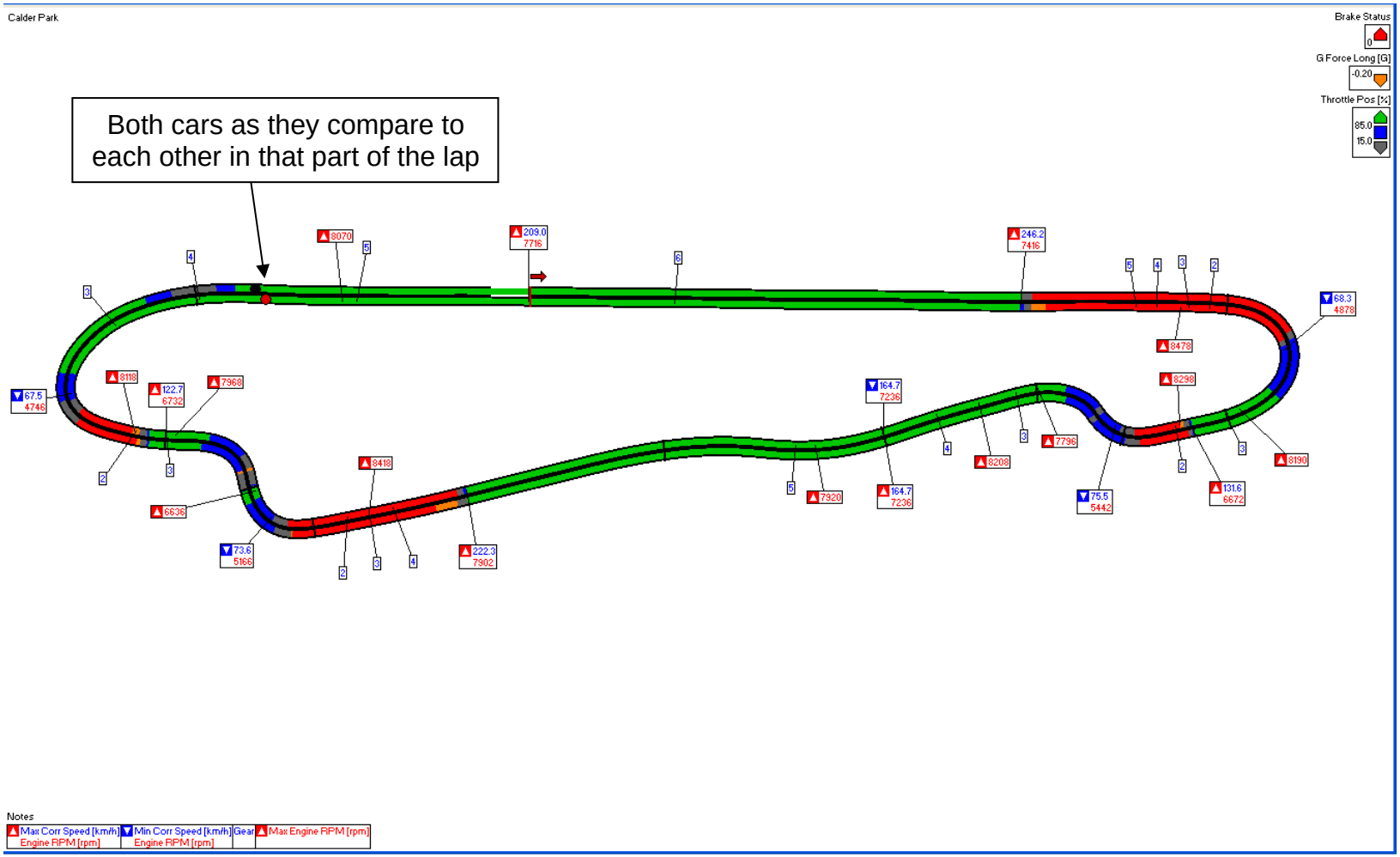
Main Lap (Red)



Where Did I Lose Time?



Overlayed Track Map



What is Lap Time Gain/Loss?

- Running time gain or loss compared to a reference lap.
- Continuously updated as the vehicle proceeds around the track.
- Gain/loss is zeroed each time the vehicle passes the beacon.
- Lap distance and running lap time channels are required.

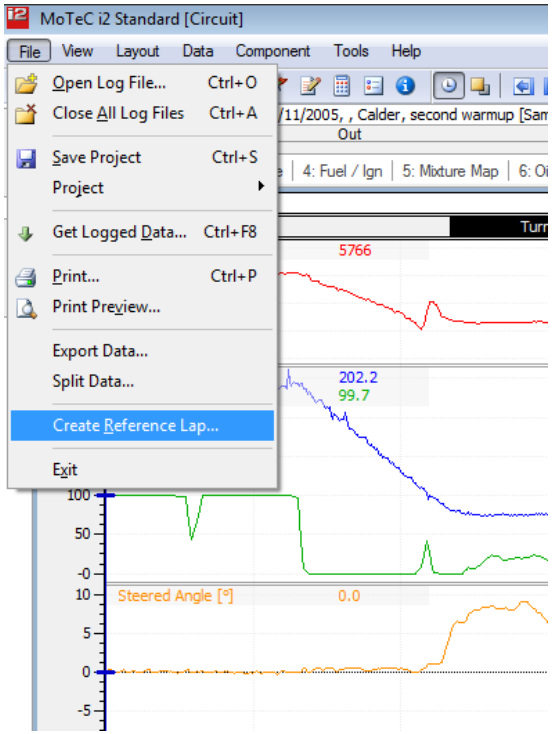
What is a Reference Lap?

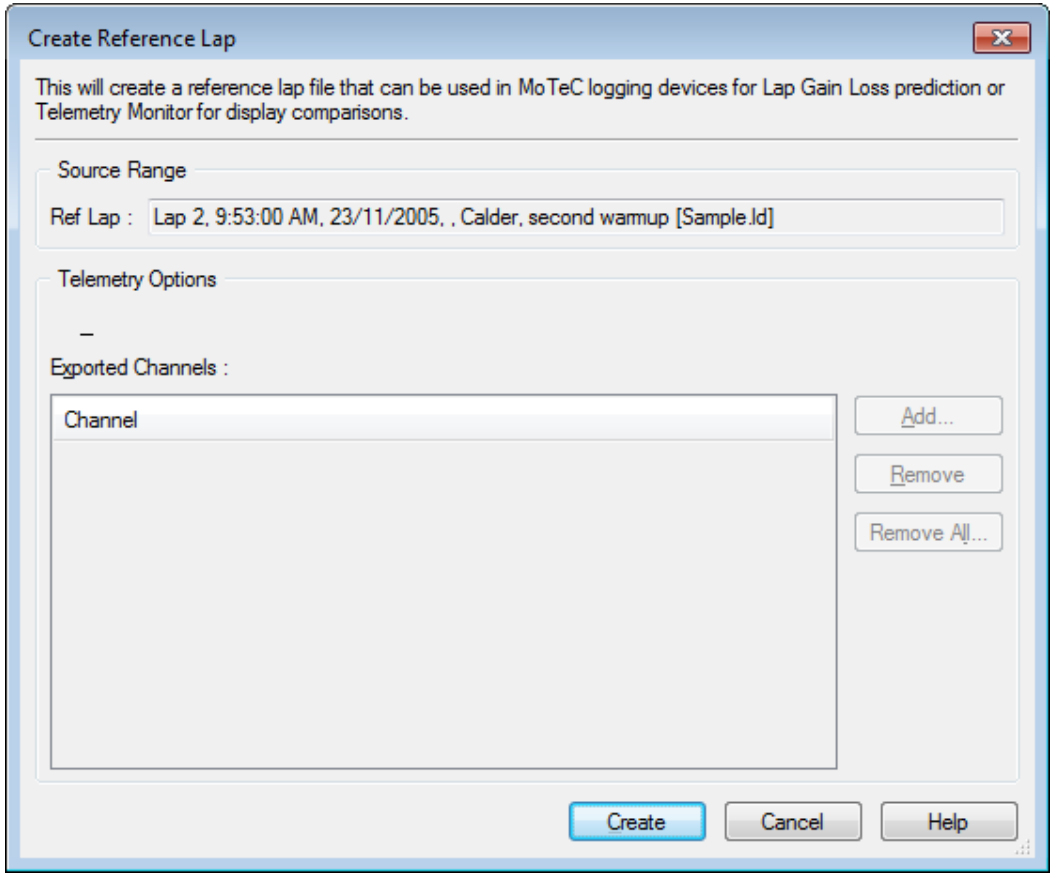
- A Reference Lap contains time and distance pairs indicating what time to expect at a certain distance around the track.

- The Reference Lap file must be created with i2, then loaded into the device using the device configuration software

Generating a Reference Lap in i2

- Click on File on the Main menu and click Create Reference Lap make sure that Lap Distance Channel is logged in the data

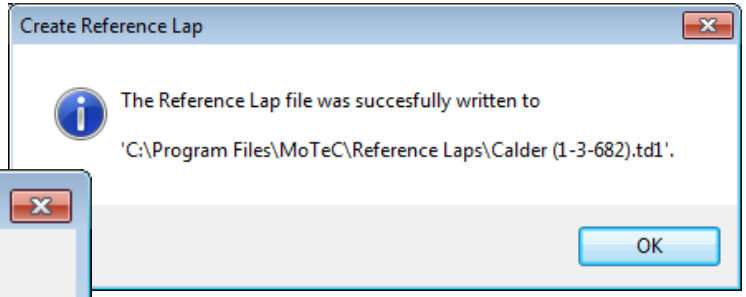


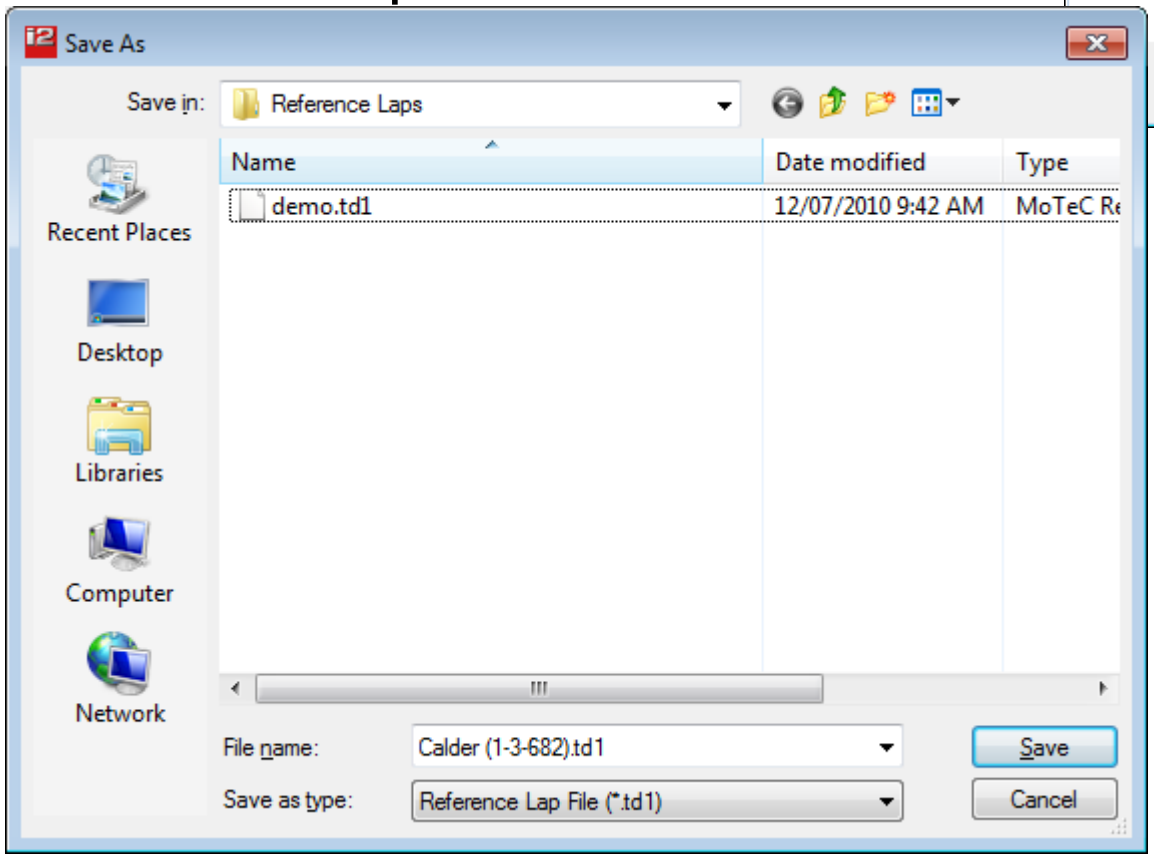


- ***i2*** will create a reference lap file for the current main lap

Generating a Reference Lap in i2

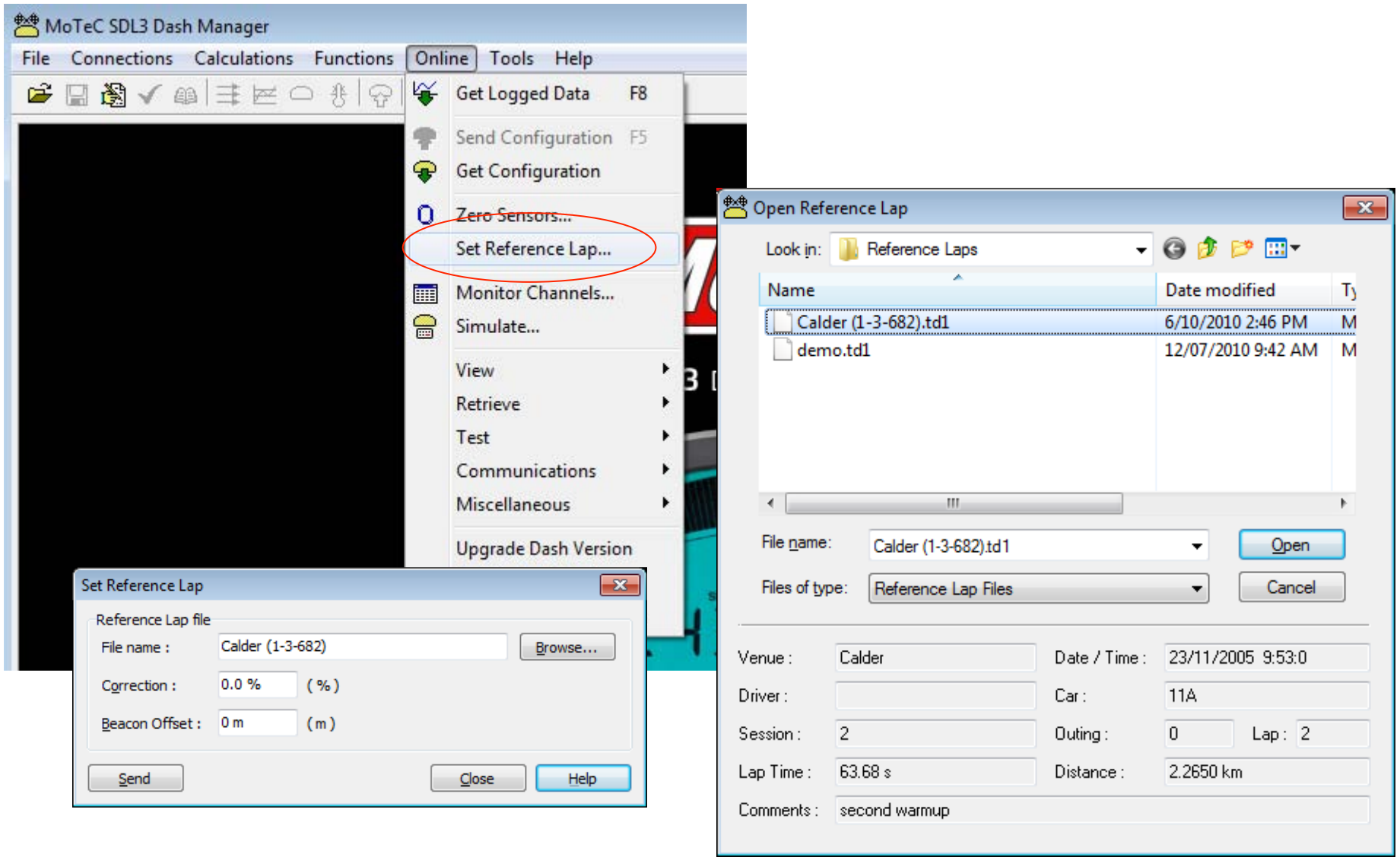
- Click Save button to create Reference lap





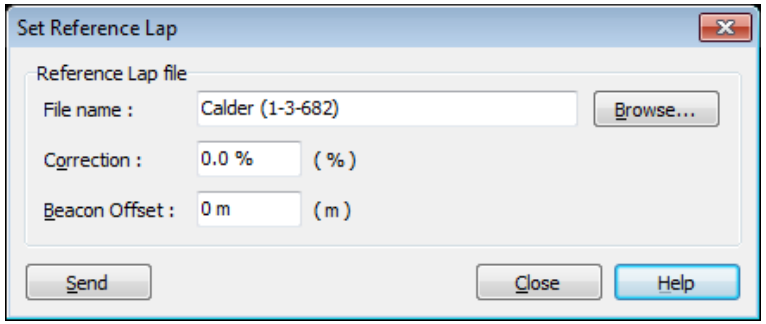
The default file name is created as follows:
Venue(Lap-time)
For example: Calder (1-3-682)
In this case the venue was Calder and the Lap- time was 1:03:682

Set Reference Lap in Dash



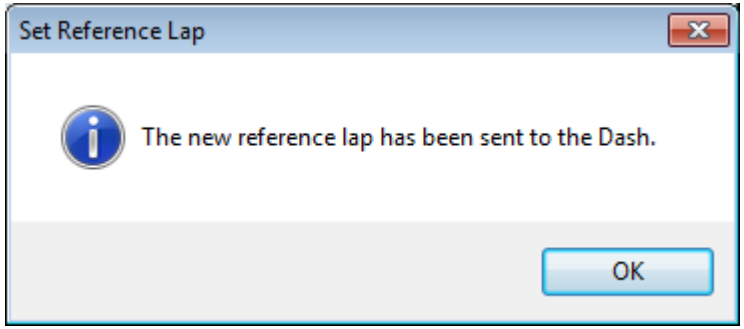
Set Reference Lap in Dash

- Click on Send button to load reference lap into SDL3



- If you want to make a correction to the lap distance or lap beacon position you can change this here

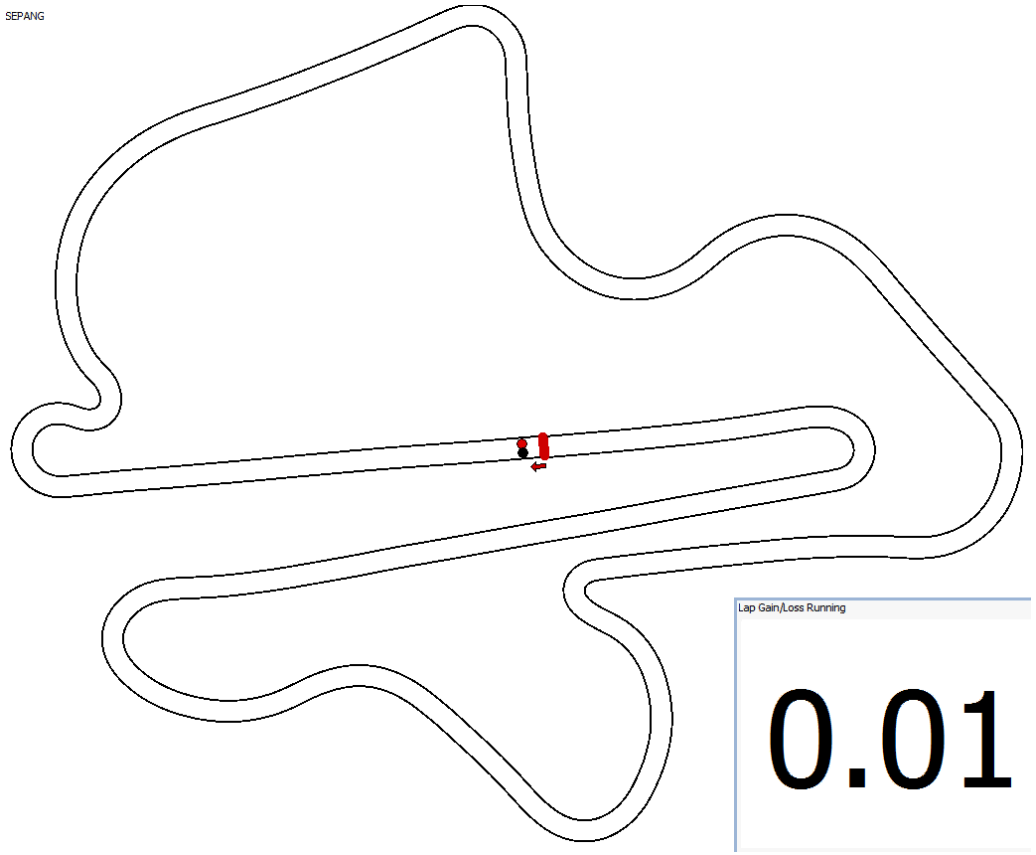
- Click OK and now your reference lap is set, always update your reference lap after a session when you have improved on your laptime



Gain Loss displayed in the car

Lap time gain loss can be displayed in any position on the ADL display. In this example, it is shown on the bottom row with the label “Fast Lap”.

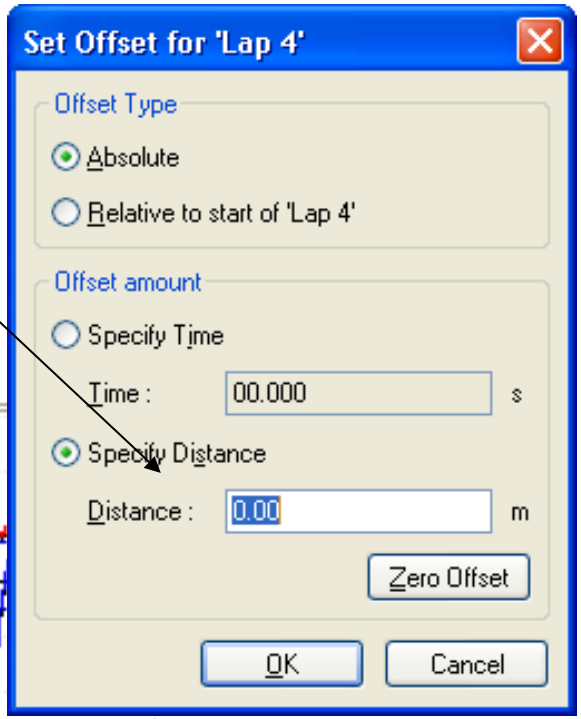
Gain Loss Video

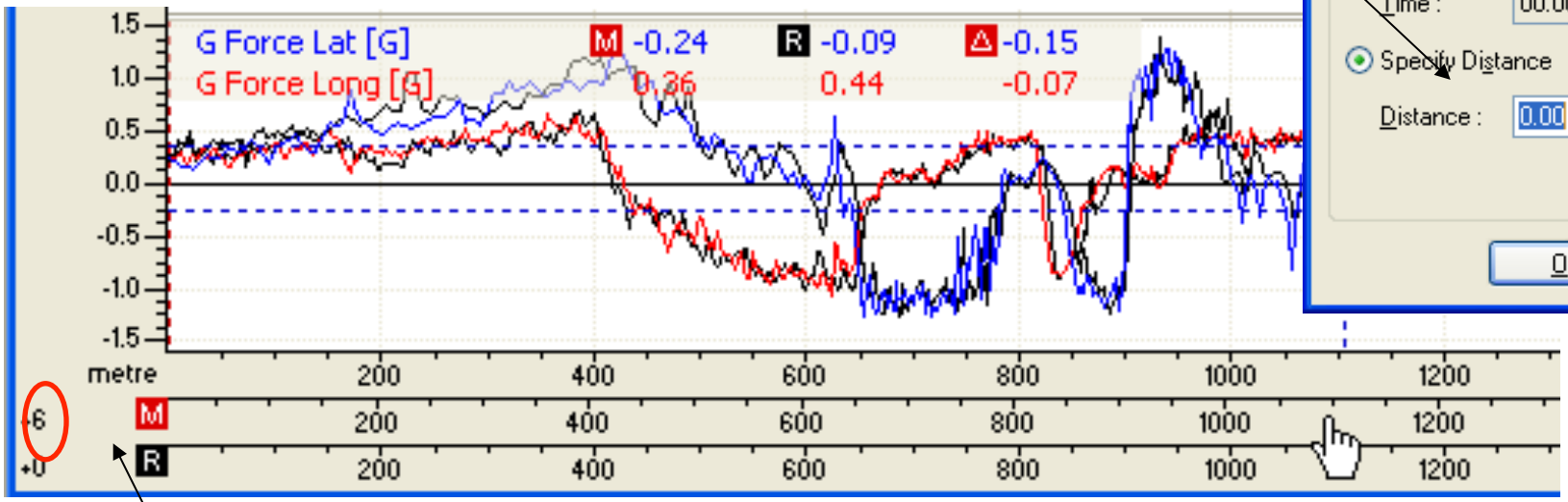


Offset Axes

Shortcut icon

Enter Offset value





Offset in Distance or Time

Click and drag Main or Ref (or Overlay) axes

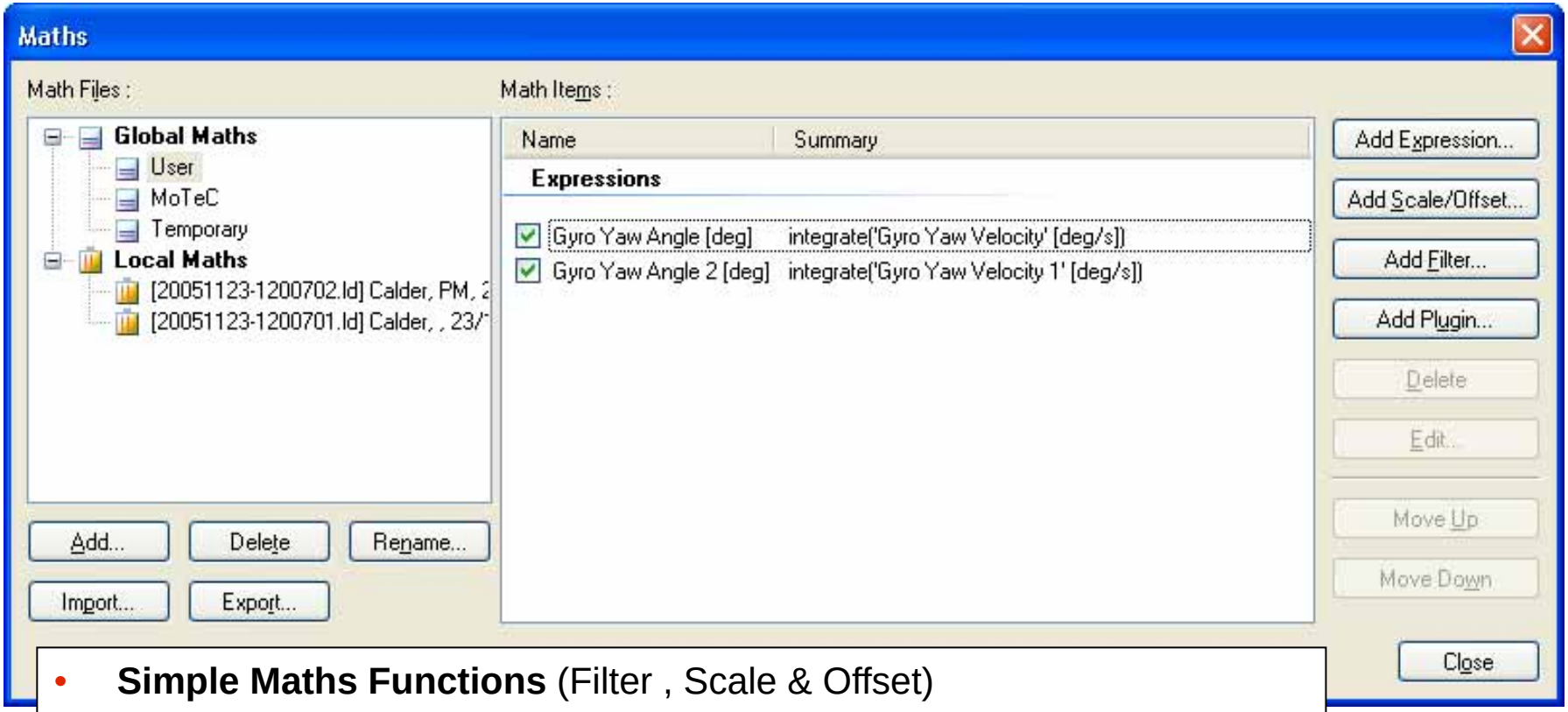
Status Channels

Status conditions shown in channels list

Status conditions shown on graph

Status conditions shown as gauges

Maths



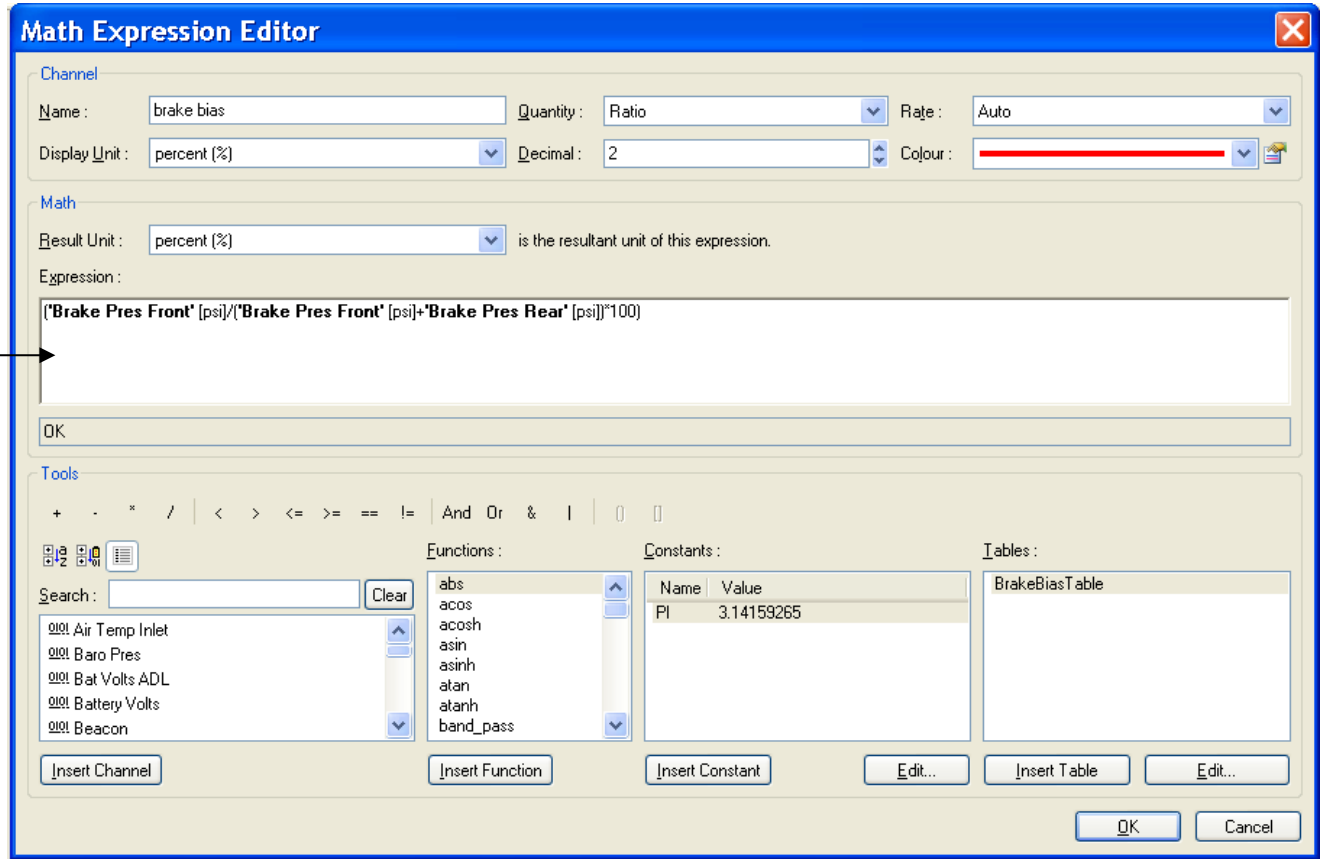
- **Simple Maths Functions** (Filter , Scale & Offset)

  A number of simplified maths functions are provided to avoid the need to use the expression editor for simple operations like Filtering and Scale & Offset. All other functions must be performed using the Expression Editor. Note that these functions modify the original channel – they do not create a new channel. To create a new channel use the corresponding functions in the expression editor.

Example Maths Expression

‘Brake Pres front’ [psi] / (‘Brake Pres front’ [psi] + ‘Brake Pres Rear’ [psi])

Type Maths Expression

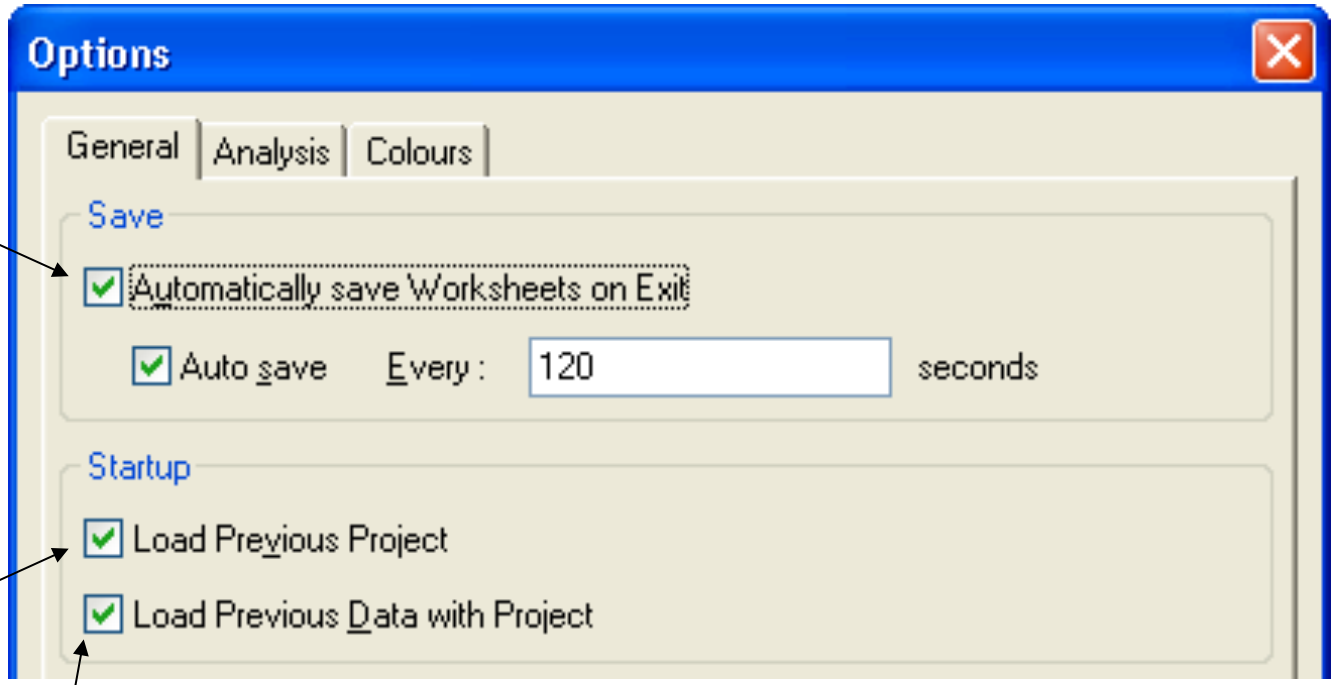


Save Project Settings

Saving project settings

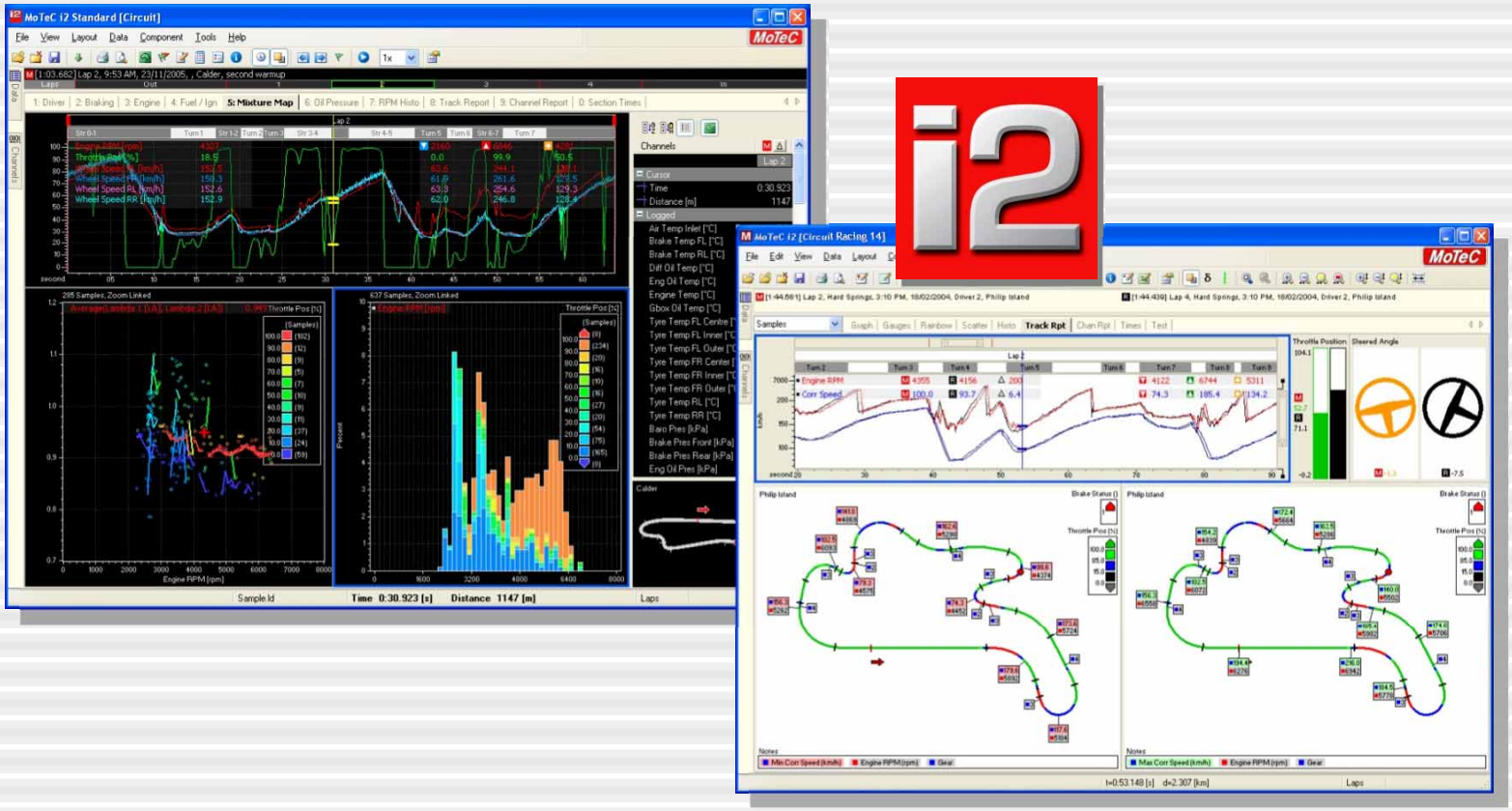
Start with same project

Start where you left off

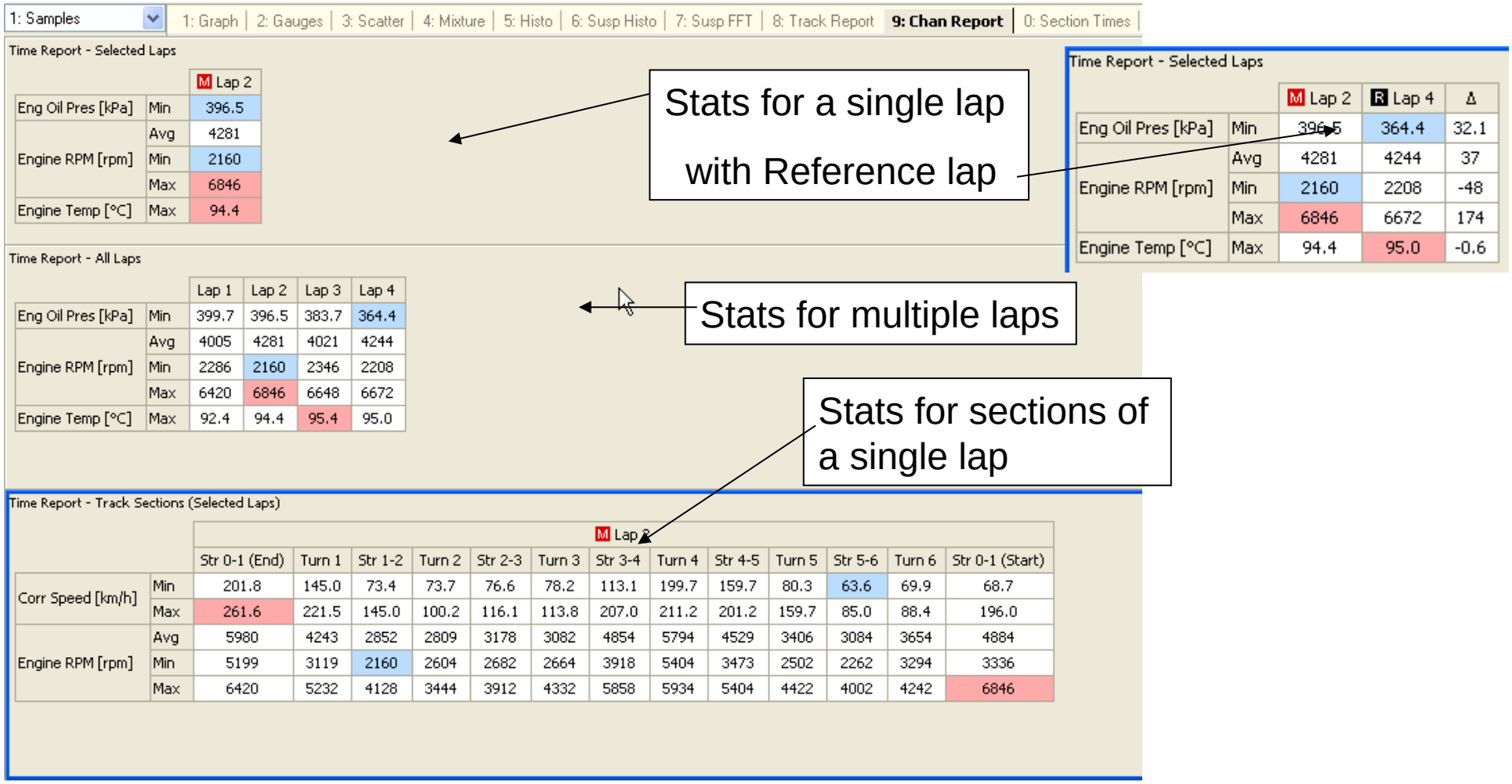


MoTeC

Reliability and Safety



Channel Report



Time Report - Selected Laps

		M Lap 2
Eng Oil Pres [kPa]	Min	396.5
Engine RPM [rpm]	Avg	4281
	Min	2160
	Max	6846
Engine Temp [°C]	Max	94.4

Time Report - Selected Laps

		M Lap 2	R Lap 4	Δ
Eng Oil Pres [kPa]	Min	396.5	364.4	32.1
Engine RPM [rpm]	Avg	4281	4244	37
	Min	2160	2208	-48
	Max	6846	6672	174
Engine Temp [°C]	Max	94.4	95.0	-0.6

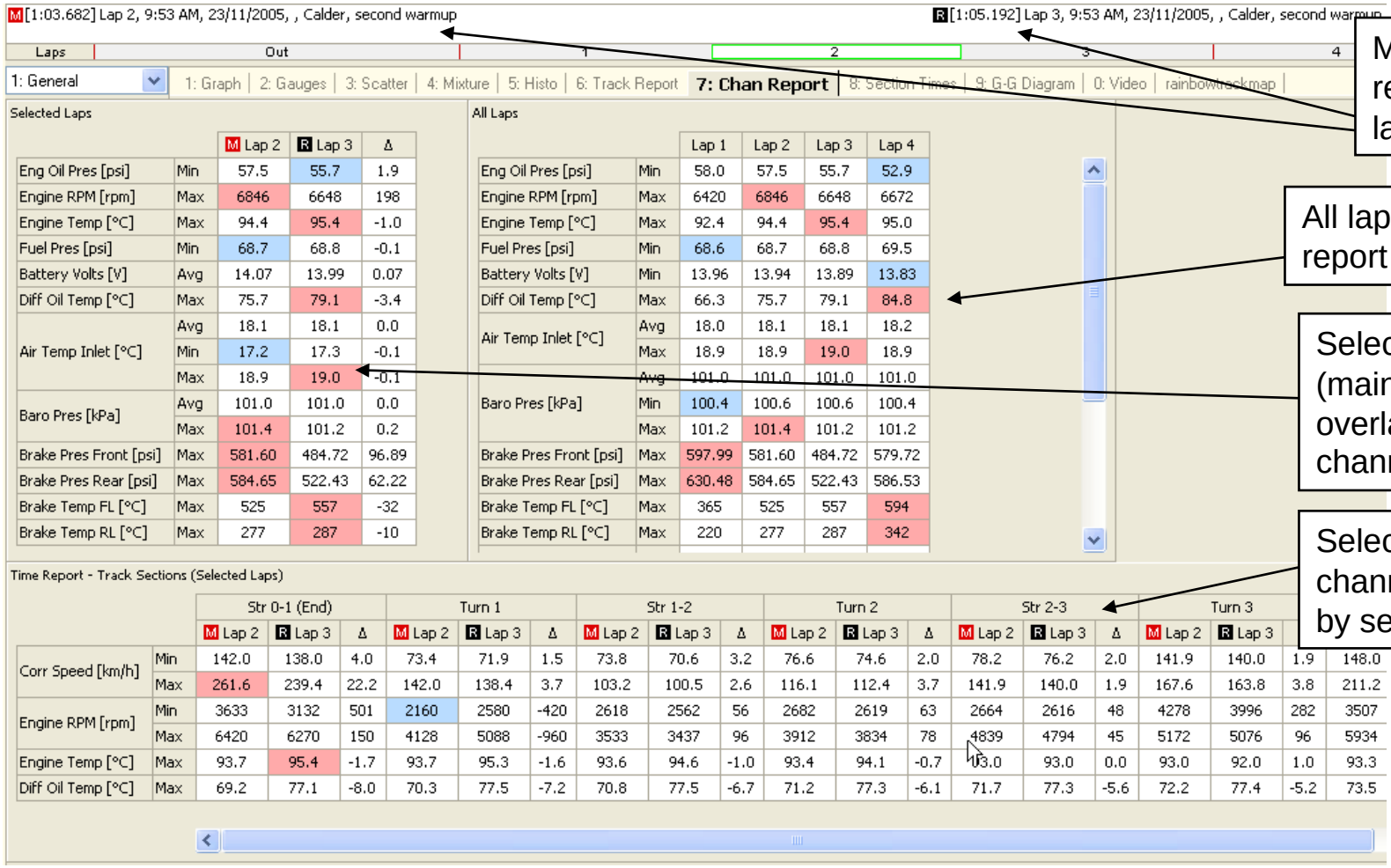
Time Report - All Laps

		Lap 1	Lap 2	Lap 3	Lap 4
Eng Oil Pres [kPa]	Min	399.7	396.5	383.7	364.4
Engine RPM [rpm]	Avg	4005	4281	4021	4244
	Min	2286	2160	2346	2208
	Max	6420	6846	6648	6672
Engine Temp [°C]	Max	92.4	94.4	95.4	95.0

Time Report - Track Sections (Selected Laps)

		M Lap 2											
		Str 0-1 (End)	Turn 1	Str 1-2	Turn 2	Str 2-3	Turn 3	Str 3-4	Turn 4	Str 4-5	Turn 5	Str 5-6	Turn 6	Str 0-1 (Start)
Corr Speed [km/h]	Min	201.8	145.0	73.4	73.7	76.6	78.2	113.1	199.7	159.7	80.3	63.6	69.9	68.7
	Max	261.6	221.5	145.0	100.2	116.1	113.8	207.0	211.2	201.2	159.7	85.0	88.4	196.0
Engine RPM [rpm]	Avg	5980	4243	2852	2809	3178	3082	4854	5794	4529	3406	3084	3654	4884
	Min	5199	3119	2160	2604	2682	2664	3918	5404	3473	2502	2262	3294	3336
	Max	6420	5232	4128	3444	3912	4332	5858	5934	5404	4422	4002	4242	6846

Using the Channel Reports



Selected Laps

		M Lap 2	R Lap 3	Δ
Eng Oil Pres [psi]	Min	57.5	55.7	1.9
Engine RPM [rpm]	Max	6846	6648	198
Engine Temp [°C]	Max	94.4	95.4	-1.0
Fuel Pres [psi]	Min	68.7	68.8	-0.1
Battery Volts [V]	Avg	14.07	13.99	0.07
Diff Oil Temp [°C]	Max	75.7	79.1	-3.4
Air Temp Inlet [°C]	Avg	18.1	18.1	0.0
	Min	17.2	17.3	-0.1
	Max	18.9	19.0	-0.1
Baro Pres [kPa]	Avg	101.0	101.0	0.0
	Max	101.4	101.2	0.2
Brake Pres Front [psi]	Max	581.60	484.72	96.89
Brake Pres Rear [psi]	Max	584.65	522.43	62.22
Brake Temp FL [°C]	Max	525	557	-32
Brake Temp RL [°C]	Max	277	287	-10

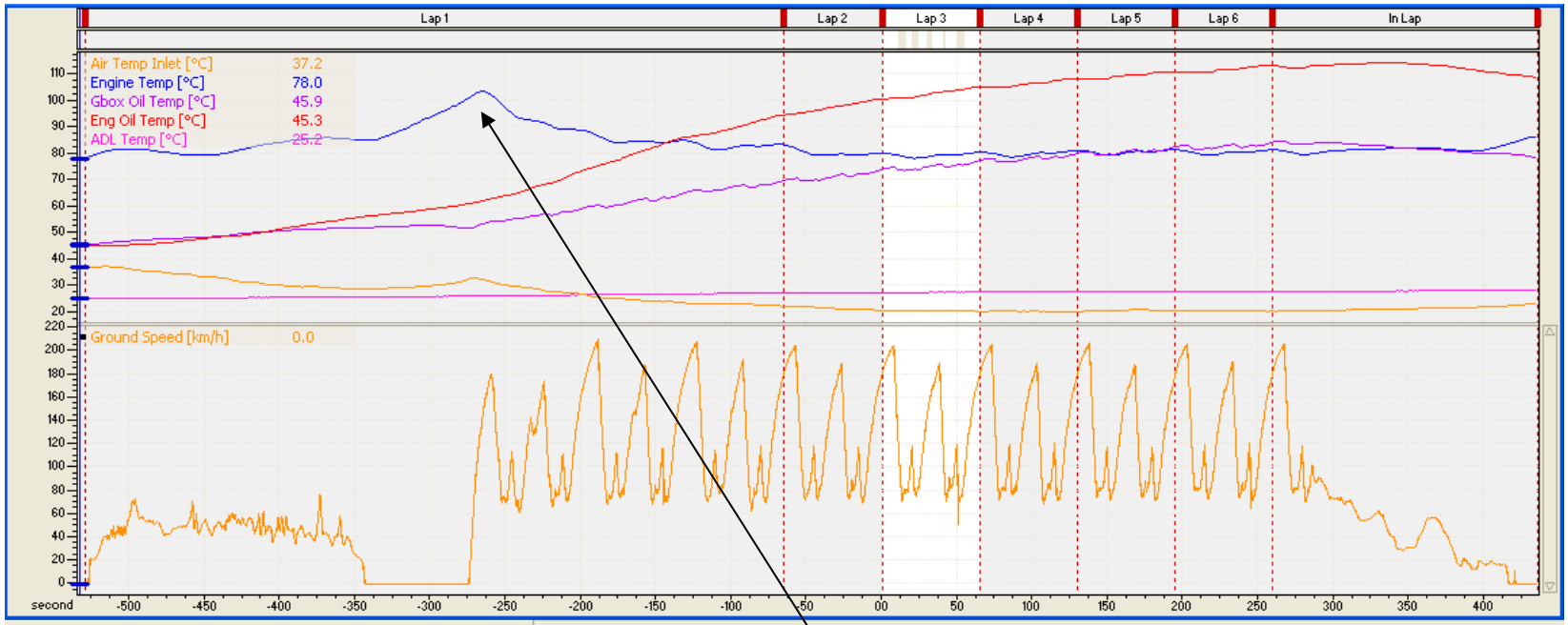
All Laps

		Lap 1	Lap 2	Lap 3	Lap 4
Eng Oil Pres [psi]	Min	58.0	57.5	55.7	52.9
Engine RPM [rpm]	Max	6420	6846	6648	6672
Engine Temp [°C]	Max	92.4	94.4	95.4	95.0
Fuel Pres [psi]	Min	68.6	68.7	68.8	69.5
Battery Volts [V]	Min	13.96	13.94	13.89	13.83
Diff Oil Temp [°C]	Max	66.3	75.7	79.1	84.8
Air Temp Inlet [°C]	Avg	18.0	18.1	18.1	18.2
	Max	18.9	18.9	19.0	18.9
	Avg	101.0	101.0	101.0	101.0
Baro Pres [kPa]	Min	100.4	100.6	100.6	100.4
	Max	101.2	101.4	101.2	101.2
Brake Pres Front [psi]	Max	597.99	581.60	484.72	579.72
Brake Pres Rear [psi]	Max	630.48	584.65	522.43	586.53
Brake Temp FL [°C]	Max	365	525	557	594
Brake Temp RL [°C]	Max	220	277	287	342

Time Report - Track Sections (Selected Laps)

		Str 0-1 (End)			Turn 1			Str 1-2			Turn 2			Str 2-3			Turn 3			
		M Lap 2	R Lap 3	Δ	M Lap 2	R Lap 3	Δ	M Lap 2	R Lap 3	Δ	M Lap 2	R Lap 3	Δ	M Lap 2	R Lap 3	Δ	M Lap 2	R Lap 3		
Corr Speed [km/h]	Min	142.0	138.0	4.0	73.4	71.9	1.5	73.8	70.6	3.2	76.6	74.6	2.0	78.2	76.2	2.0	141.9	140.0	1.9	148.0
	Max	261.6	239.4	22.2	142.0	138.4	3.7	103.2	100.5	2.6	116.1	112.4	3.7	141.9	140.0	1.9	167.6	163.8	3.8	211.2
Engine RPM [rpm]	Min	3633	3132	501	2160	2580	-420	2618	2562	56	2682	2619	63	2664	2616	48	4278	3996	282	3507
	Max	6420	6270	150	4128	5088	-960	3533	3437	96	3912	3834	78	4839	4794	45	5172	5076	96	5934
Engine Temp [°C]	Max	93.7	95.4	-1.7	93.7	95.3	-1.6	93.6	94.6	-1.0	93.4	94.1	-0.7	93.0	93.0	0.0	93.0	92.0	1.0	93.3
Diff Oil Temp [°C]	Max	69.2	77.1	-8.0	70.3	77.5	-7.2	70.8	77.5	-6.7	71.2	77.3	-6.1	71.7	77.3	-5.6	72.2	77.4	-5.2	73.5

Reading Temperatures



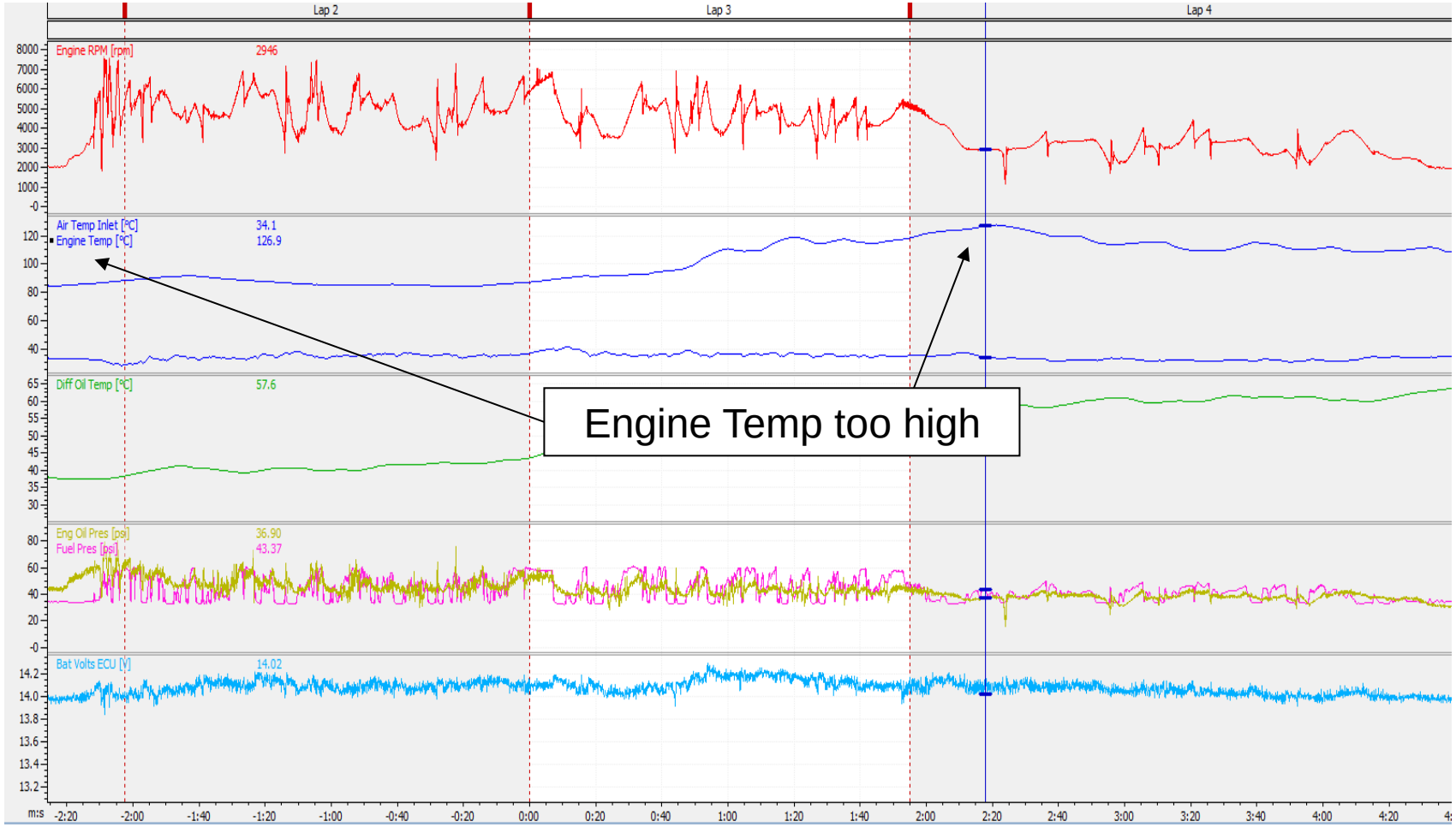
Channel Report - All Laps

		Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6
ADL Temp [°C]	Max	27.3	27.6	27.7	27.8	27.9	28.1
Air Temp Inlet [°C]	Max	37.4	22.3	20.9	20.6	21.1	20.8
Eng Oil Temp [°C]	Max	94.7	100.6	105.0	108.5	111.0	113.3
Engine Temp [°C]	Max	103.5	83.3	80.5	81.3	81.6	81.6
Gbox Oil Temp [°C]	Max	69.9	74.1	77.5	80.2	82.7	84.2

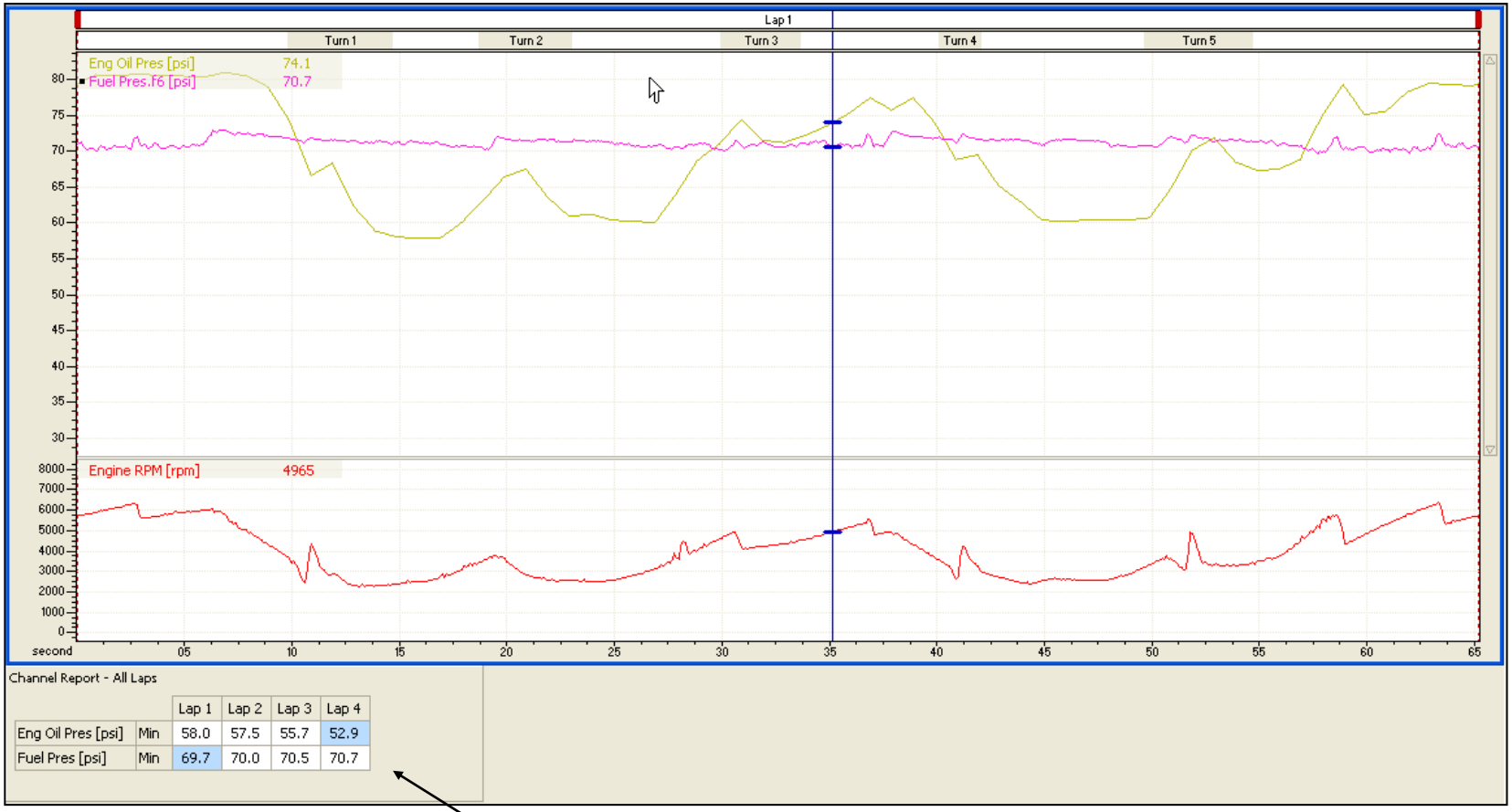
Max Engine Temp

The maximum temps for each channel by lap

Engine Temperature Problem



Reading Pressures



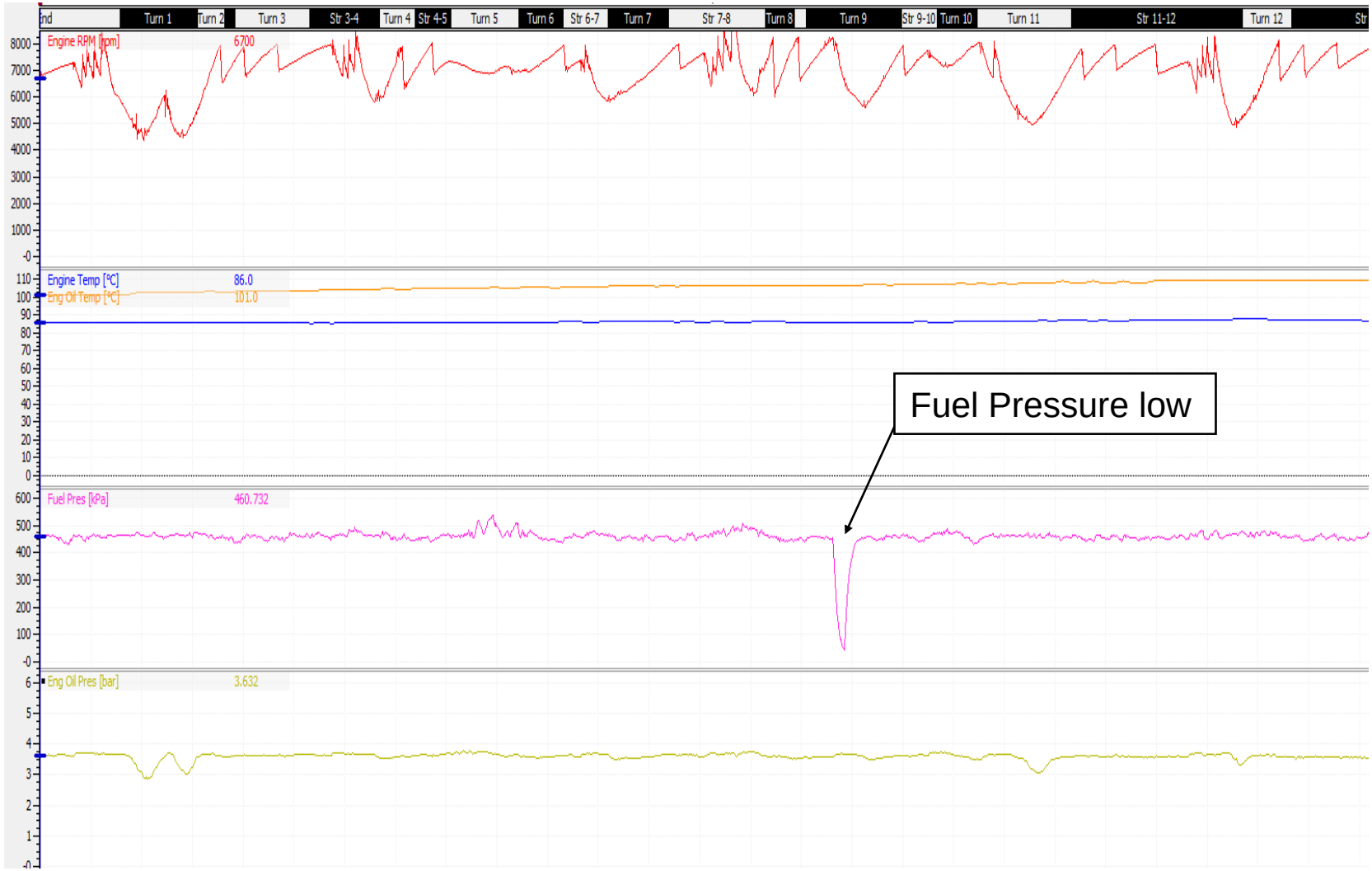
Channel Report - All Laps

		Lap 1	Lap 2	Lap 3	Lap 4
Eng Oil Pres [psi]	Min	58.0	57.5	55.7	52.9
Fuel Pres [psi]	Min	69.7	70.0	70.5	70.7

Pressure summary per lap

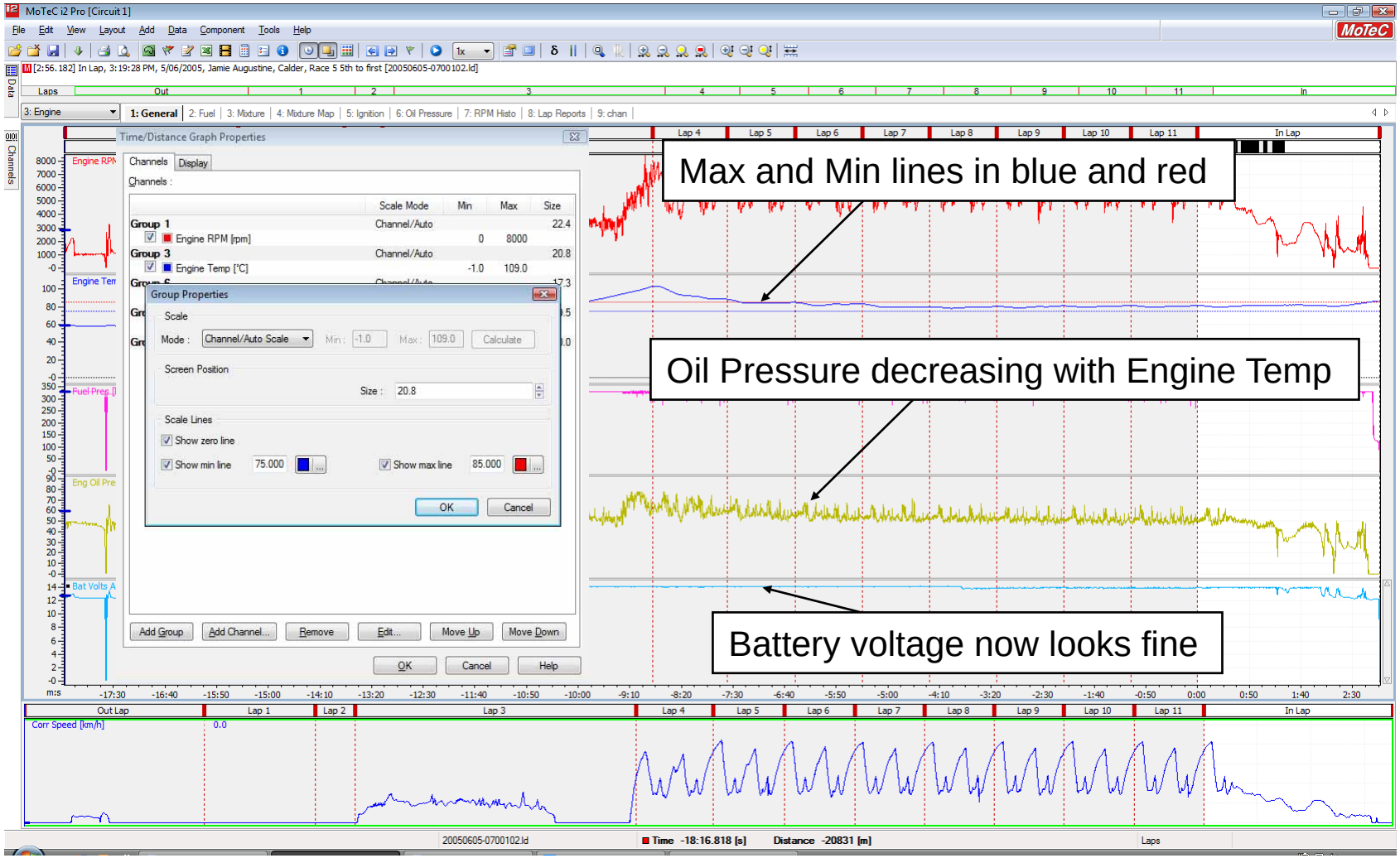
Oil Pressure Problem

Fuel Pressure Problem

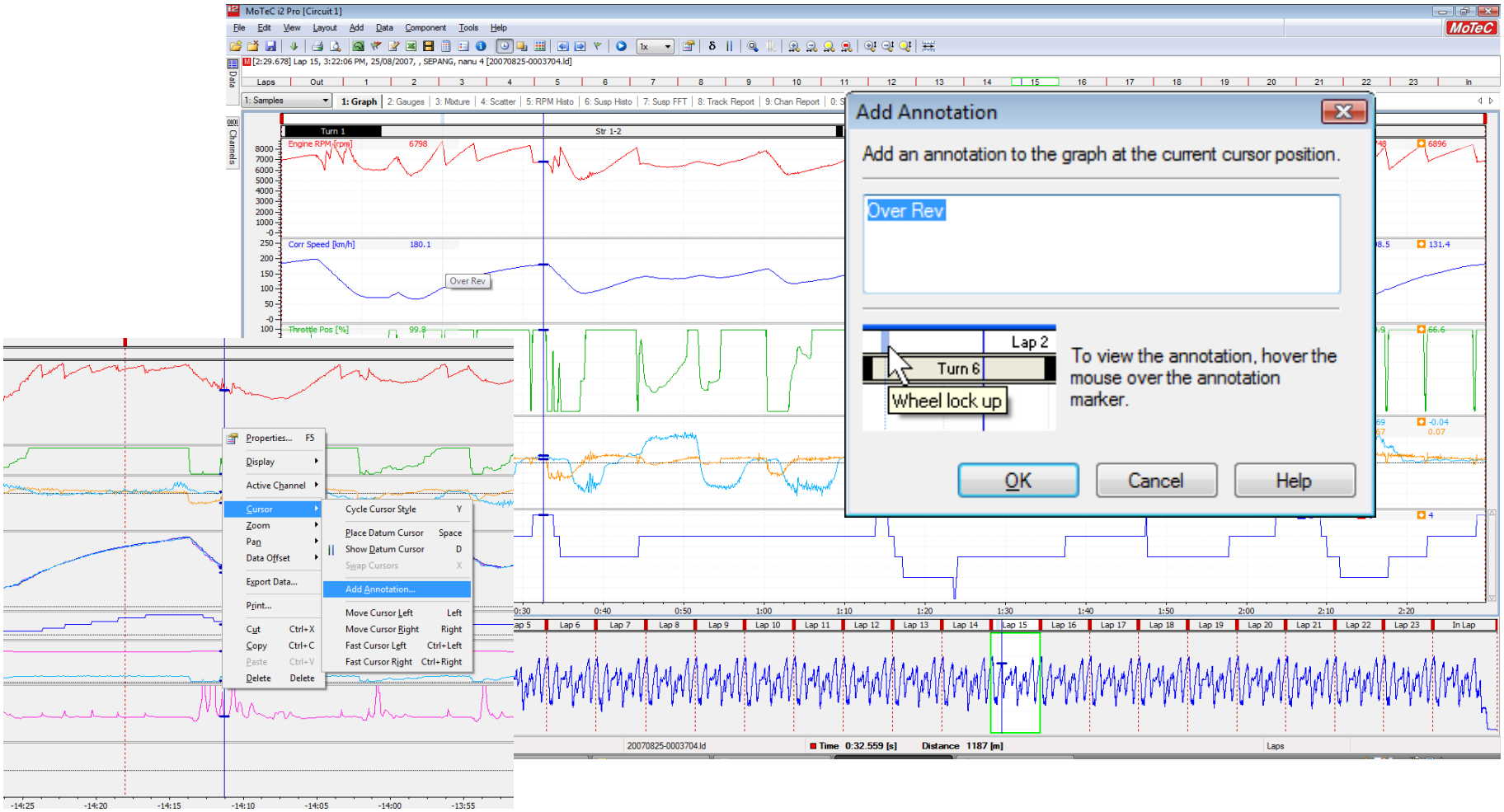


Reading Battery Voltages

Useful Tips

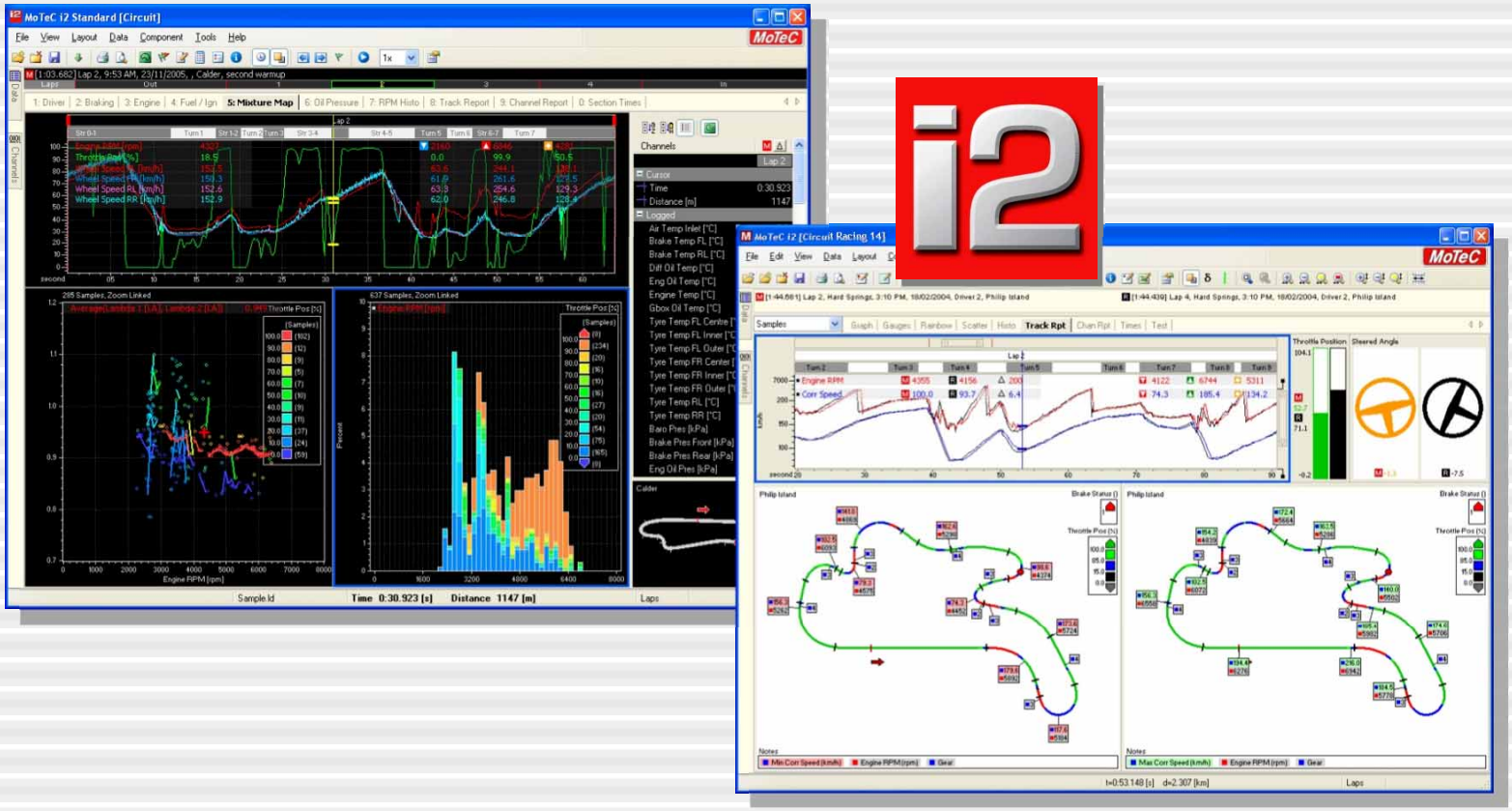

Max and Min lines in blue and red
Oil Pressure decreasing with Engine Temp
Battery voltage now looks fine

Annotations

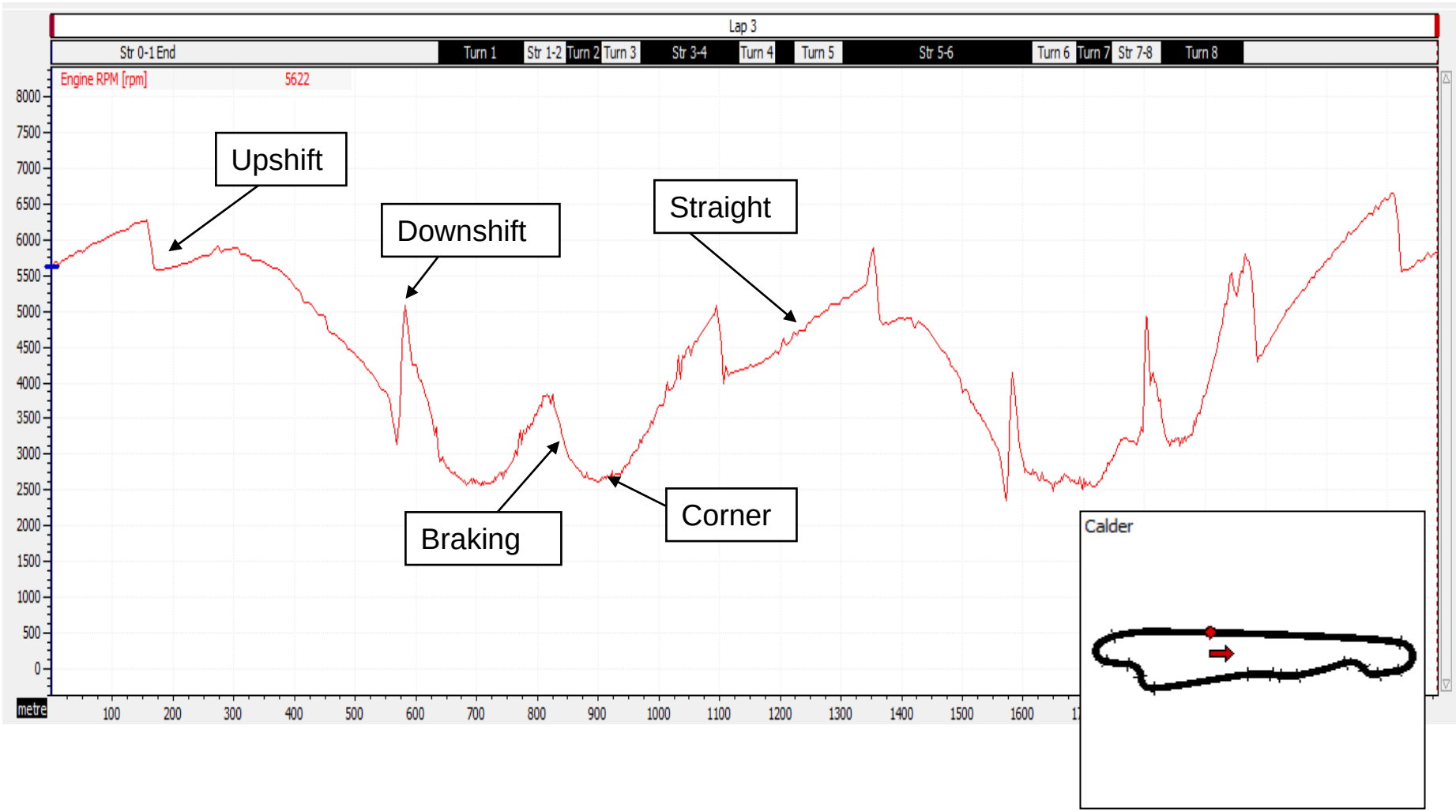


MoTeC

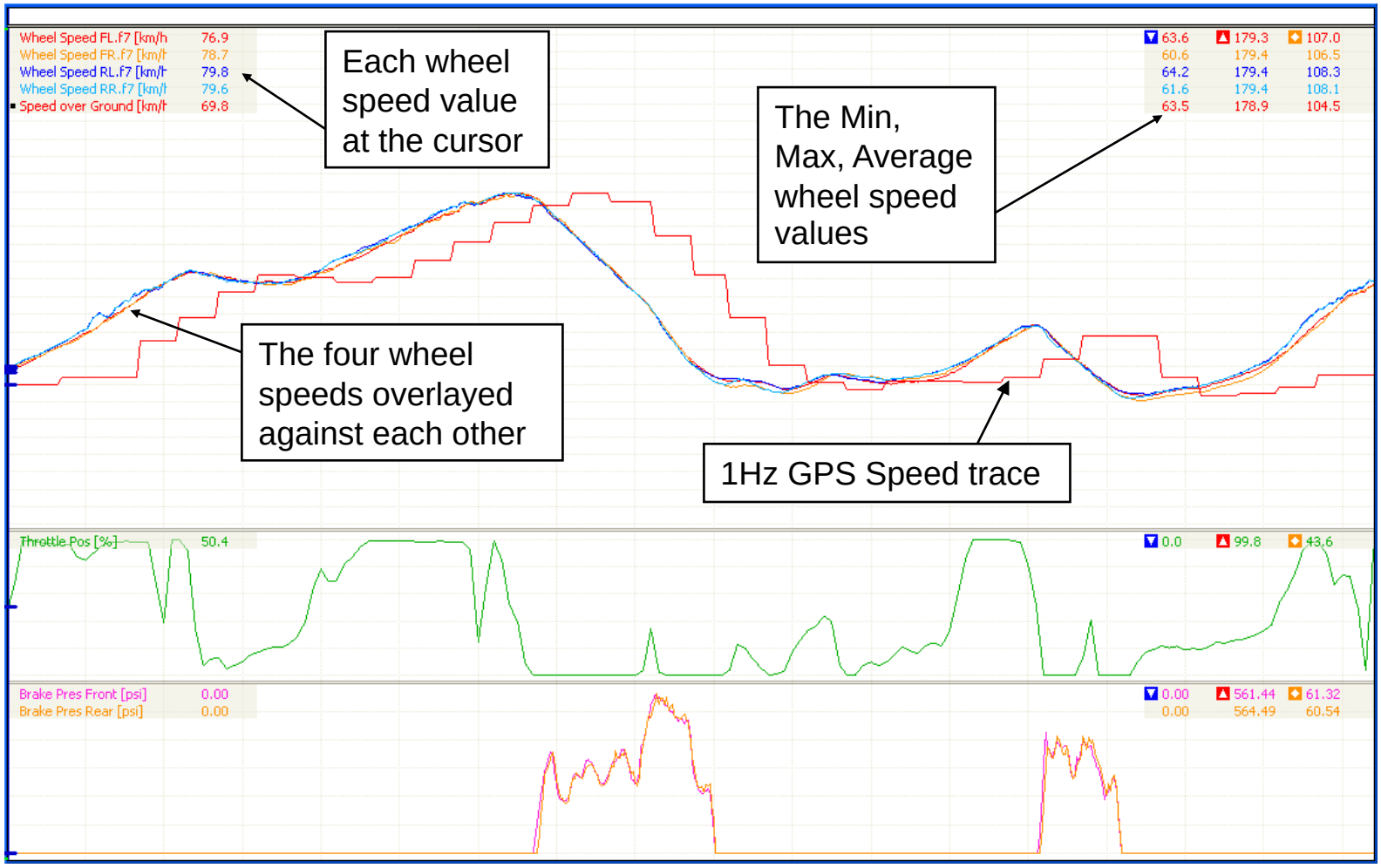
Evaluating Driver Performance



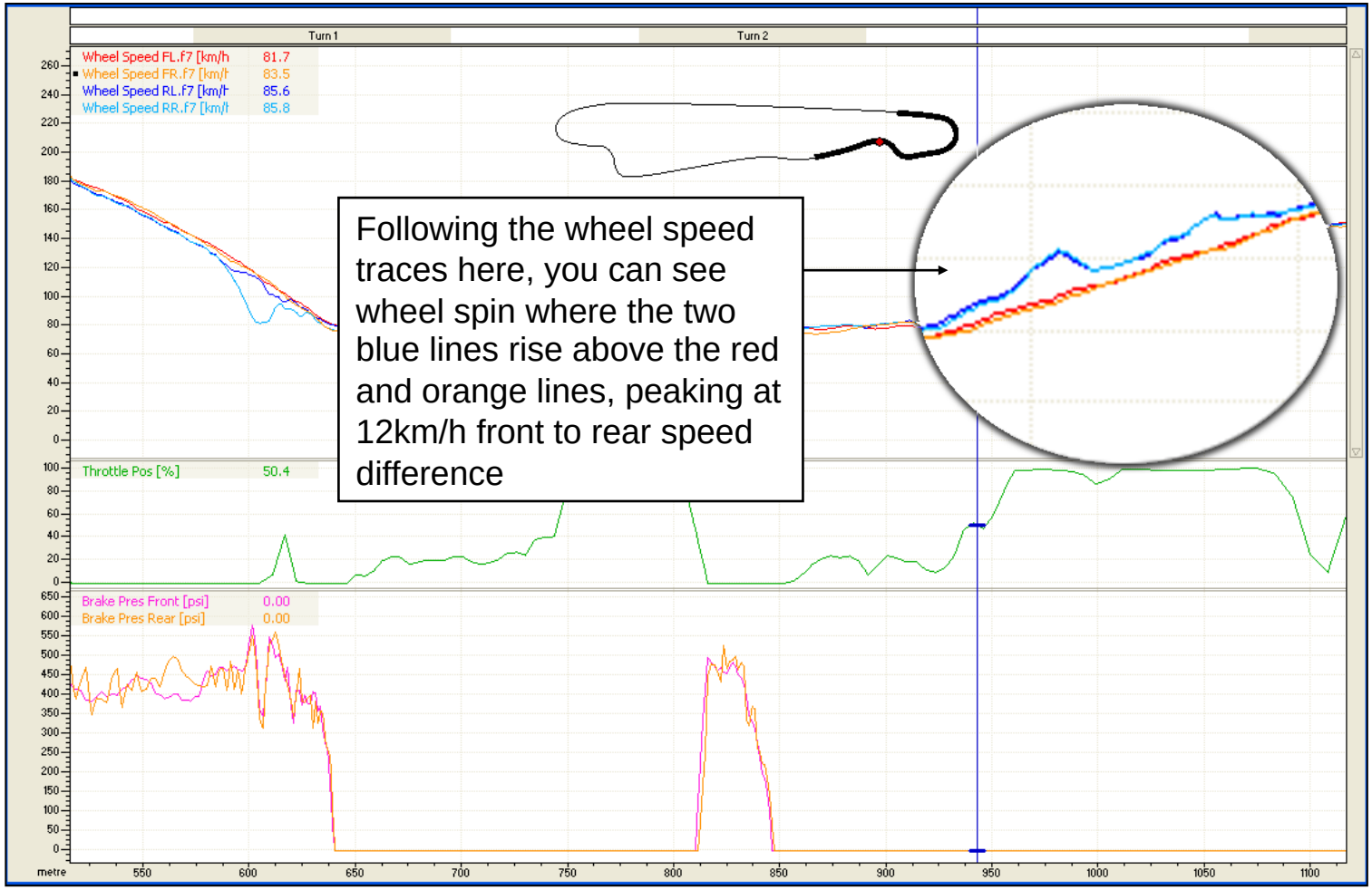
Reading Engine RPM Trace



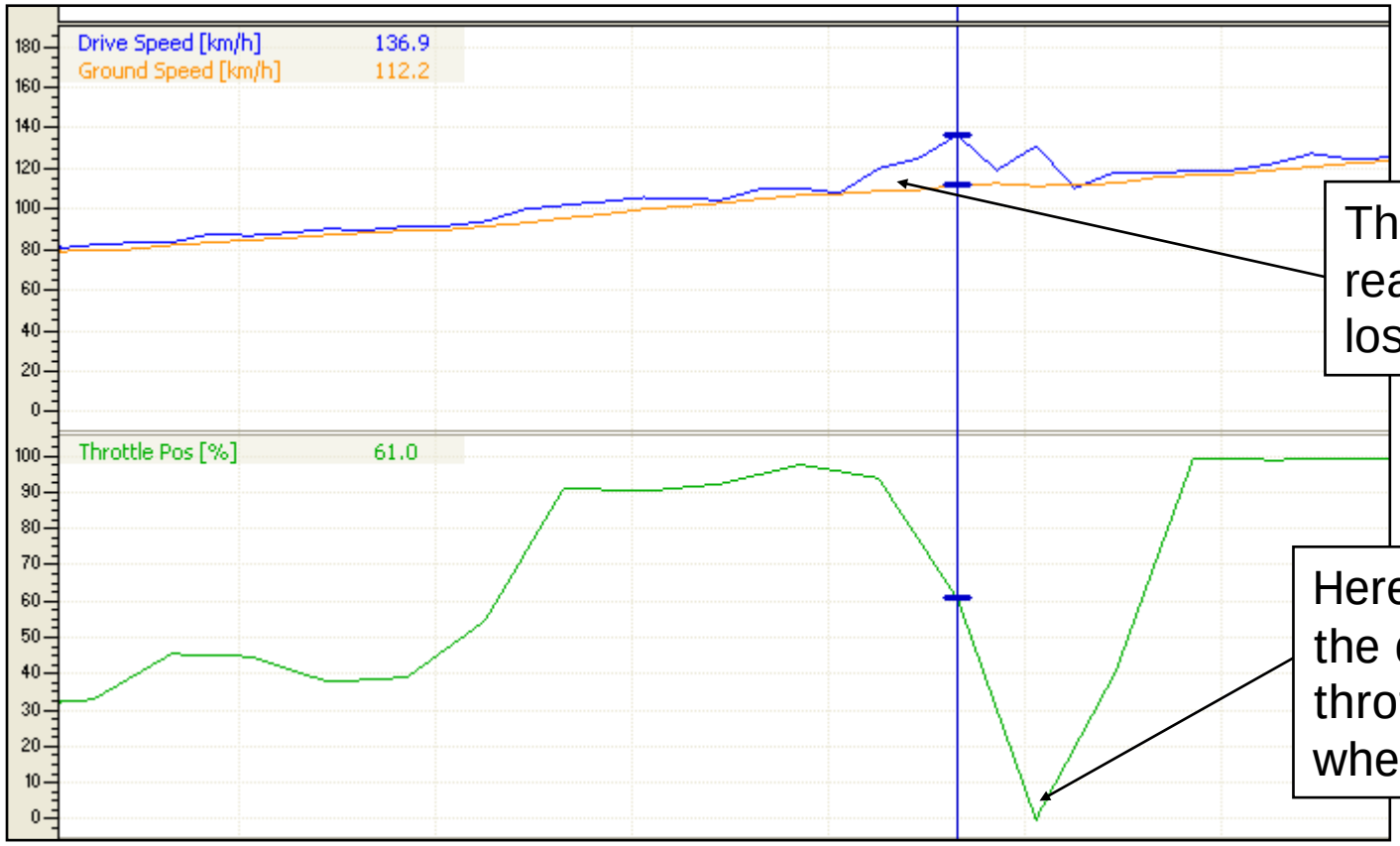
Reading a Wheel Speed Trace



Wheel Spin


Turn 1
Turn 2
Wheel Speed FL.f7 [km/h 81.7
Wheel Speed FR.f7 [km/h 83.5
Wheel Speed RL.f7 [km/h 85.6
Wheel Speed RR.f7 [km/h 85.8
Throttle Pos [%] 50.4
Brake Pres Front [psi] 0.00
Brake Pres Rear [psi] 0.00
metre
Following the wheel speed traces here, you can see wheel spin where the two blue lines rise above the red and orange lines, peaking at 12km/h front to rear speed difference

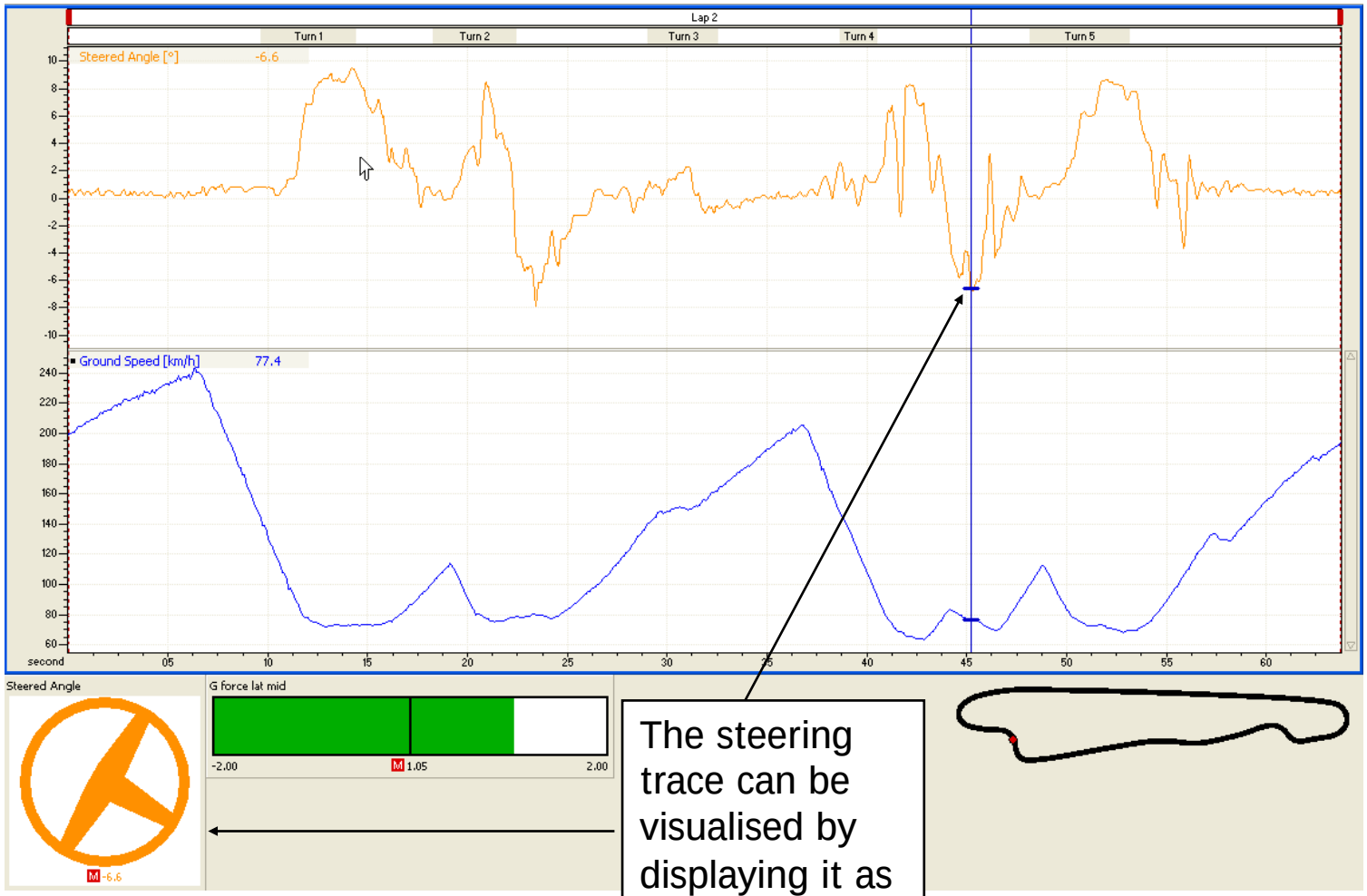
Reading a Throttle Trace



This is where the rear wheels have lost traction

Here you can see the driver lifting the throttle to stop the wheel spin

Reading a Steering Trace

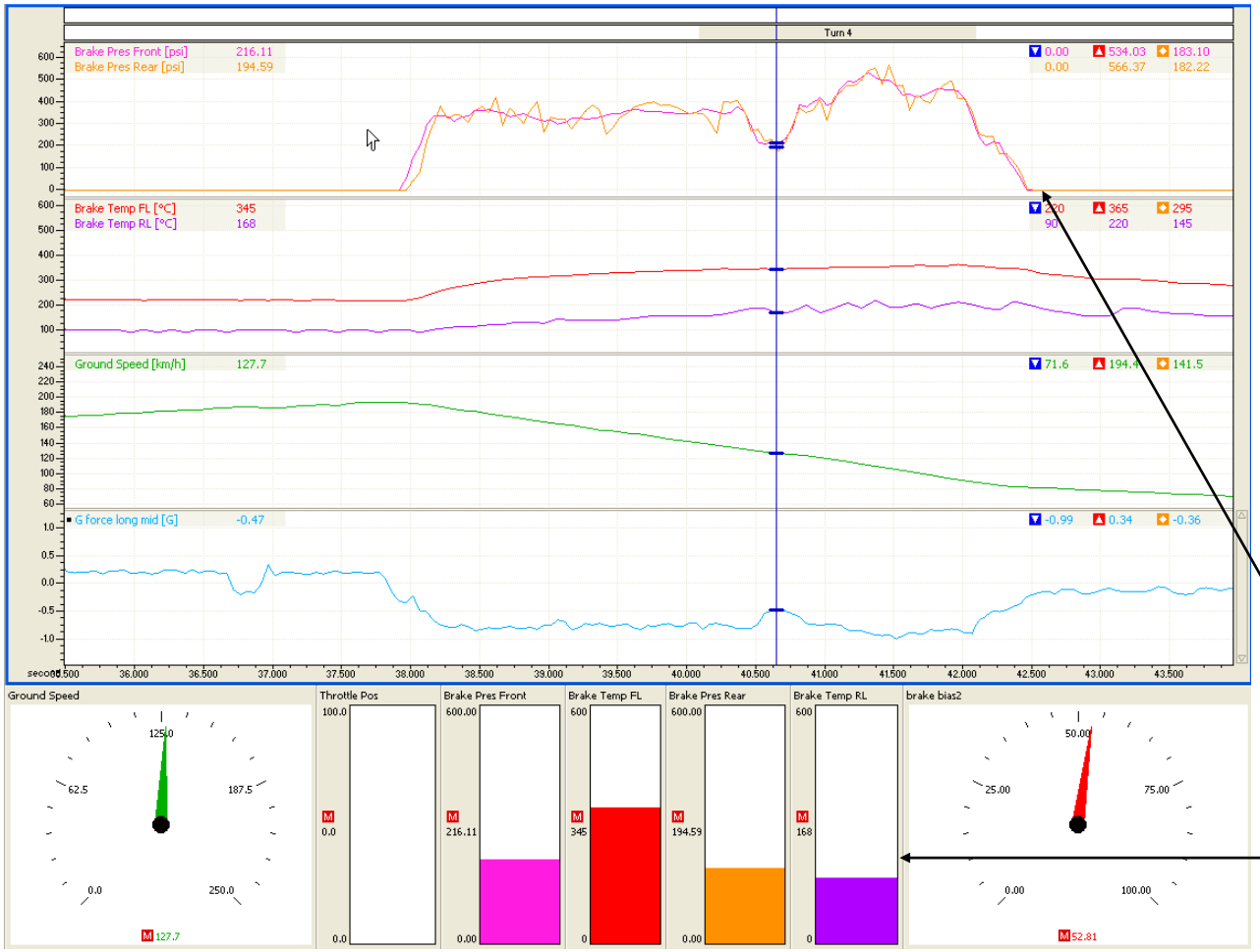


The steering trace can be visualised by displaying it as a gauge.

Reading a G Force Trace

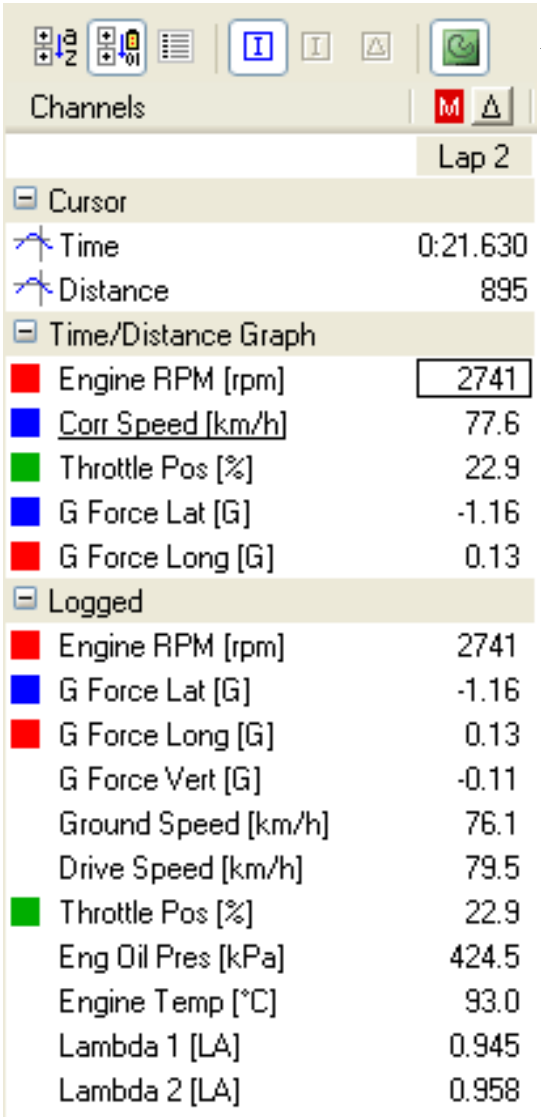
G Force long and lateral alongside braking and throttle

Reading Brake Pressure Trace



Brake pressures and temps shown both on graph and as gauges for clarity.

Values Box



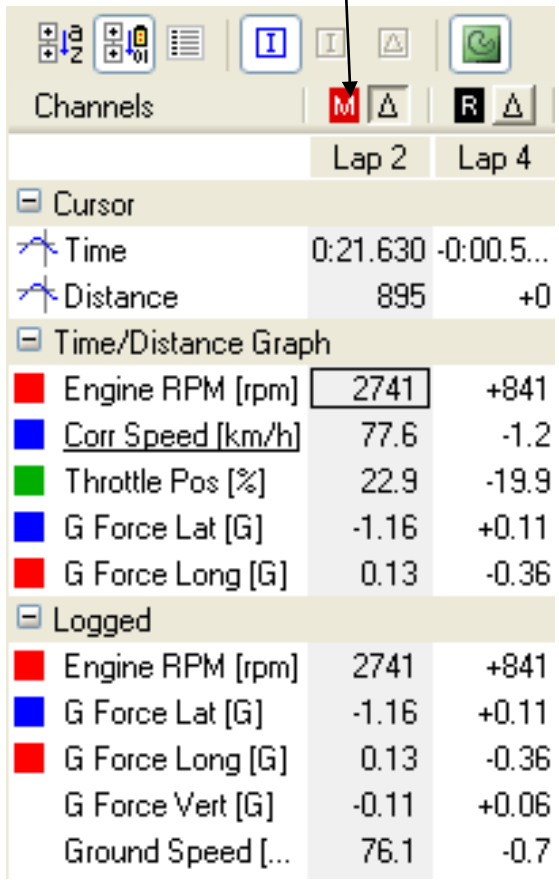
Hide/Show Track Map

Time and Distance at Cursor

Channels on the graph.
box = active channel

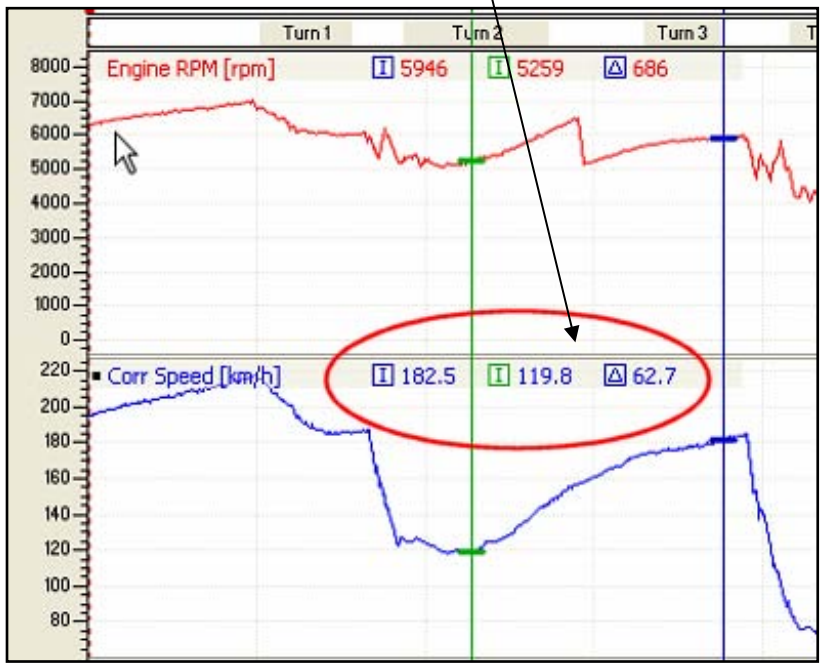
Values of all channels.

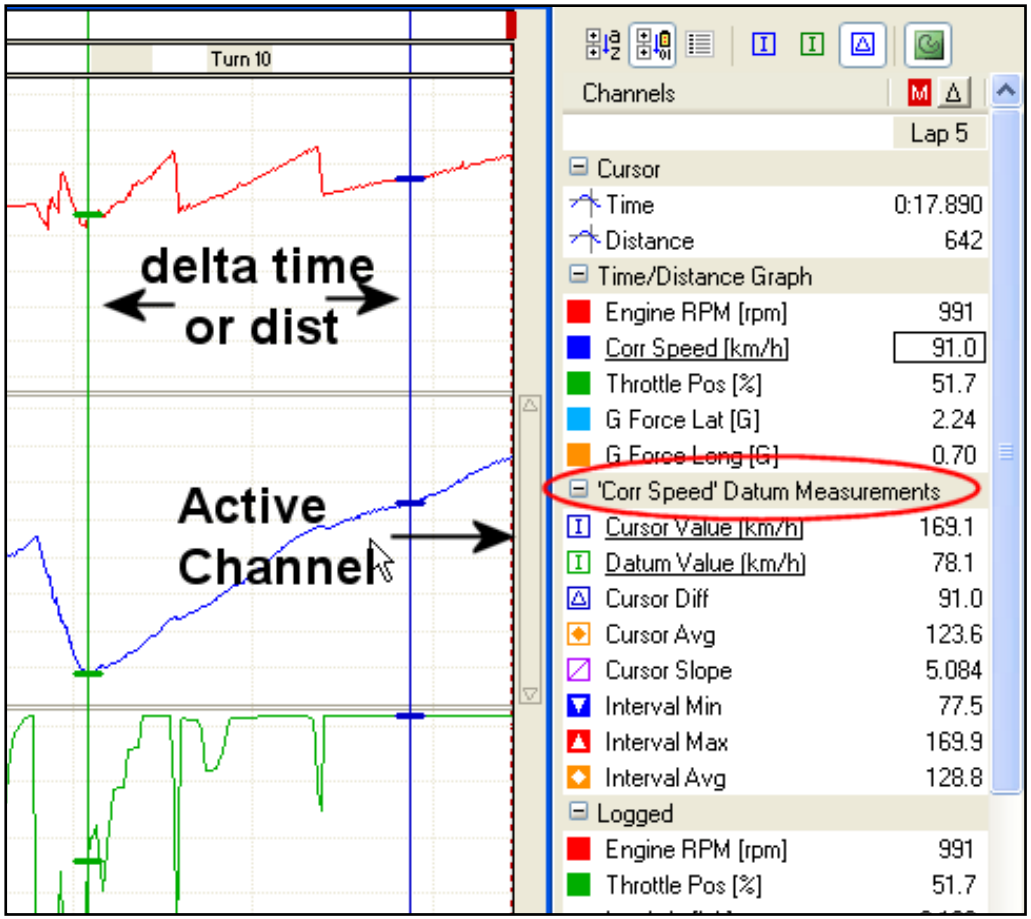
Show difference between Main and Ref laps



Datum Cursor

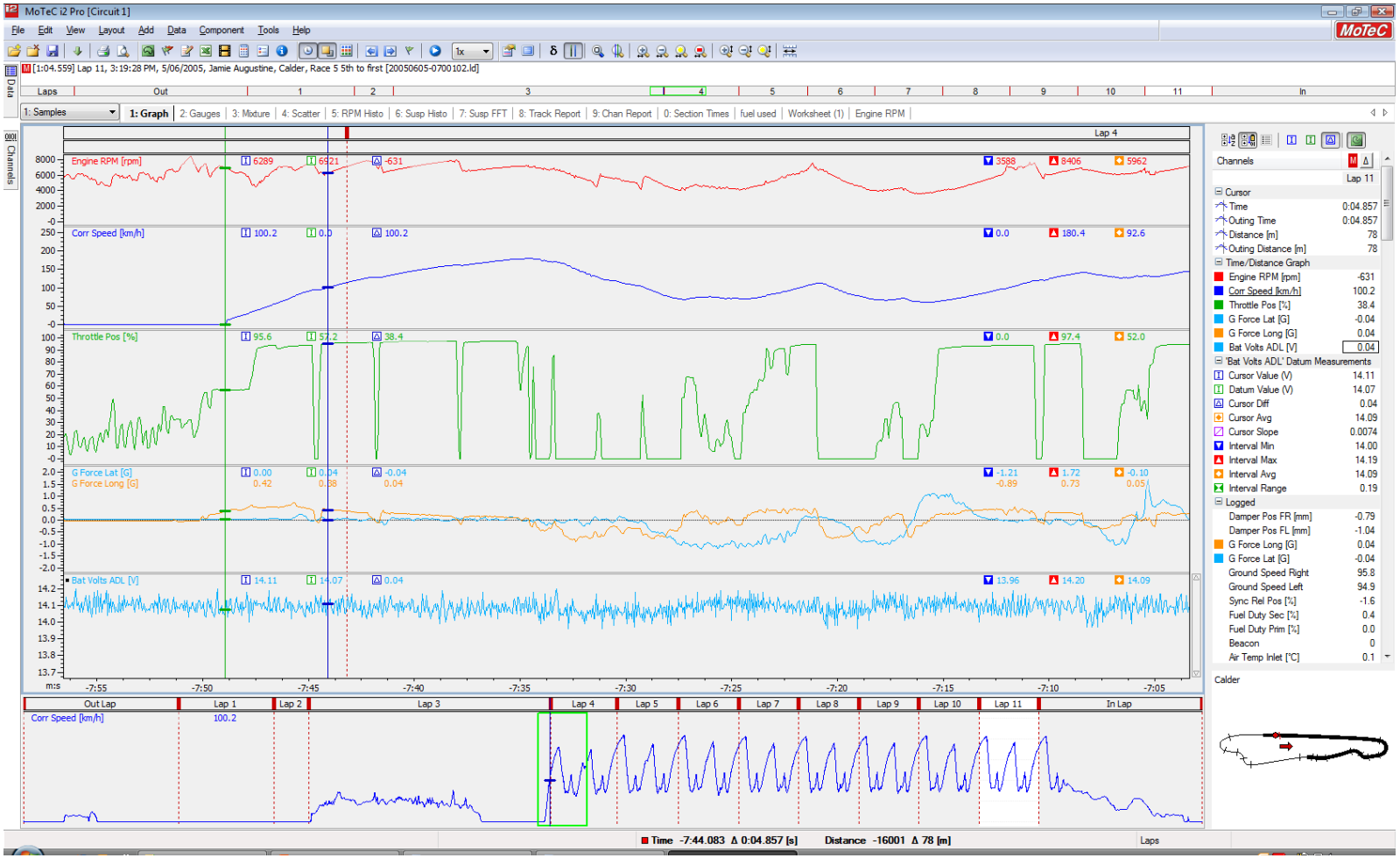
Show differences between 2 points on a graph





Straight Line Acceleration

- Race Starts, 0-100kmh and 0-400m times use Datum Cursor

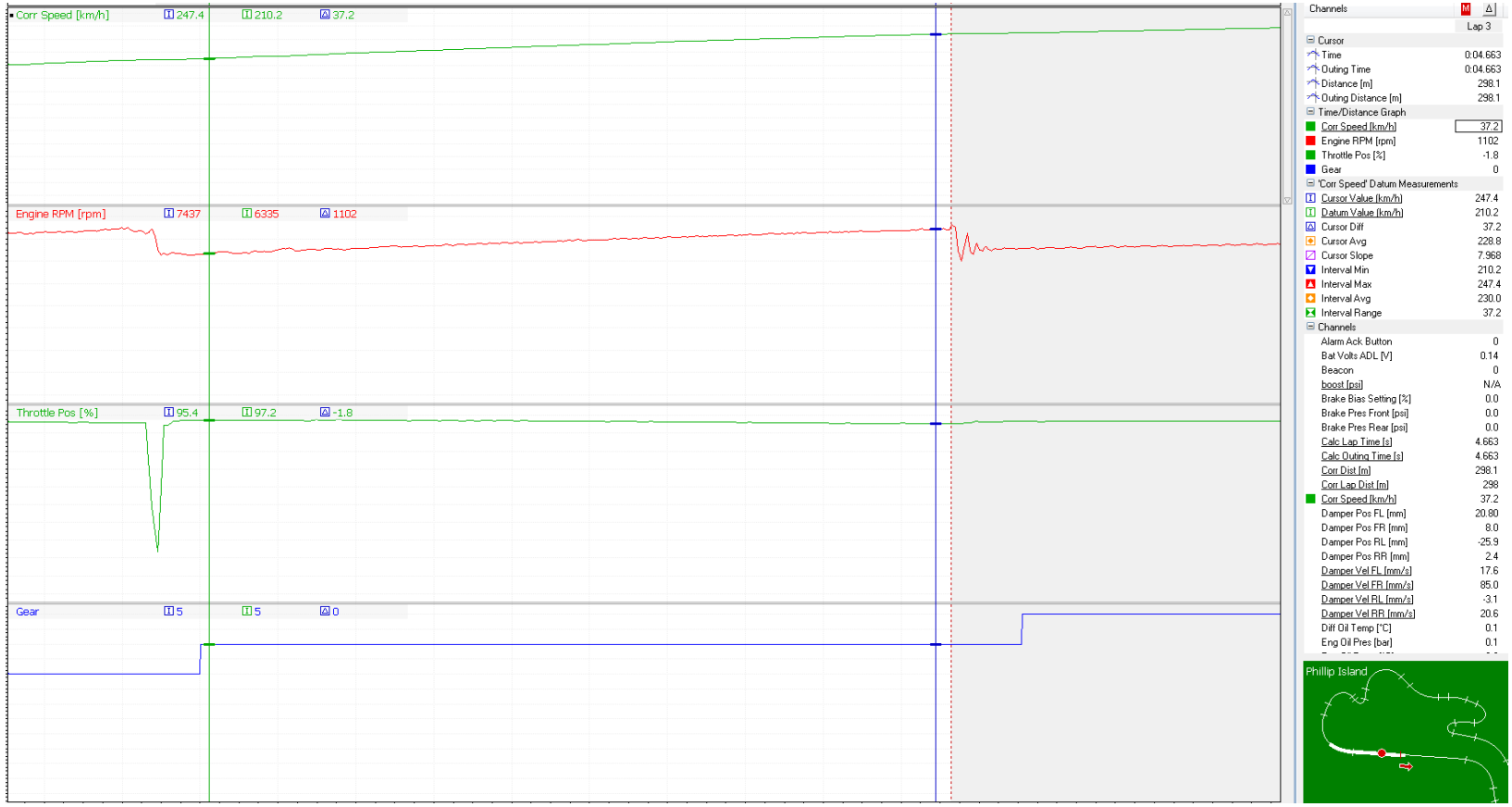


Straight Line Acceleration

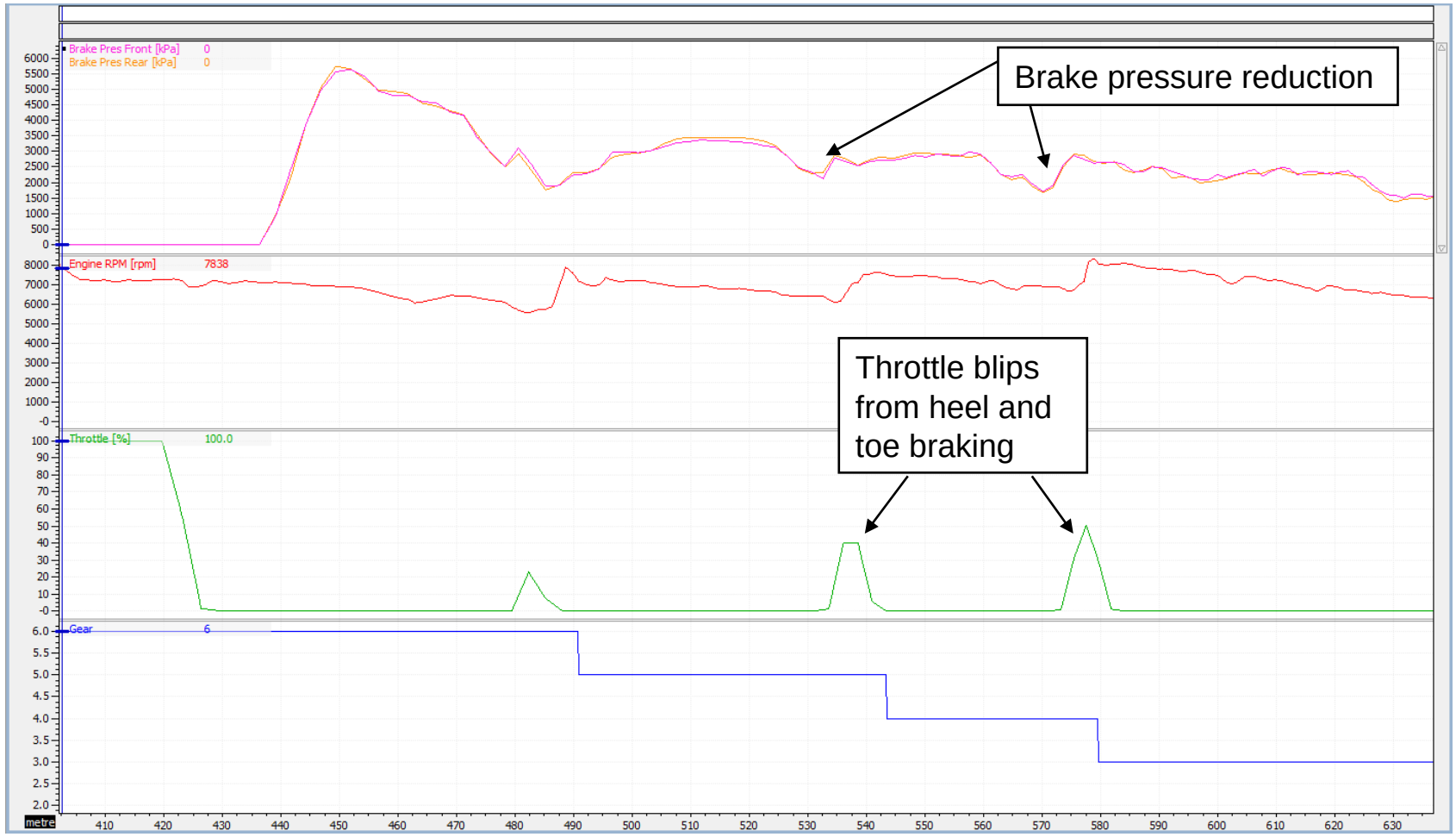
- Duration of an Upshift use Datum Cursor

Rate of Change Measurement

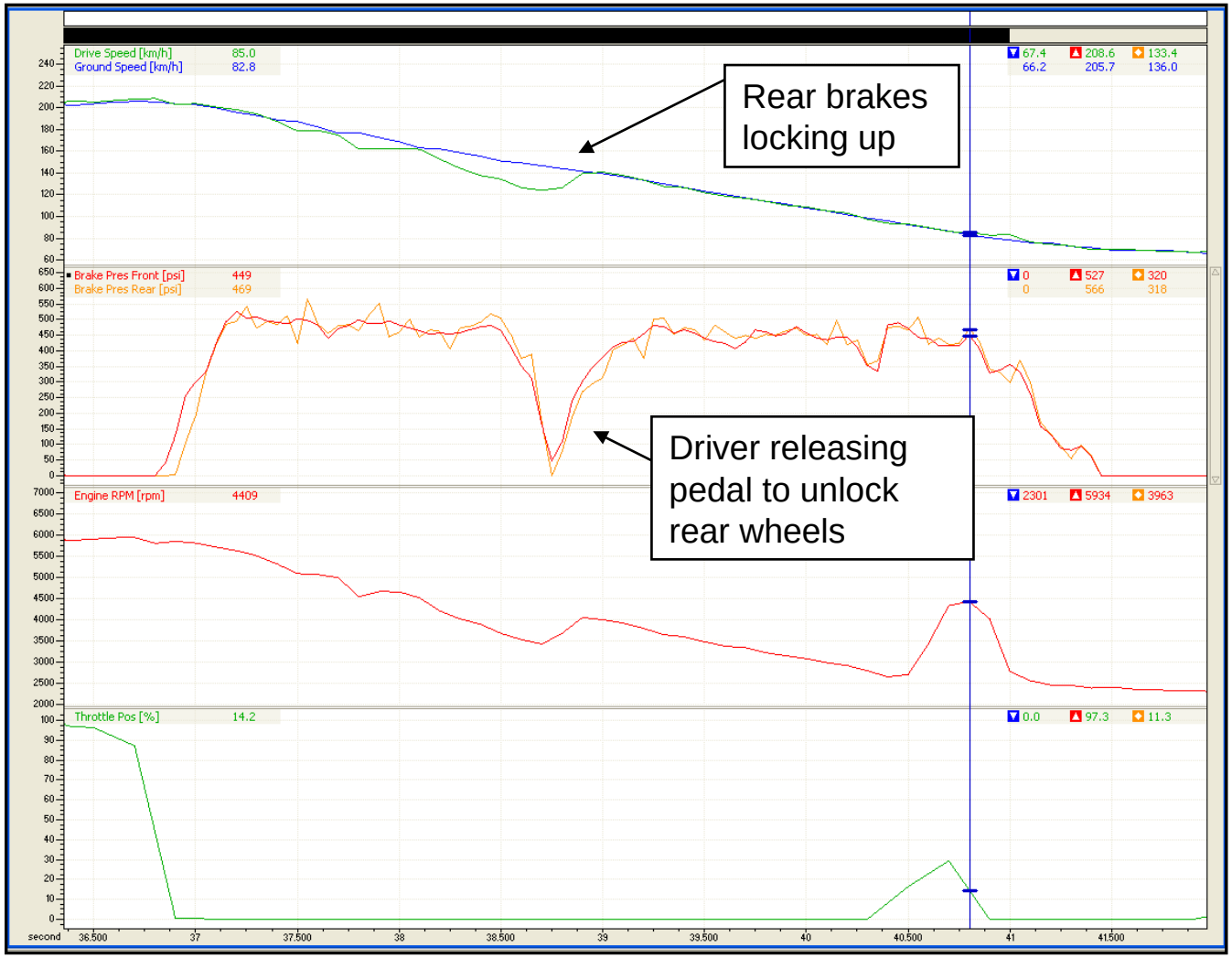
You can easily measure rate of change using the Datum cursor. Below, see the acceleration (in KM/h/Sec) of a V8 Supercar at Phillip Island in 5th gear. You should keep this number in mind when dyno tuning your car next time.



Braking Analysis

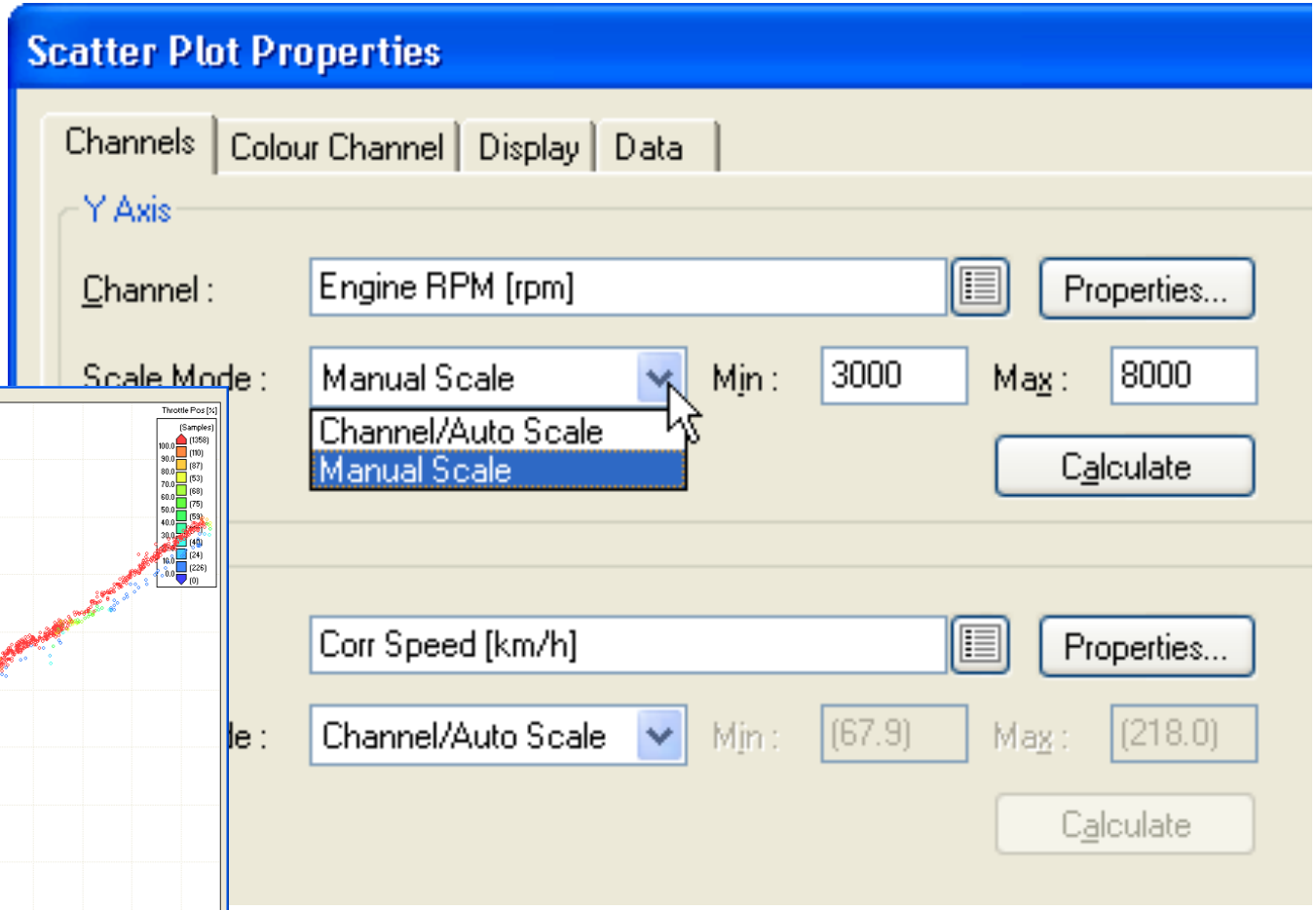


Brake Pressures

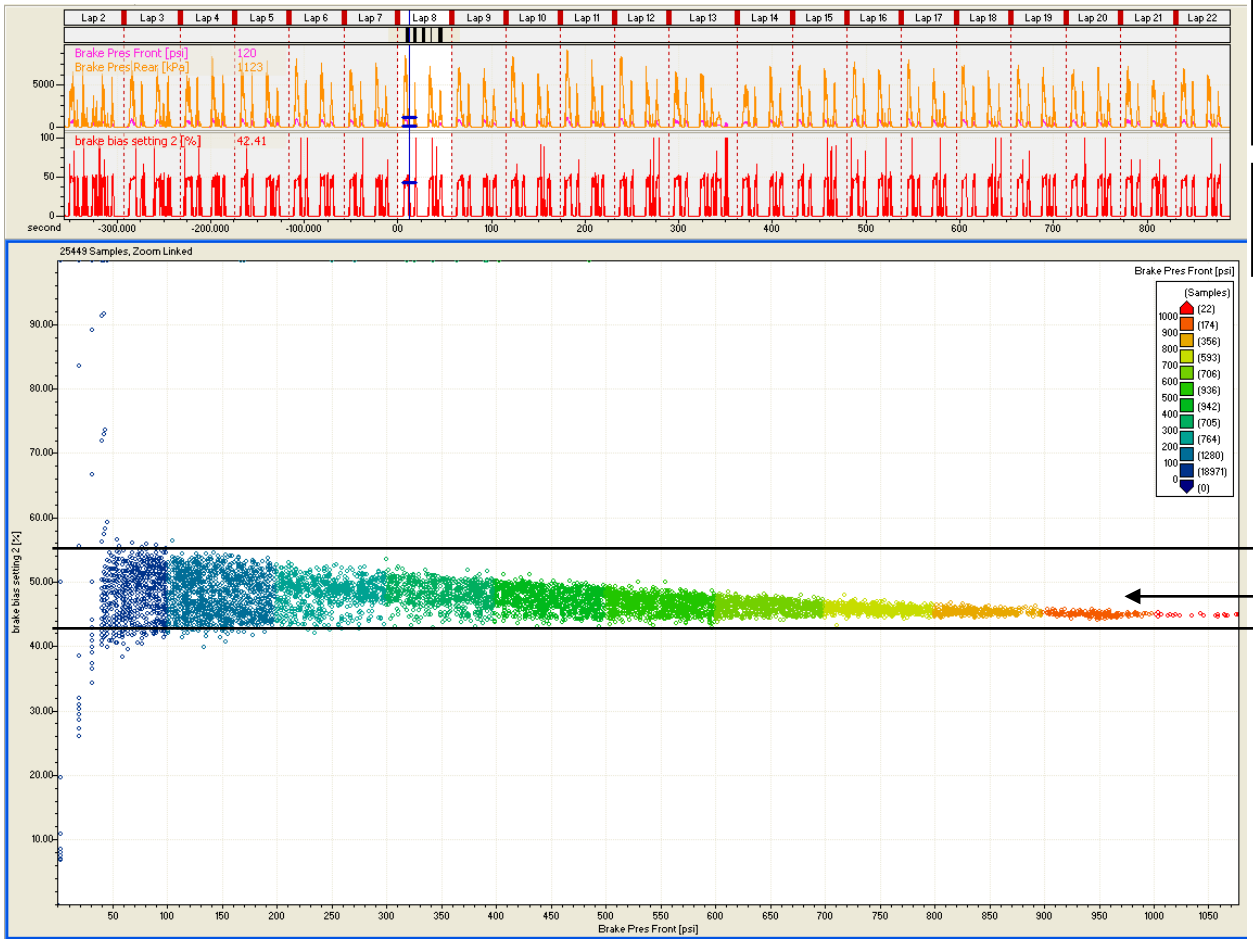


Scatter Plot

Engine RPM vs Speed



Brake Pressure Scatter Plot



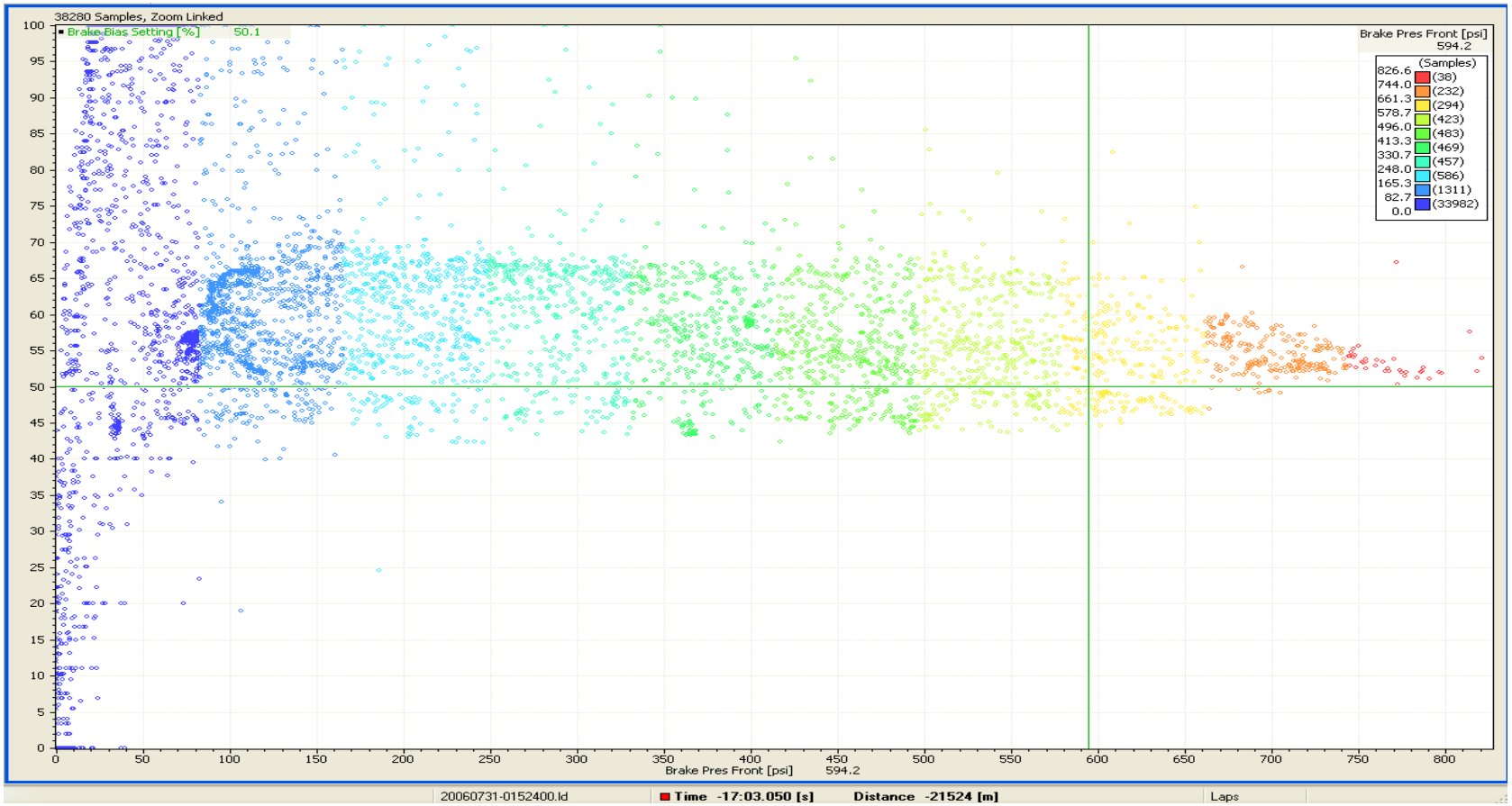
Front/Rear brake pressures zoom linked to histogram

Calculated brake bias channel

Of the 25,500 samples, most pressures above 180psi exist between 43% and 55% bias

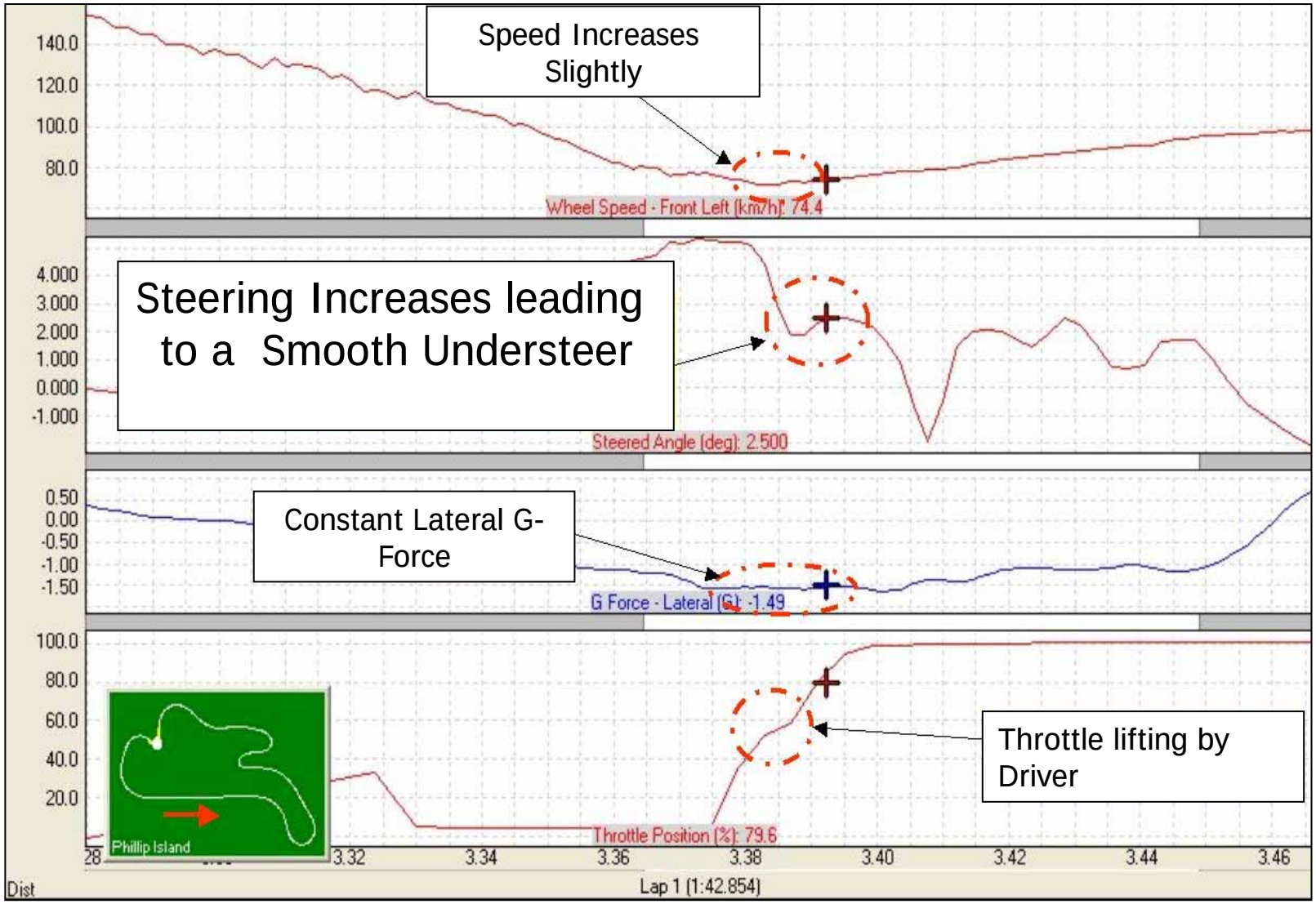
Brake Pressure Scatter Plot

Here is a brake pressure scatter plot from a poorly performing brake system



Wheel Lockup

Understeer


Speed Increases Slightly
Wheel Speed - Front Left (km/h): 74.4
Steering Increases leading to a Smooth Understeer
Steered Angle (deg): 2.500
Constant Lateral G-Force
G Force - Lateral (G): -1.49
Throttle lifting by Driver
Throttle Position (%): 79.6
Phillip Island
Dist
Lap 1 (1:42.854)

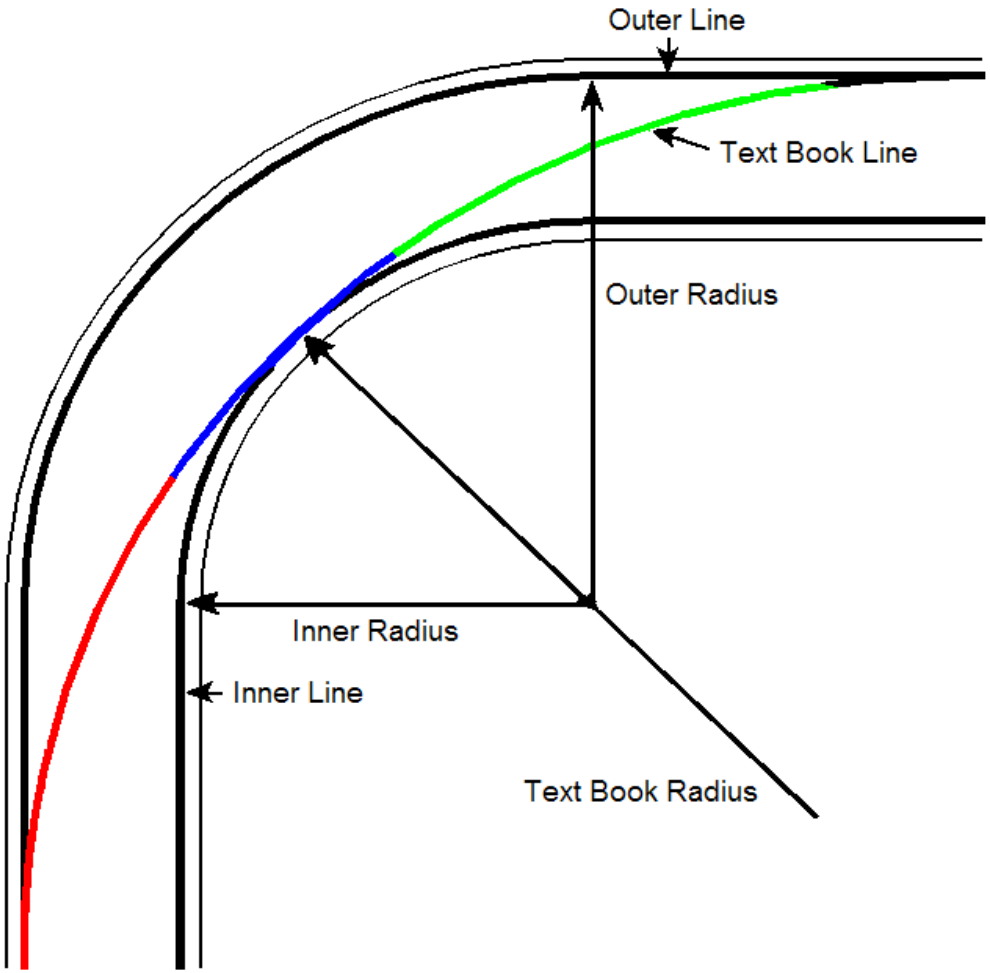
Oversteer

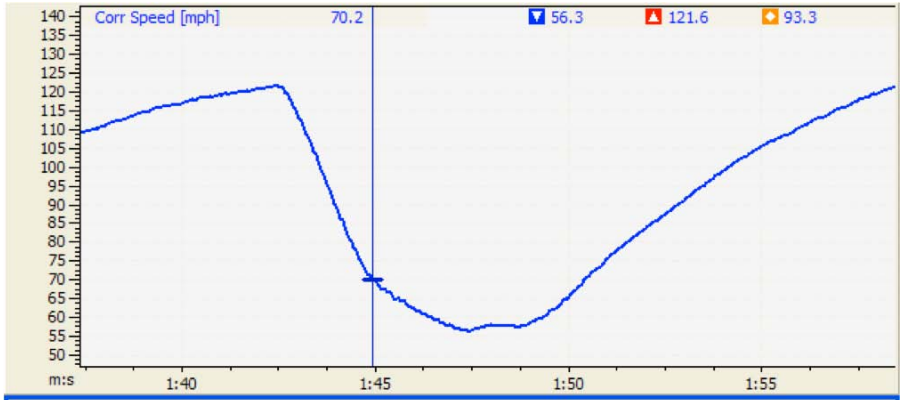
Rear wheel speed here is 6km/h faster than the undriven fronts

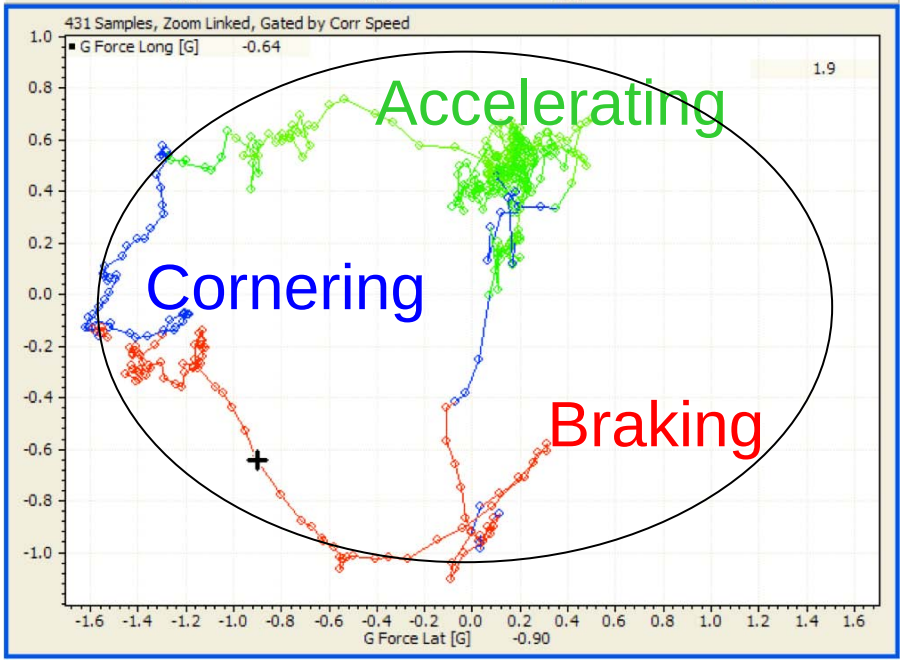
The throttle is lifted to reduce the wheel spin

The steering trace and gauge show the driver winding on opposite lock

Driving Line Analysis

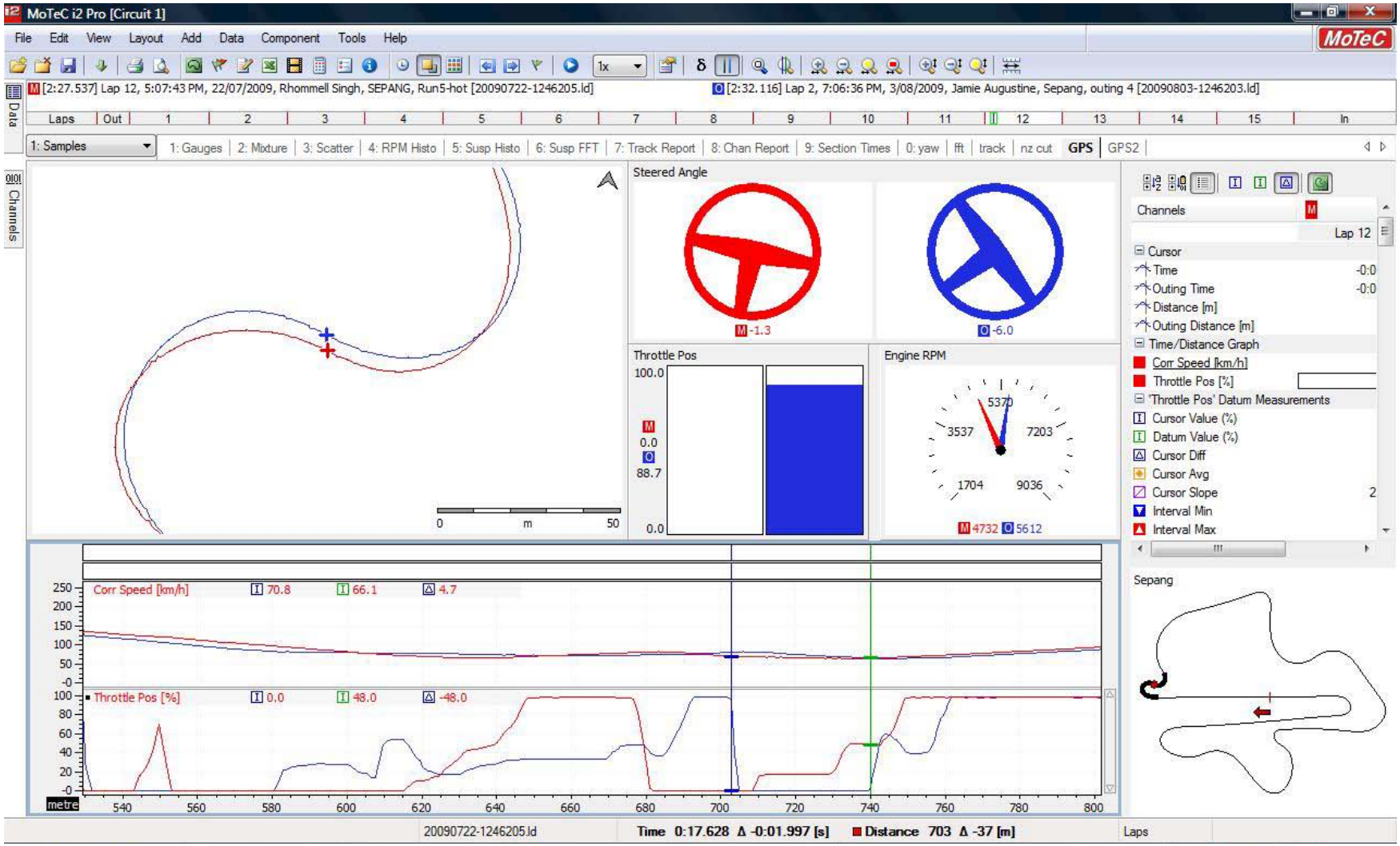




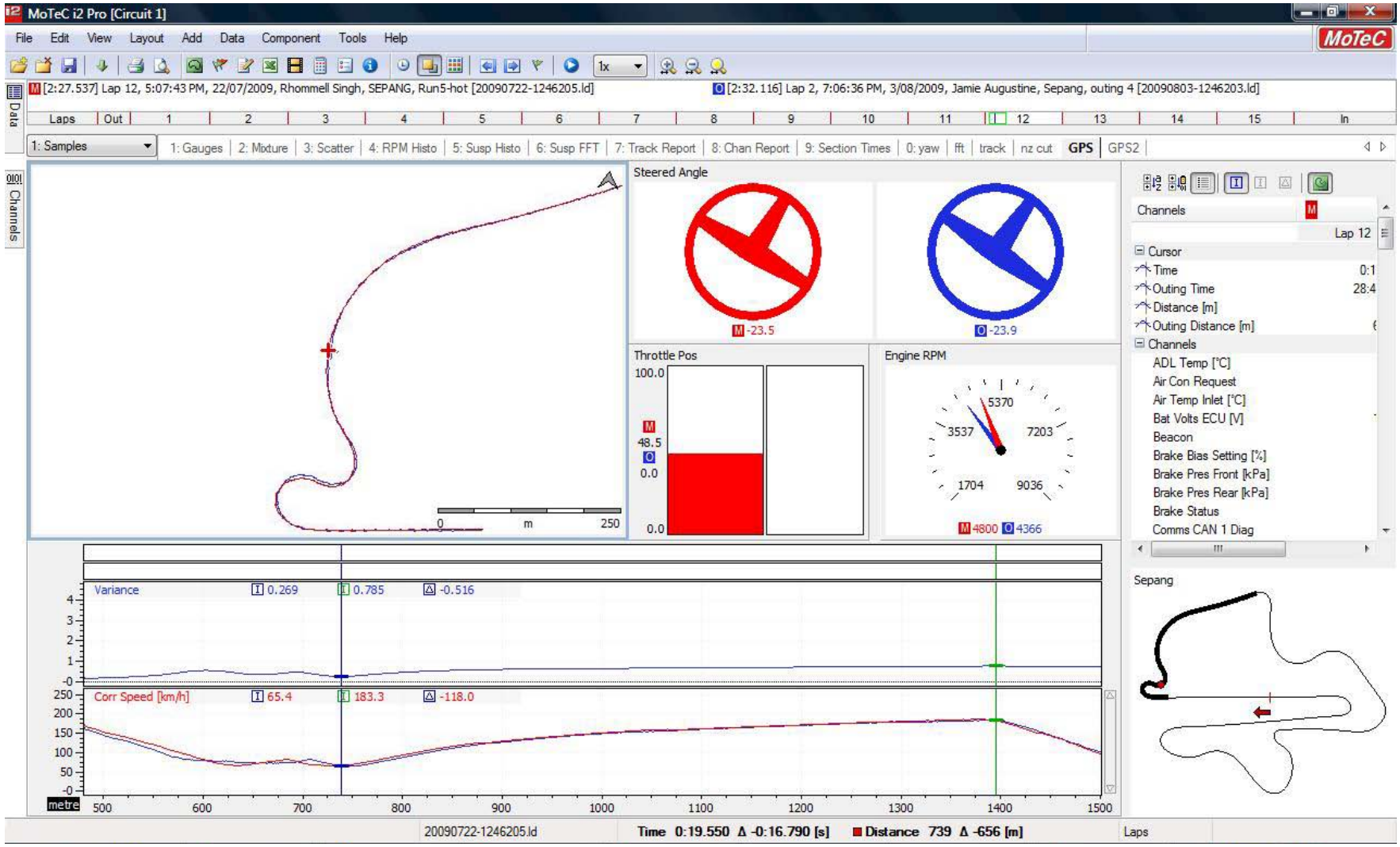


This method maintains the highest “minimum corner speed” possible through a corner. Driving the *Traction Circle* is the fastest way through this corner.

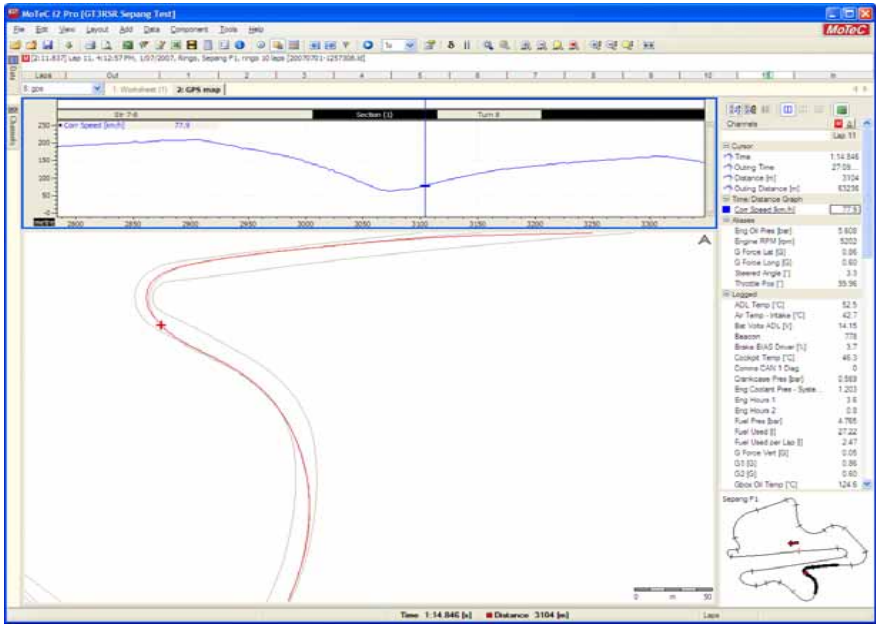
GPS Race Line Analysis

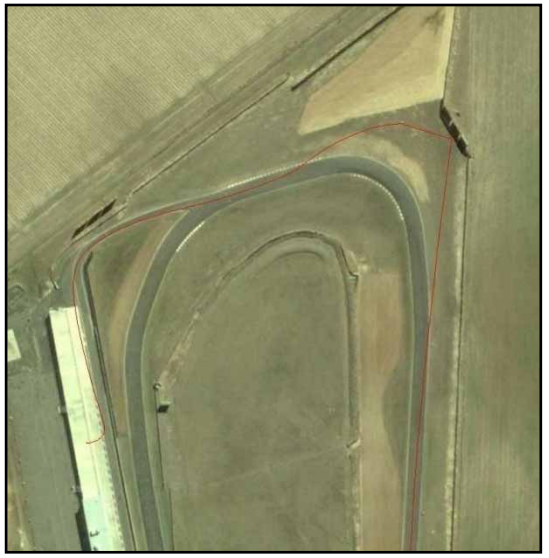


GPS Race Line Analysis



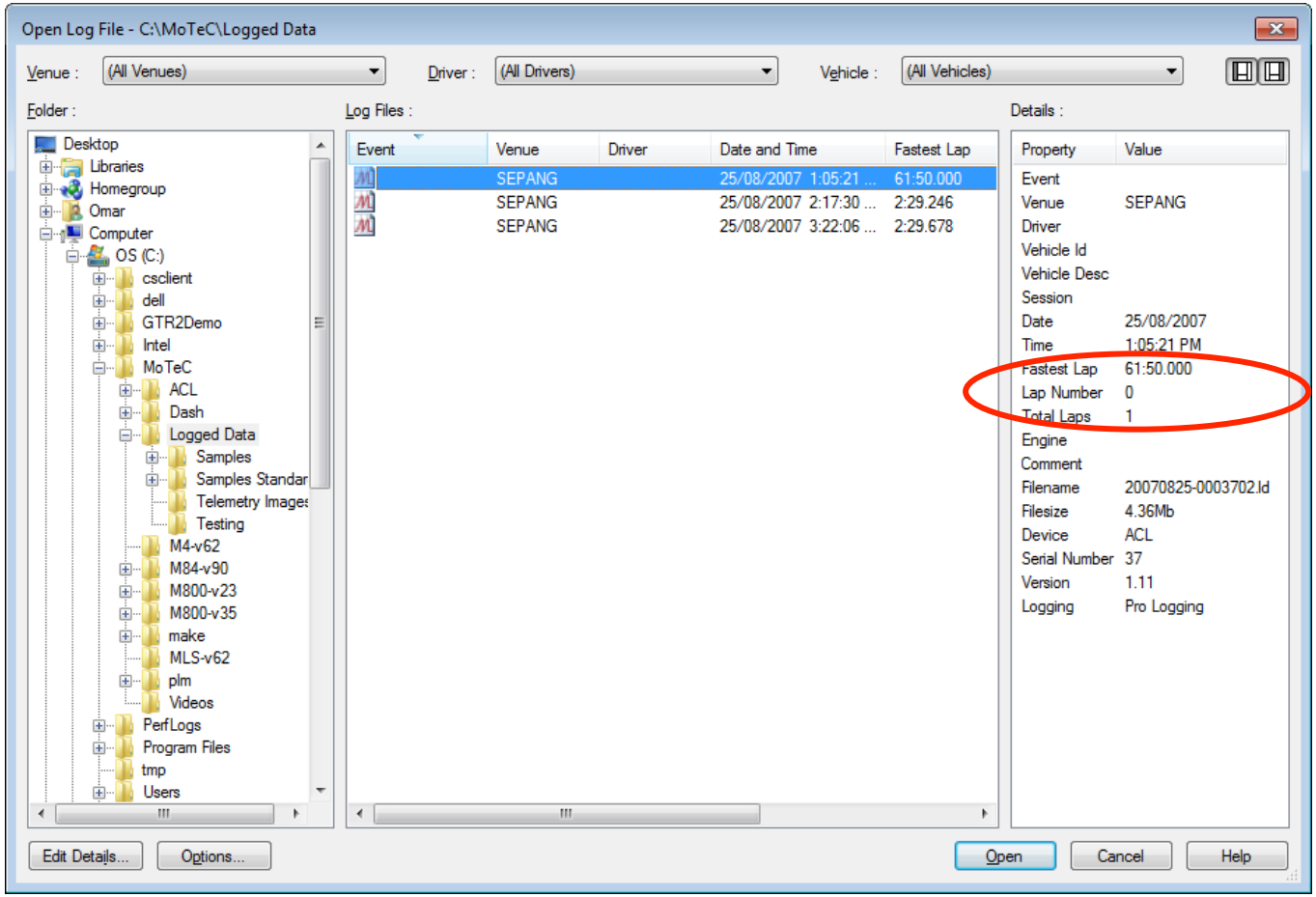
GPS Mapping





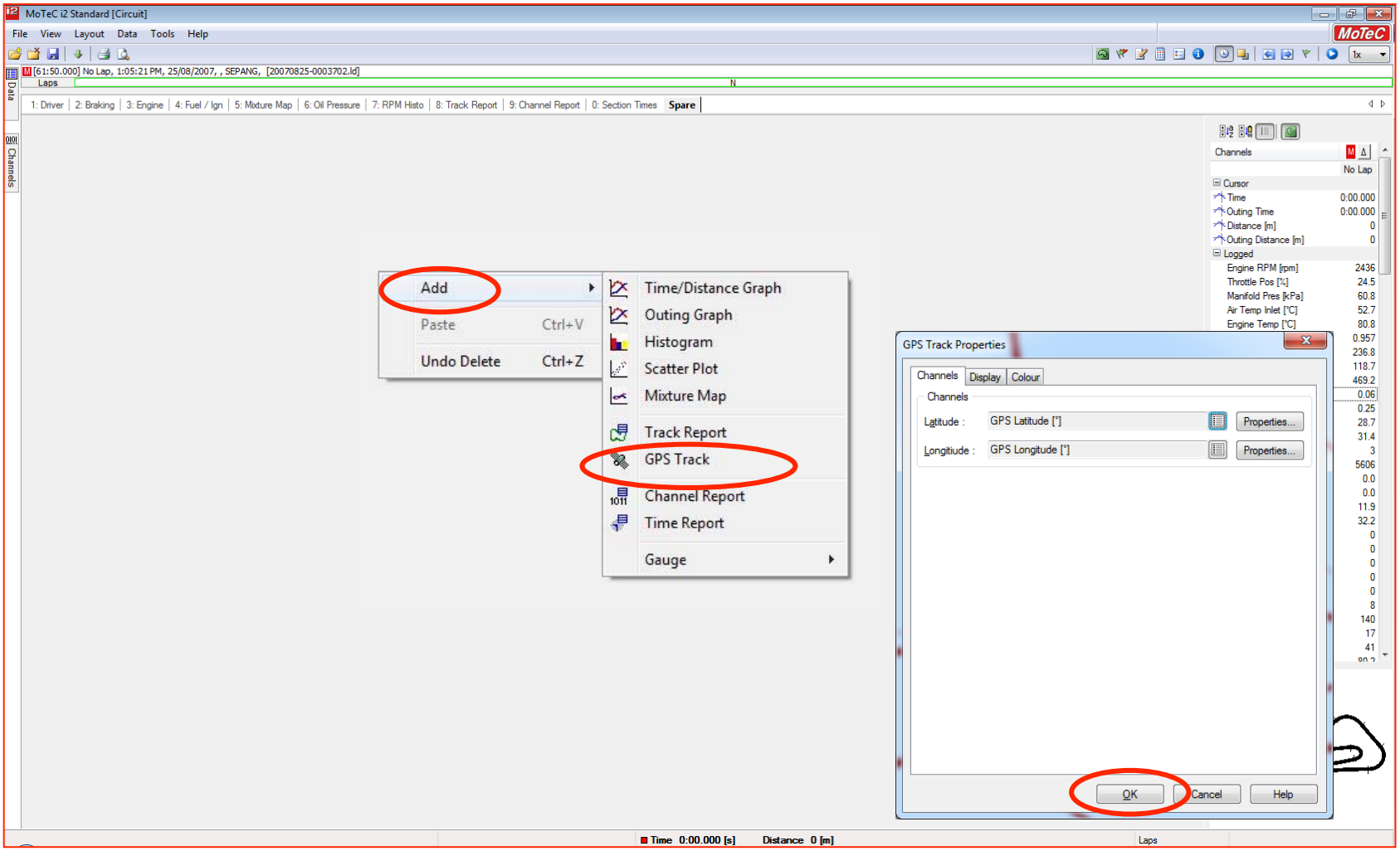
Open a log file

- Navigate to your log file and click open button

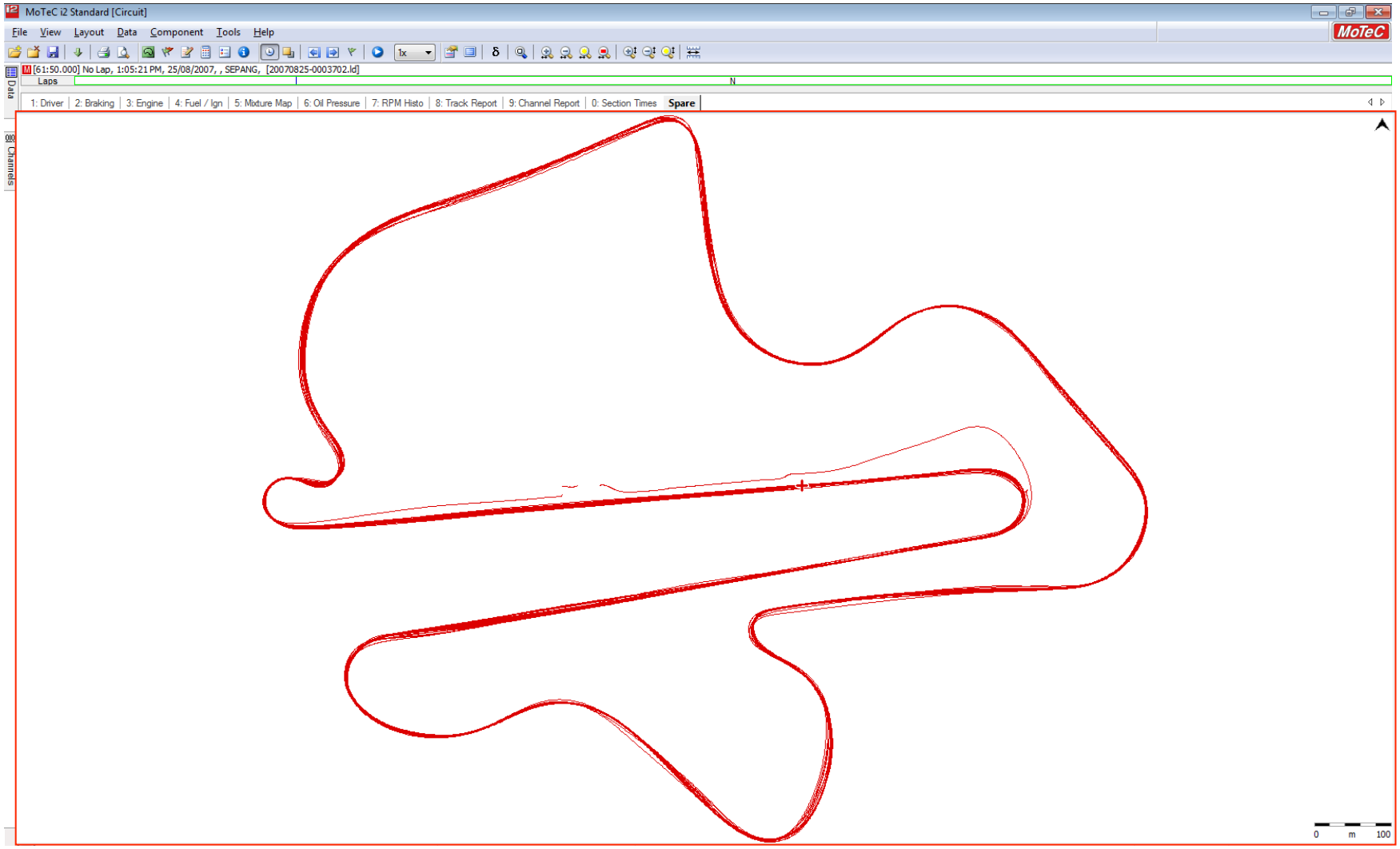


Open a log file

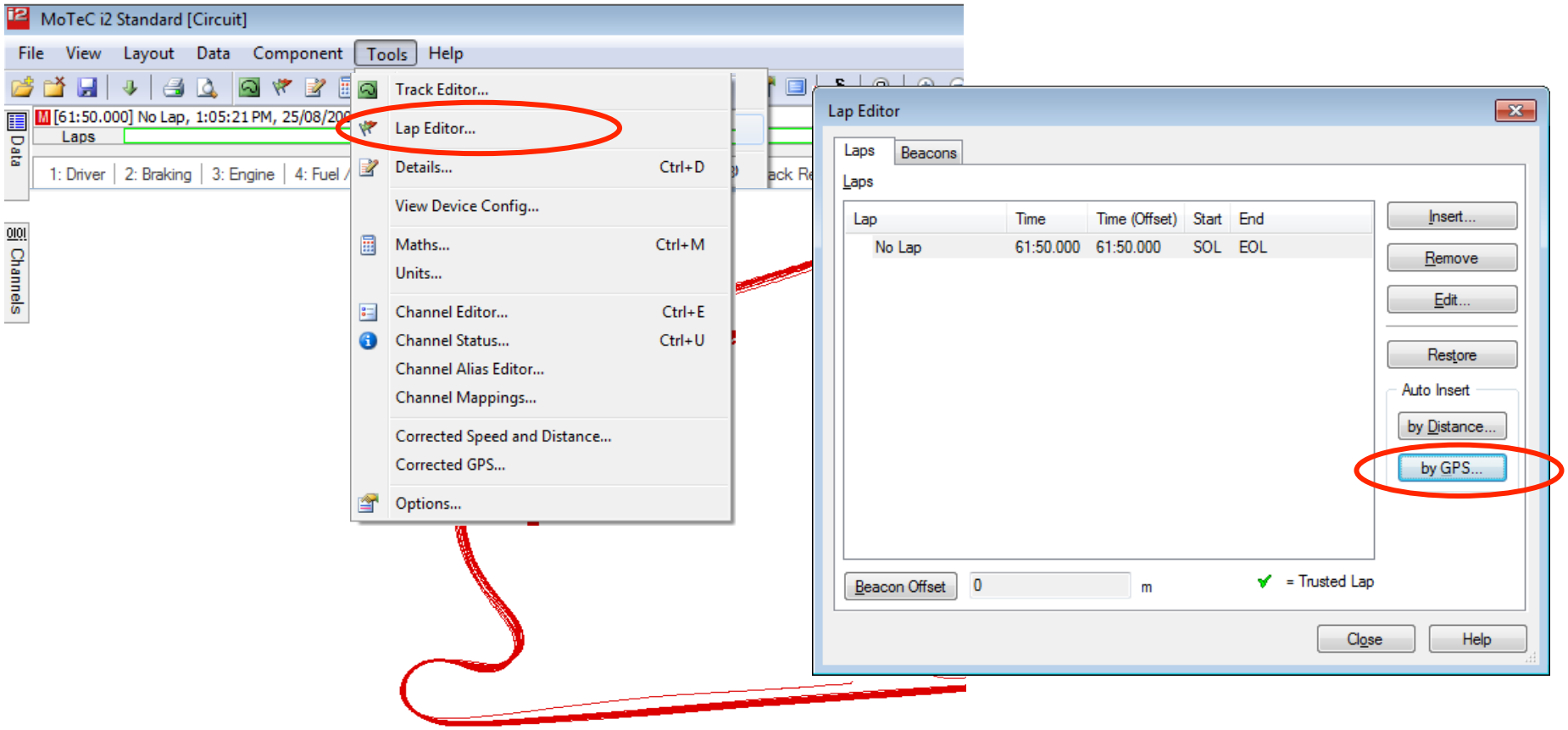
Add GPS track map



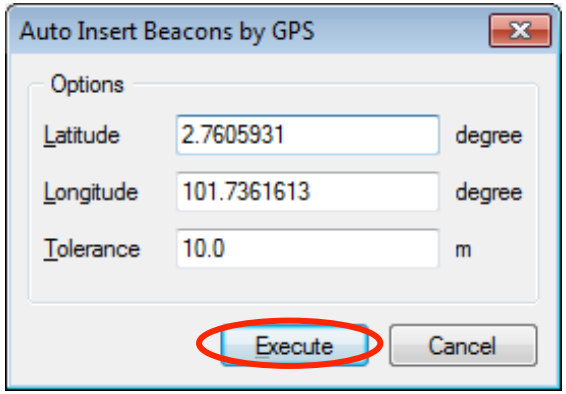
Determining a Beacon Position

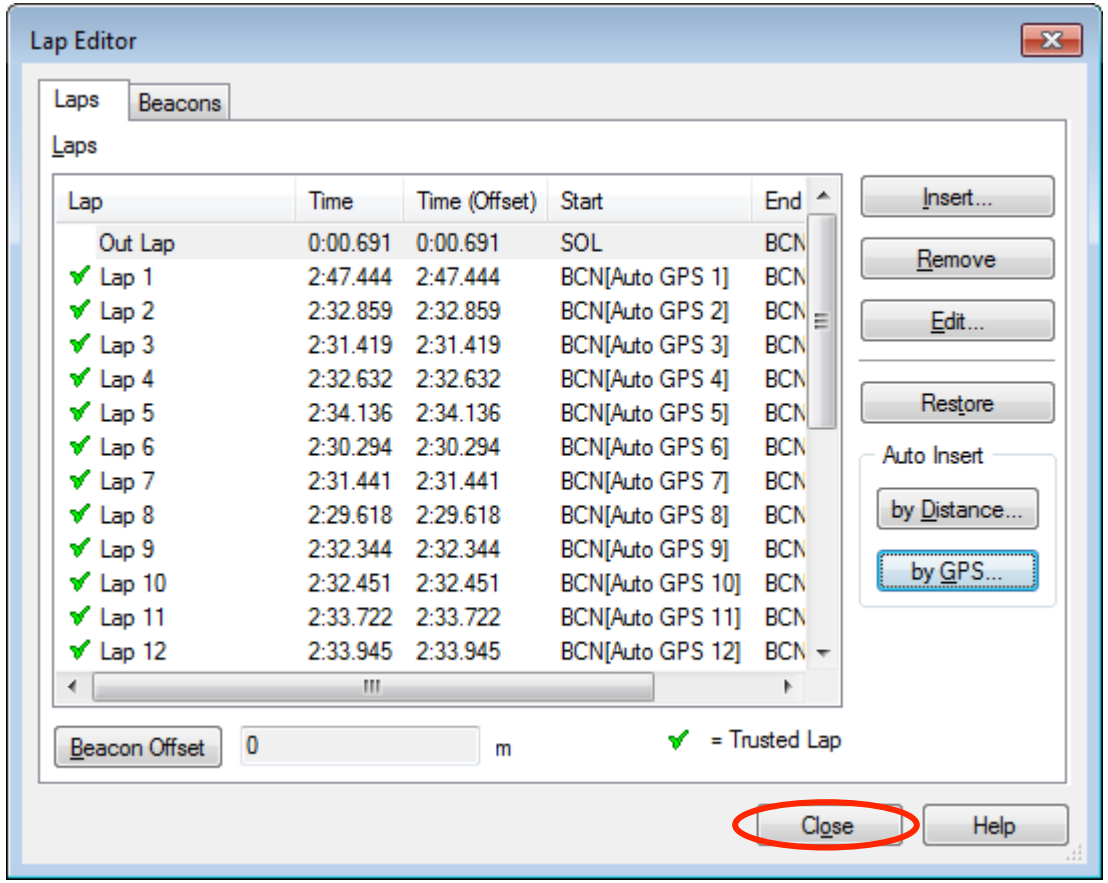


Auto Inserting Beacons in i2

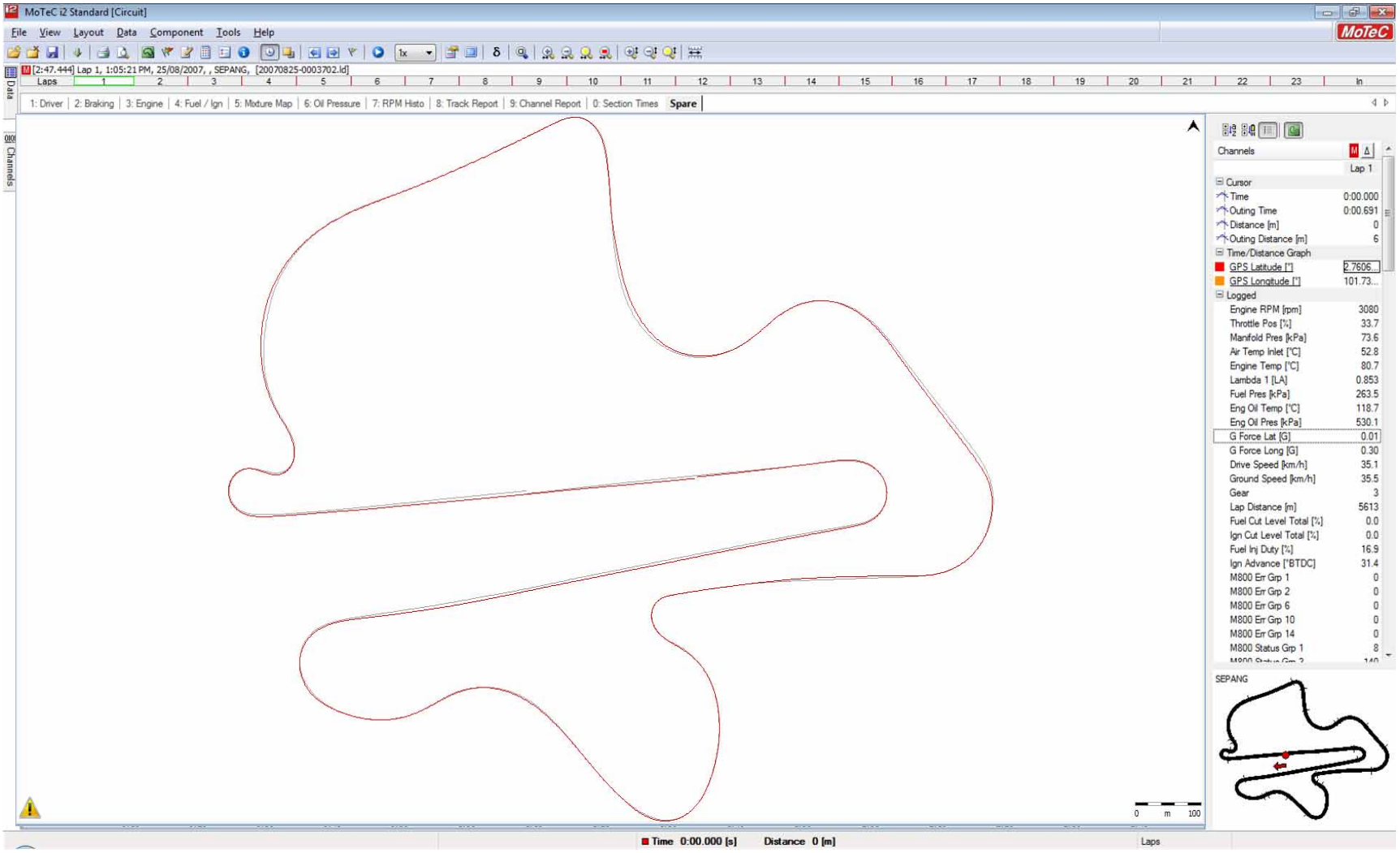


Auto Inserting Beacons in i2

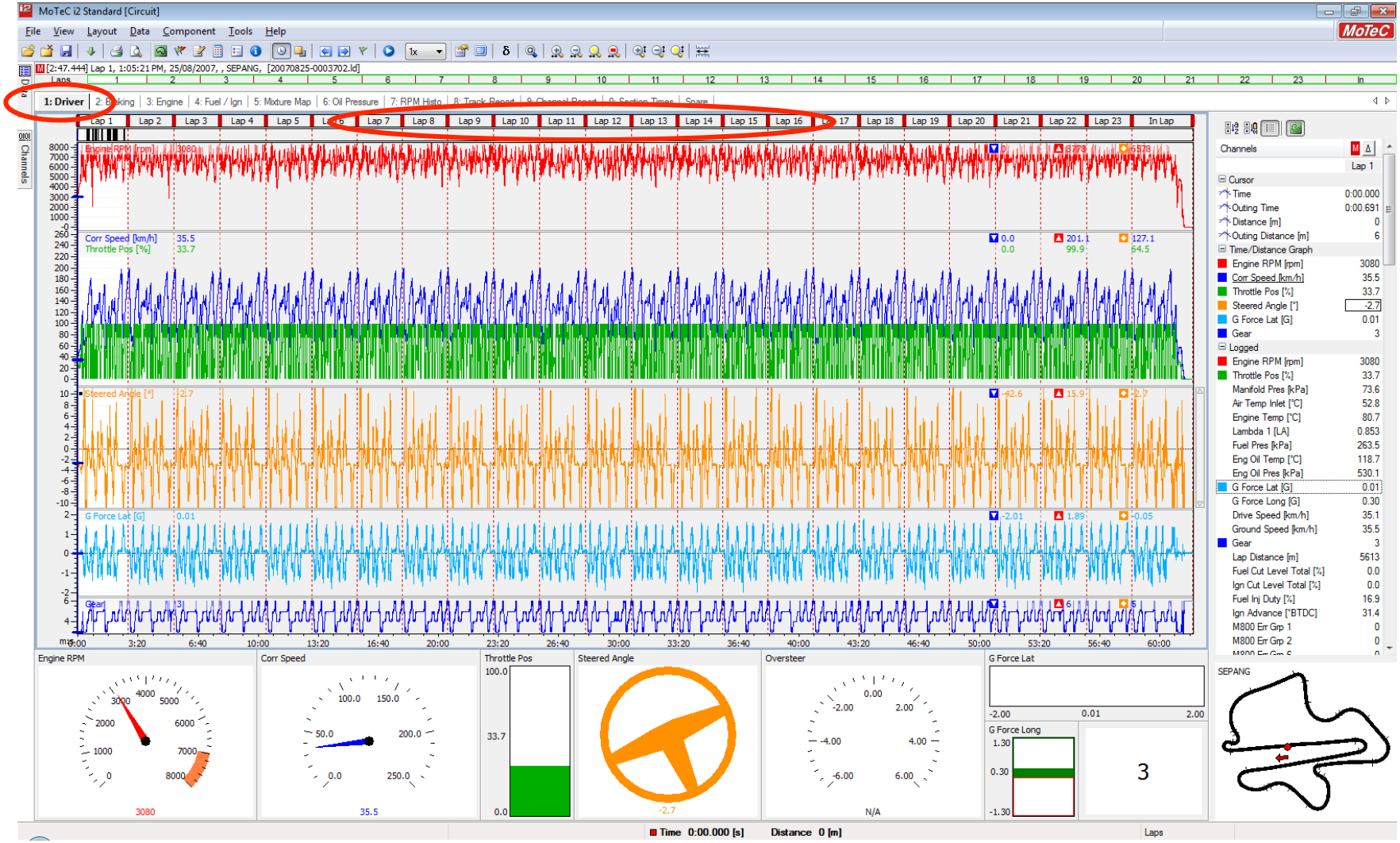




Auto Inserting Beacons in i2



Zoom out in i2



Driver Consistency

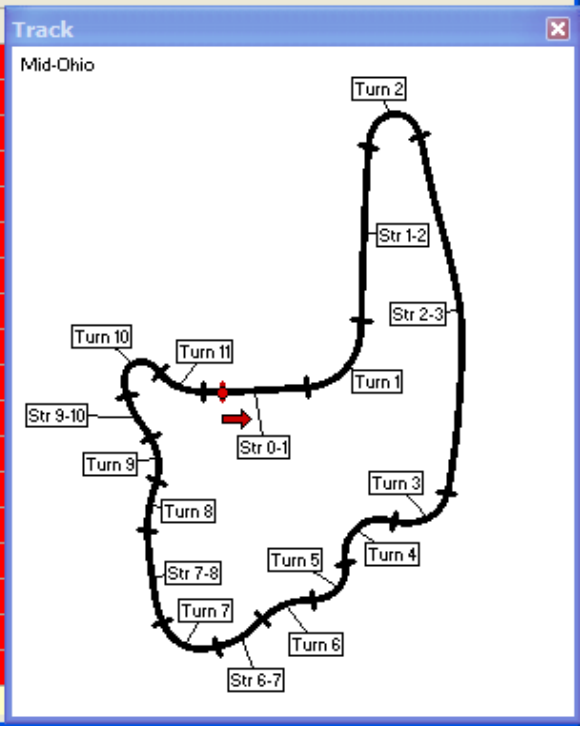
- Use Time Report

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	1:26.636	1:26.749	1:26.523	1:26.511	**1:26.480**	1:25.376	1:26.208



Fastest Rolling Lap

Section and Split Times

	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Str 0-1 (End)	0:11.720	0:11.601	0:12.243	0:11.534	0:11.534	0:11.534
Turn 1	0:05.108	0:04.850	0:04.847	0:04.884	0:04.847	0:04.884
Str 1-2	0:03.615	0:03.500	0:03.575	0:03.557	0:03.500	0:03.557
Turn 2	0:02.565	0:02.500	0:02.490	0:02.575	0:02.490	0:02.575
Turn 3	0:02.693	0:02.500	0:02.573	0:02.569	0:02.500	0:02.569
Str 3-4	0:06.015	0:05.750	0:05.819	0:05.548	0:05.548	0:05.548
Turn 4	0:00.670	0:00.650	0:00.675	0:00.652	0:00.650	0:00.652
Str 4-5	0:10.160	0:09.650	0:10.332	0:09.736	0:09.650	0:09.736
Turn 5	0:03.056	0:03.200	0:02.997	0:03.172	0:02.997	0:03.172
Turn 6	0:02.571	0:02.550	0:02.587	0:02.451	0:02.451	0:02.451
Str 6-7	0:03.856	0:03.800	0:04.054	0:03.666	0:03.666	0:03.666
Turn 7	0:03.919	0:03.850	0:04.015	0:03.821	0:03.821	0:03.821
Str 0-1 (Start)						

Time Report - Track Sections (All Laps)

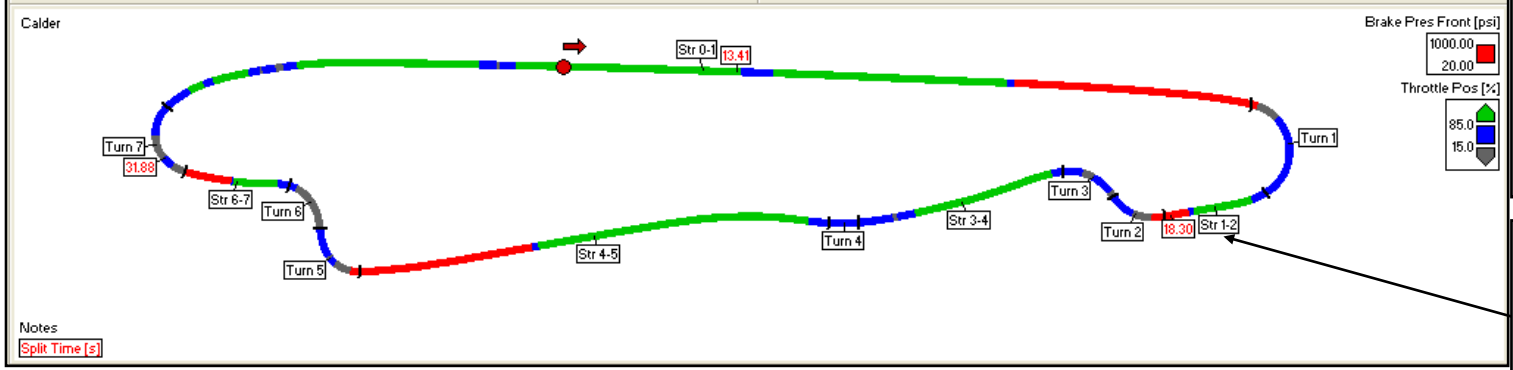
	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Turn 1	0:05.108	0:04.850	0:04.847	0:04.884	0:04.847	0:04.847
Turn 2	0:02.565	0:02.500	0:02.490	0:02.575	0:02.490	0:02.490
Turn 3	0:02.693	0:02.500	0:02.573	0:02.569	0:02.500	0:02.573
Turn 4	0:00.670	0:00.650	0:00.675	0:00.652	0:00.650	0:00.675
Turn 5	0:03.056	0:03.200	0:02.997	0:03.172	0:02.997	0:02.997
Turn 6	0:02.571	0:02.550	0:02.587	0:02.451	0:02.451	0:02.550
Turn 7	0:03.919	0:03.850	0:04.015	0:03.821	0:03.821	0:03.850
Totals	0:20.585	**0:20.100**	0:20.188	0:20.127	0:19.758	0:19.985

Track Sections (All Laps)

	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Split 1	0:18.894	0:18.301	0:19.027	0:18.331	0:18.301	0:18.331
Split 2	0:32.856	0:31.888	0:32.806	0:31.666	0:31.666	0:31.666
Split 3	0:13.413	0:13.493	0:13.359	0:13.762	0:13.359	0:13.359
Totals	1:05.163	**1:03.682**	1:05.192	1:03.759	1:03.326	1:03.356

Time Report - Track Sections (All Laps)

	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Str 0-1 (End)	0:11.720	0:11.601	0:12.243	0:11.534	0:11.534	0:11.534
Str 1-2	0:03.615	0:03.500	0:03.575	0:03.557	0:03.500	0:03.557
Str 3-4	0:06.015	0:05.750	0:05.819	0:05.548	0:05.548	0:05.548
Str 4-5	0:10.160	0:09.650	0:10.332	0:09.736	0:09.650	0:09.736
Str 6-7	0:03.856	0:03.800	0:04.054	0:03.666	0:03.666	0:03.666
Str 0-1 (Start)	0:09.209	0:09.281	0:08.978	0:09.587	0:08.978	0:08.978
Totals	0:44.577	**0:43.582**	0:45.003	0:43.631	0:42.877	0:43.022



Corner section times for all laps.

All section times for all laps

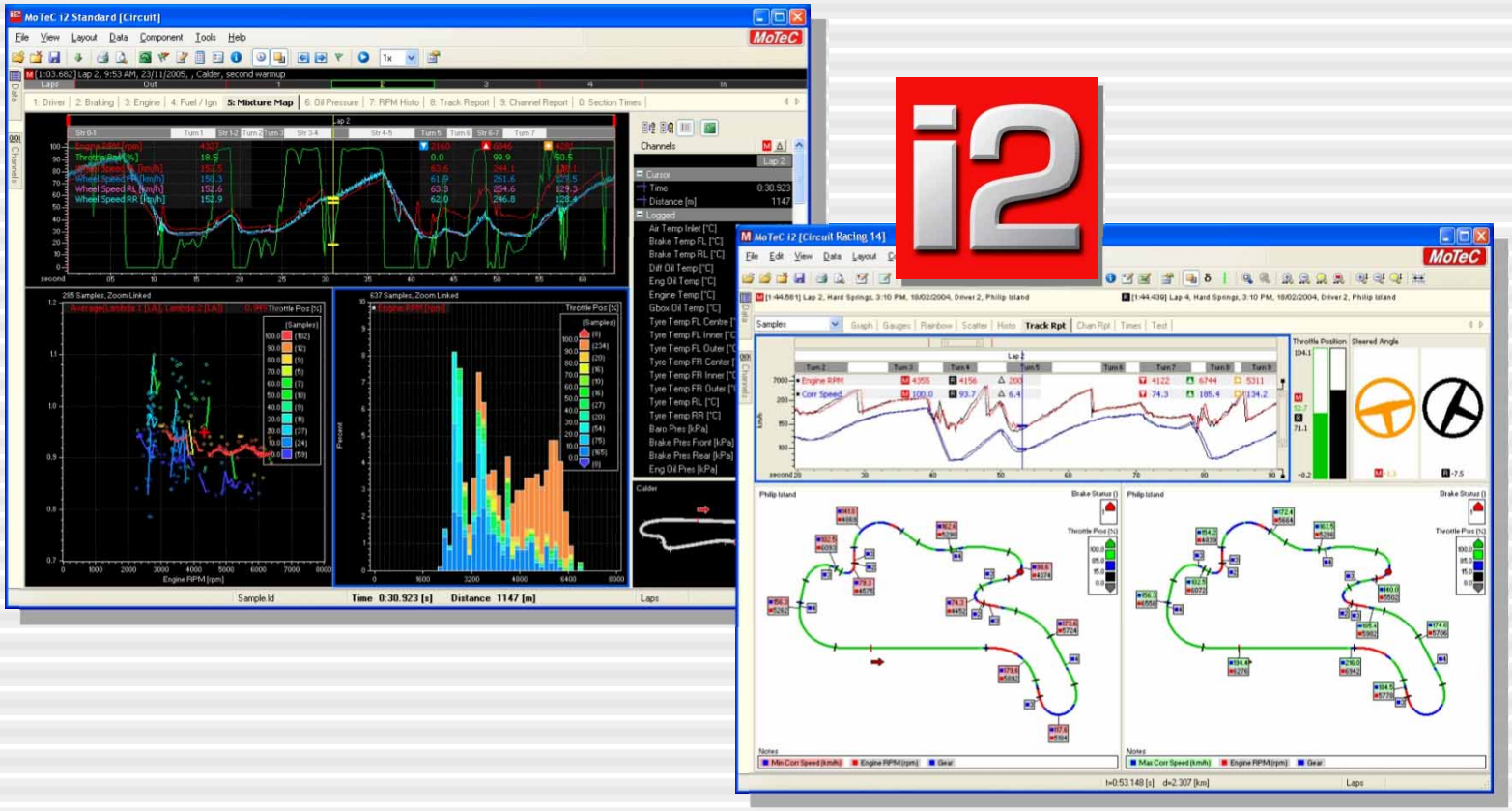
Straight section times for all laps

Times from the split beacons from all laps

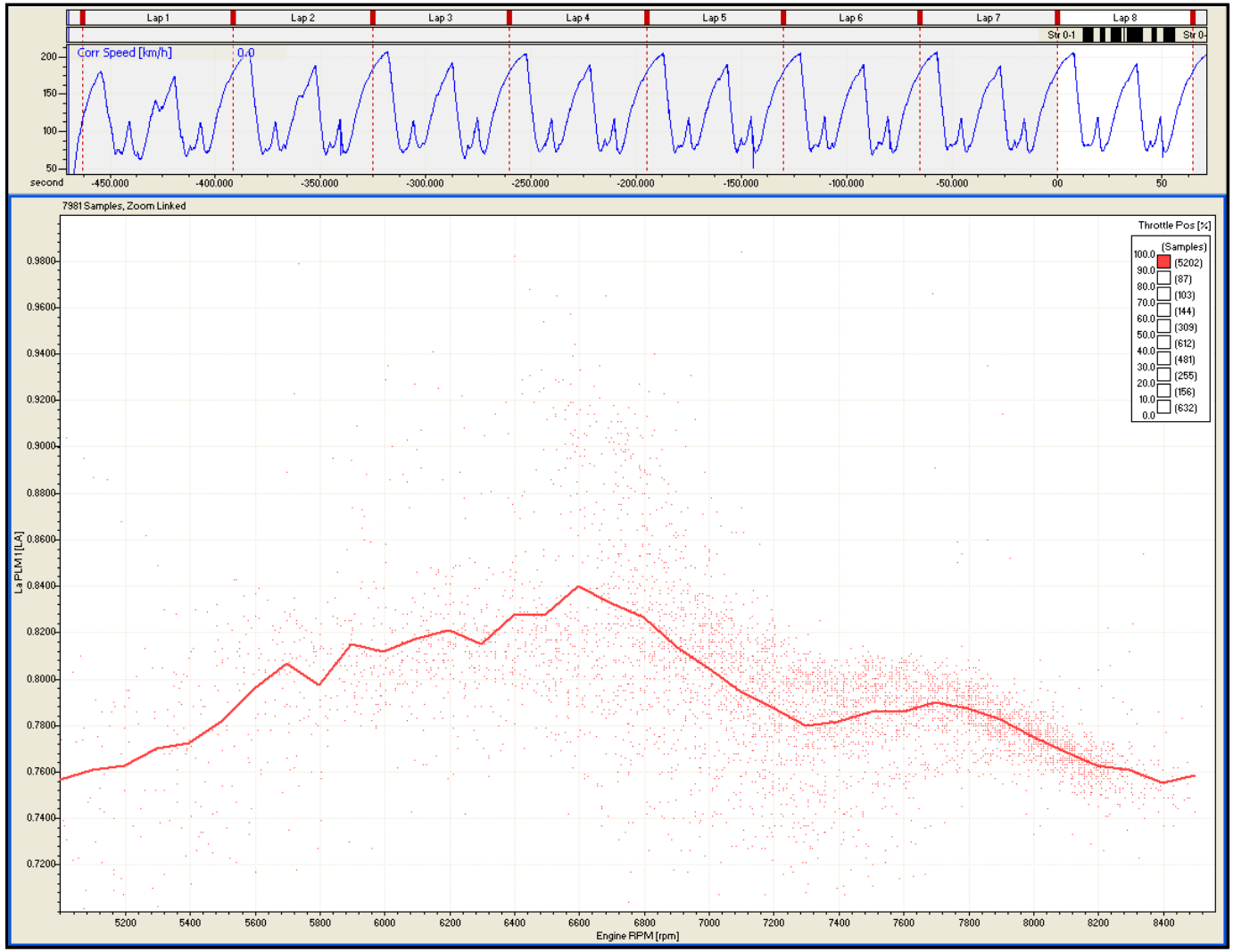
Split times and section markers for selected lap

MoTeC

Evaluating Chassis Performance



Mixture Maps 1

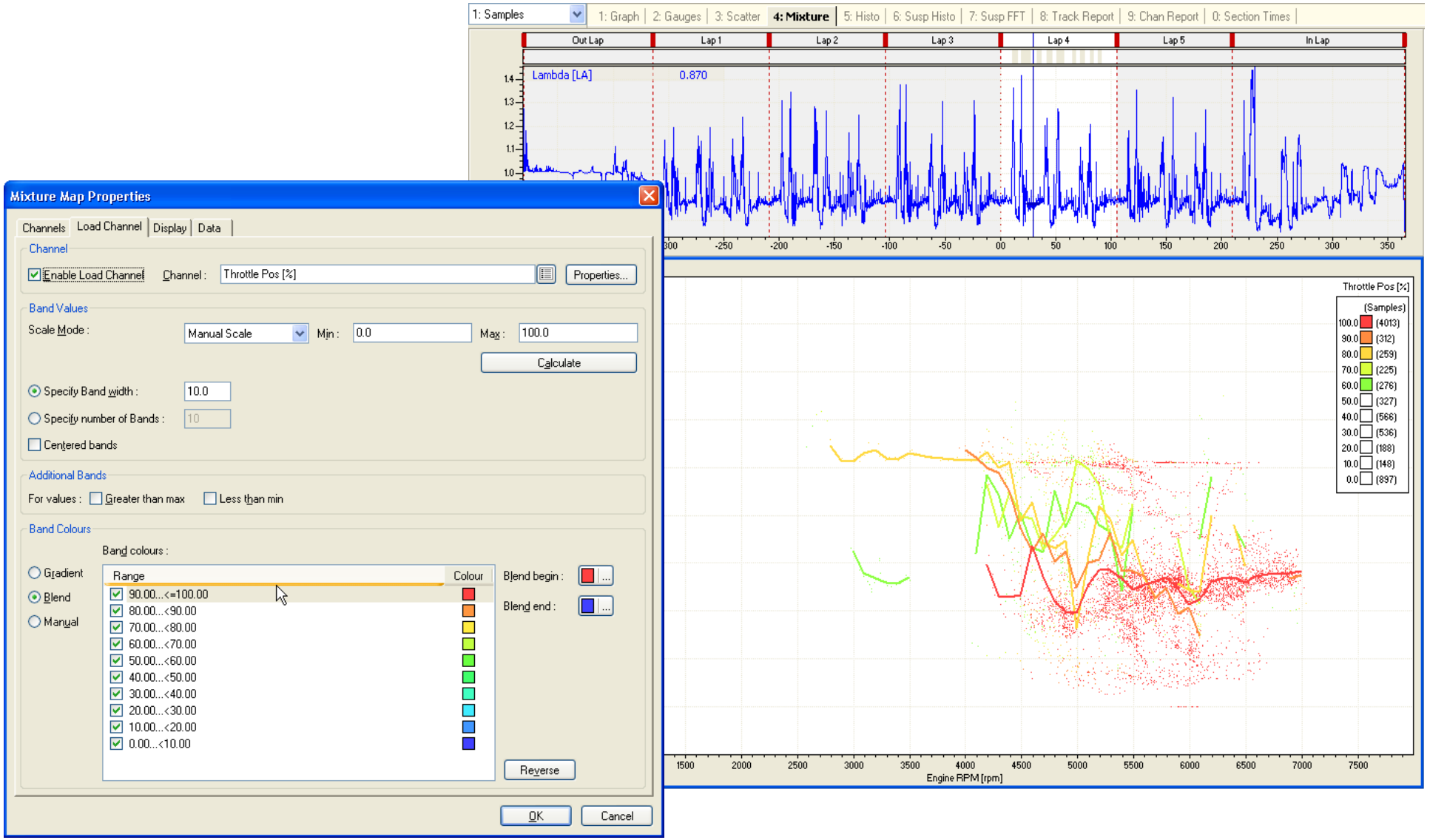


Lean

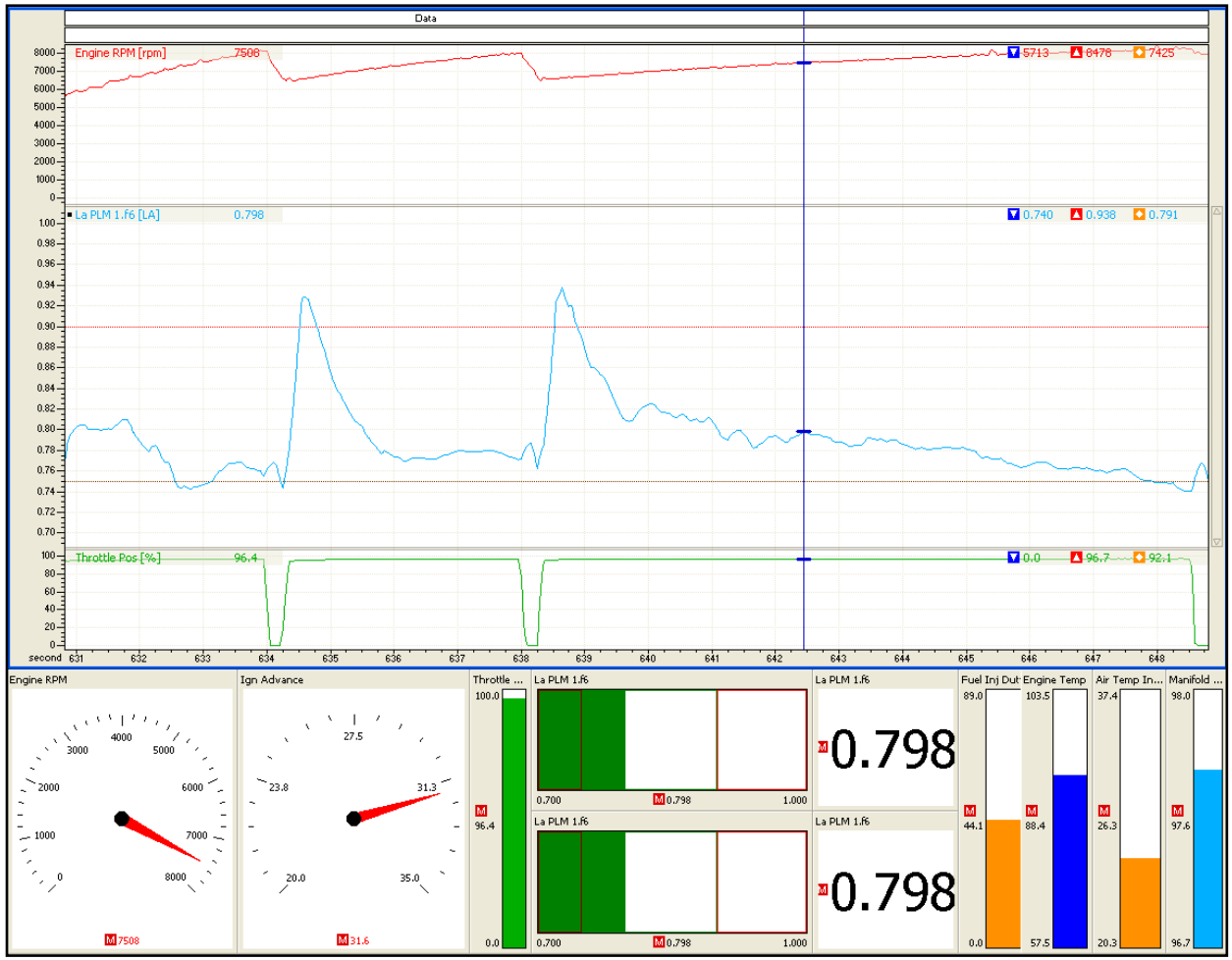
Rich

Colour channel legend
Ranges can be turned off/on by clicking on colour box

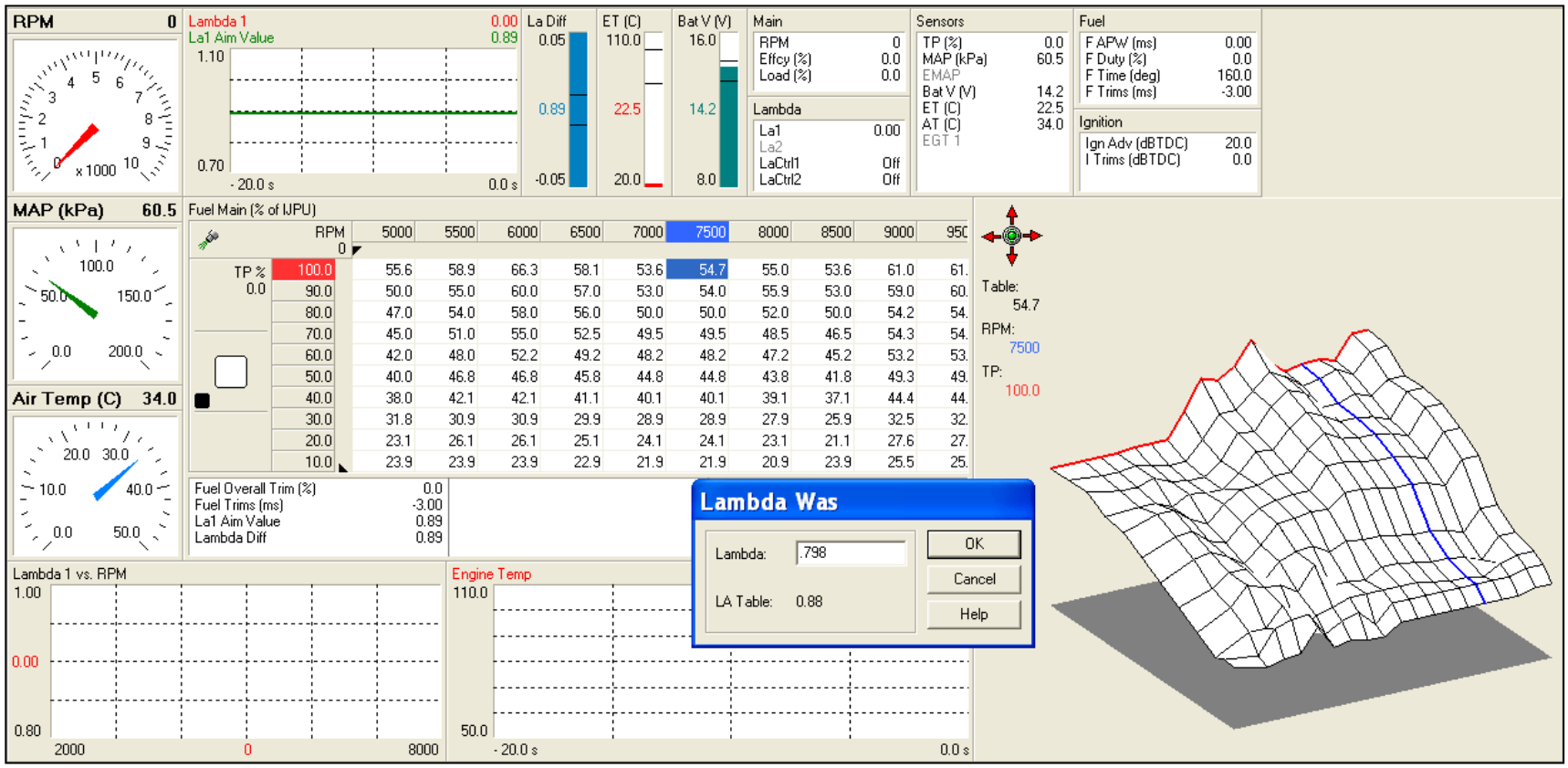
Mixture Maps 2



Engine Tuning with Data 1

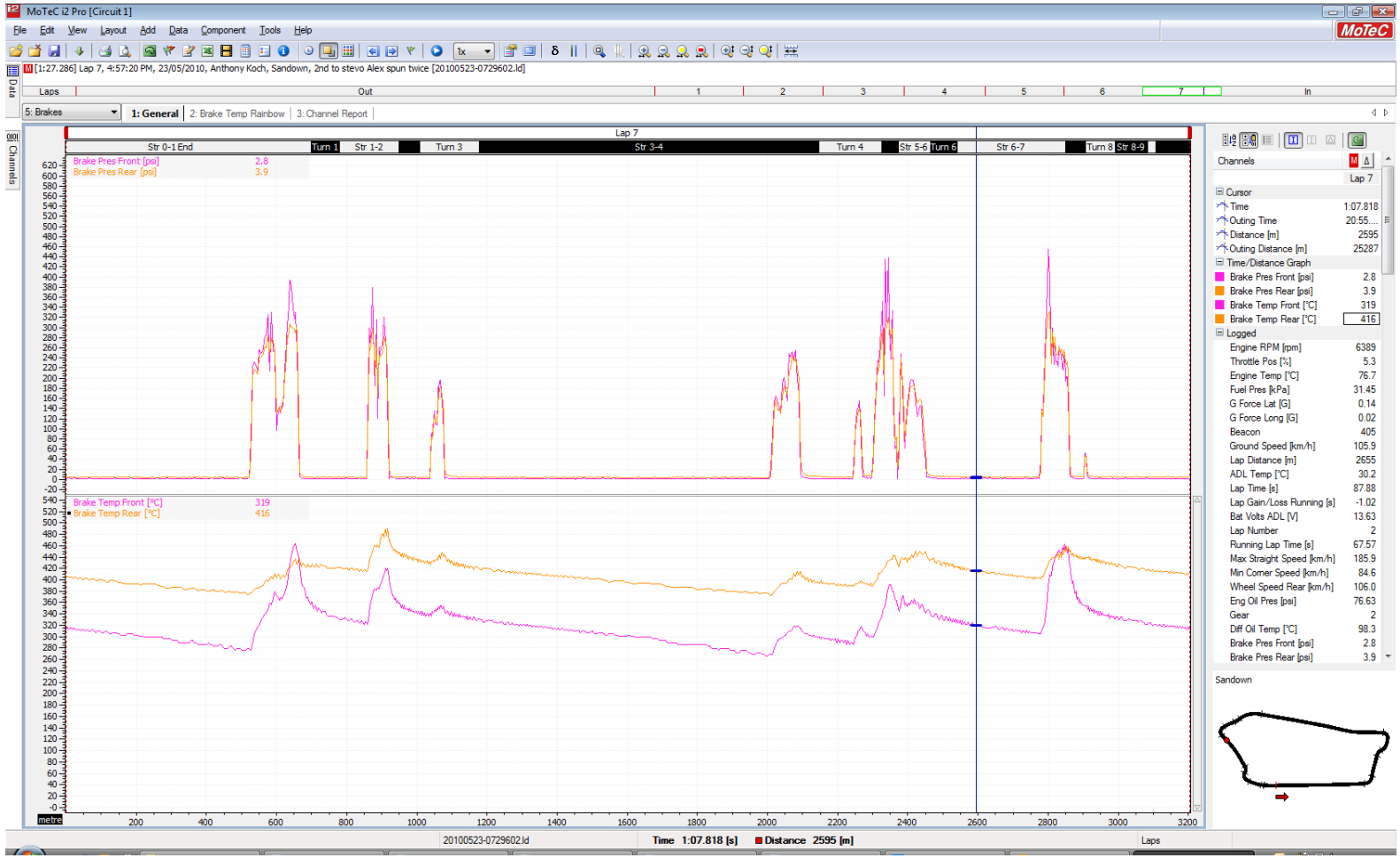


Engine Tuning with Data 2



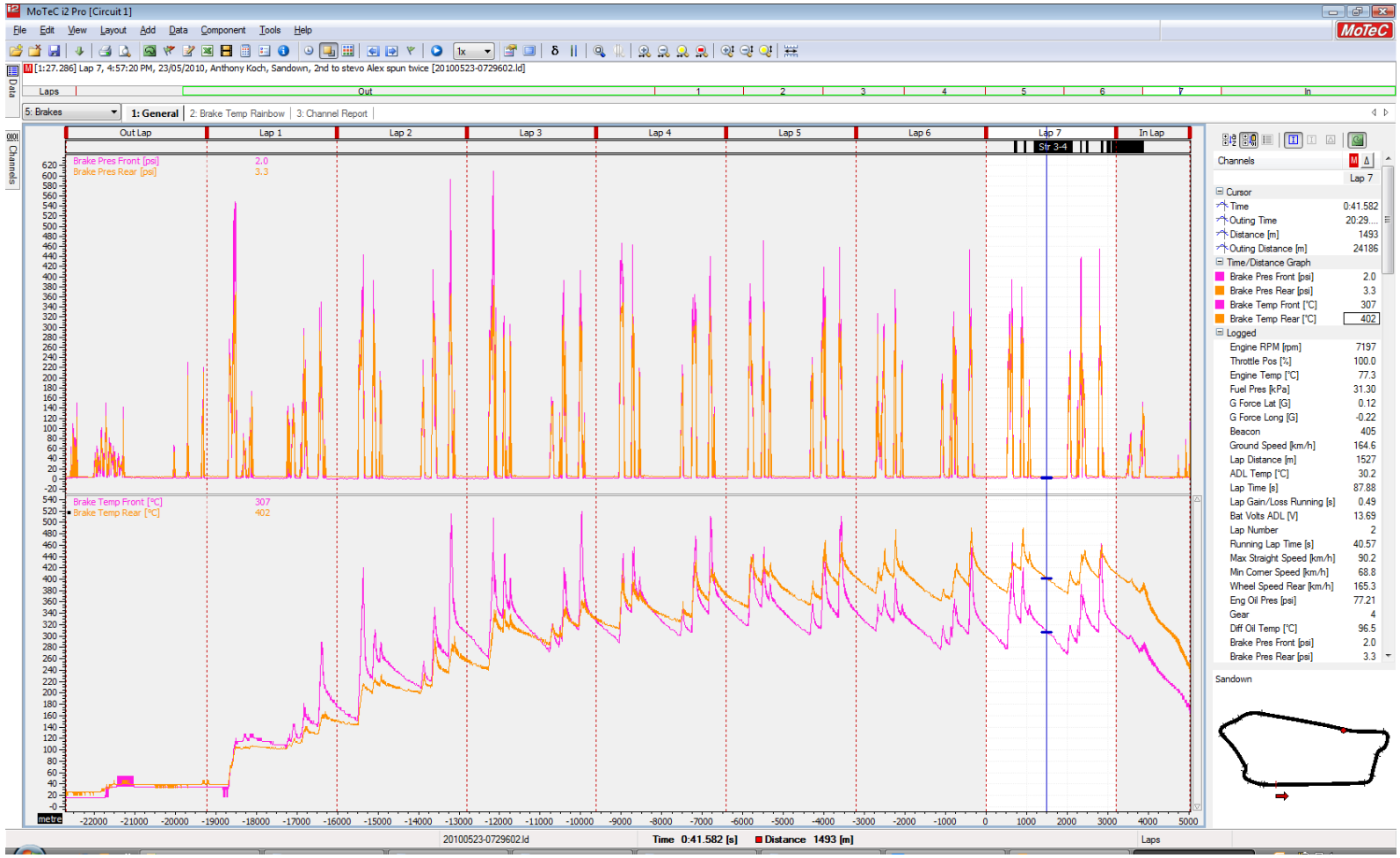
Brake Temp Analysis

- Single Lap



Brake Temp Data

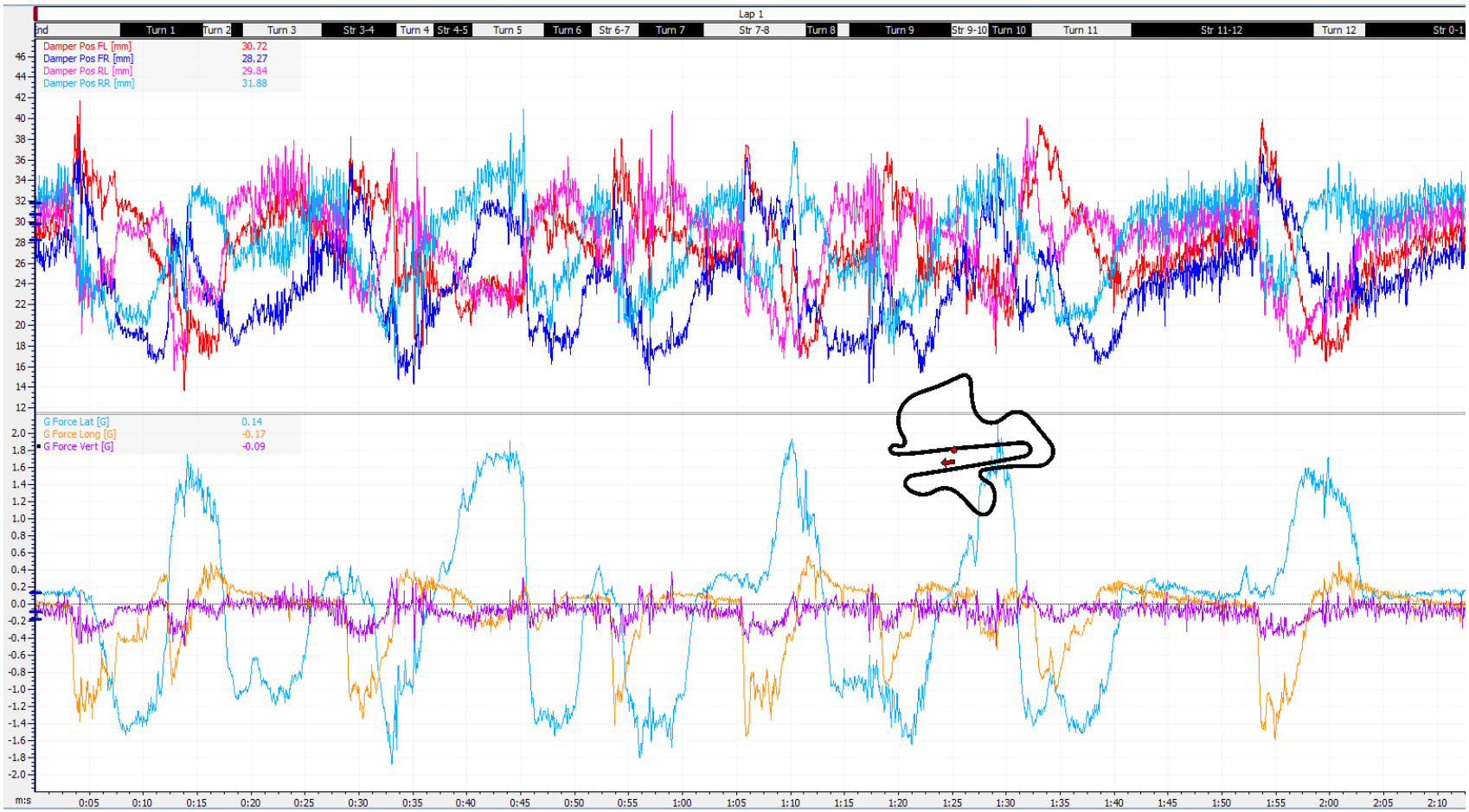
- Entire race



Suspension Analysis

Suspension Analysis

In this example, the front suspension goes negative under braking. Therefore, for suspension position, bump or compression is negative. This is the easiest convention for people to follow.



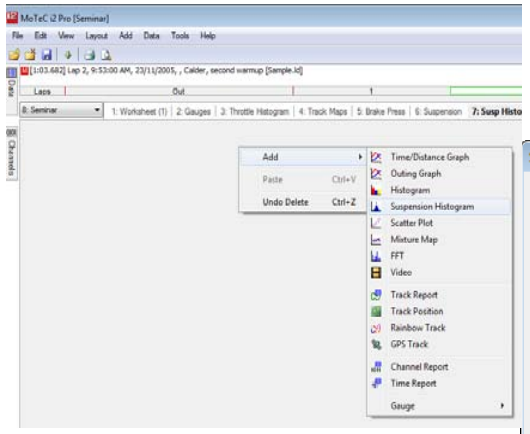
Talk to the Driver

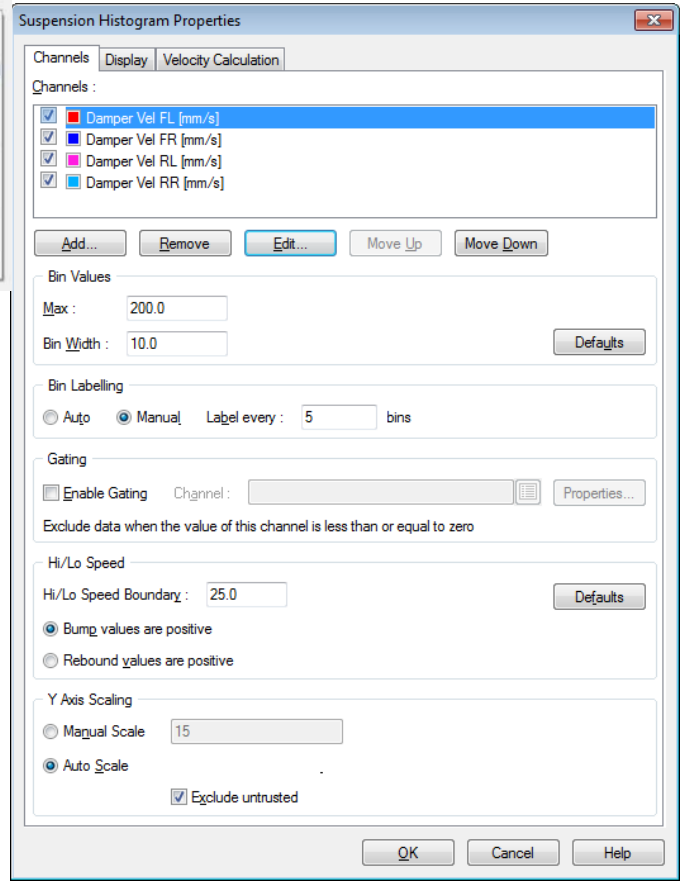
- The experience of your driver, the comments that he gives and the way he feels the car will all affect the analysis of the data.

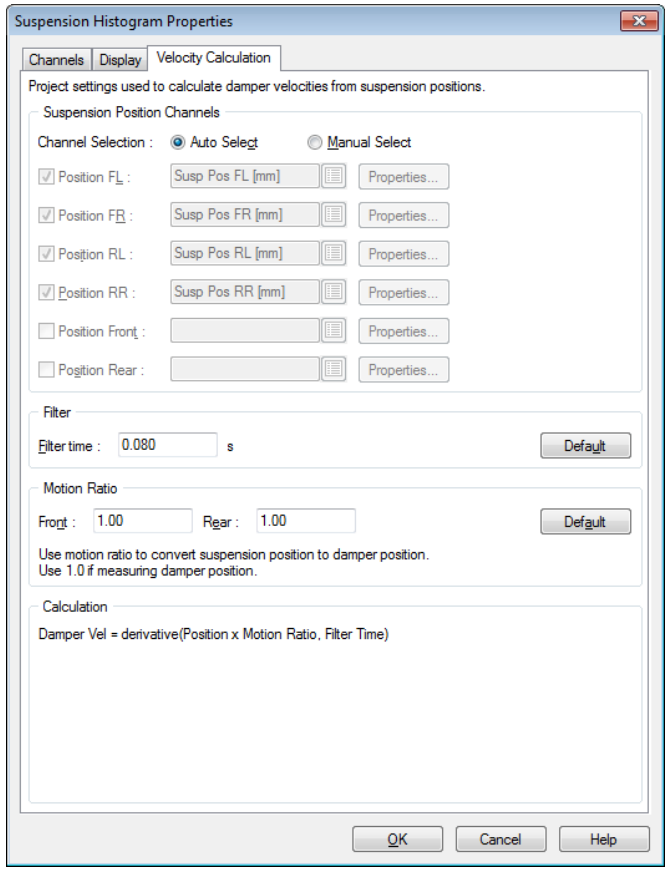
- Is there a balance problem in just one corner? Or is it in all ‘right handers’?

- Zoom into the corner(s) and look at what the damper position is at each corner of the car with relation to the G trace and other channels

Add a Damper Histogram





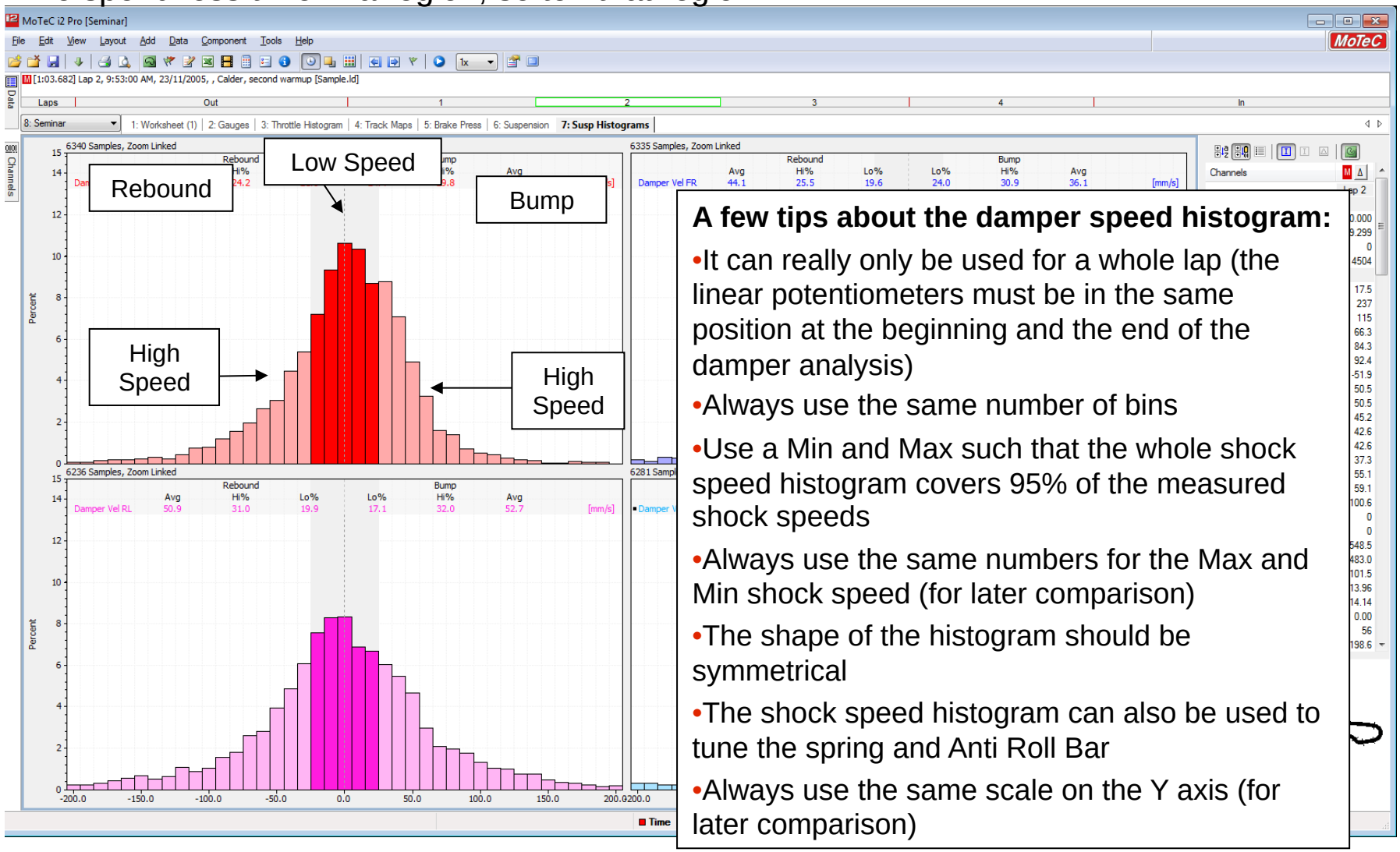


Damper Histogram Analysis

To spend more time in a region, stiffen that region.

To spend less time in a region, soften that region.

Graph of “AMOUNT OF TIME” spent at different “DAMPER SPEEDS”

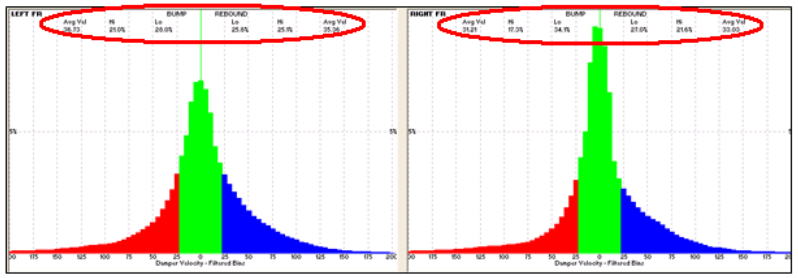


A few tips about the damper speed histogram:

- It can really only be used for a whole lap (the linear potentiometers must be in the same position at the beginning and the end of the damper analysis)
- Always use the same number of bins
- Use a Min and Max such that the whole shock speed histogram covers 95% of the measured shock speeds
- Always use the same numbers for the Max and Min shock speed (for later comparison)
- The shape of the histogram should be symmetrical
- The shock speed histogram can also be used to tune the spring and Anti Roll Bar
- Always use the same scale on the Y axis (for later comparison)

Damper Histogram Analysis

Setting dampers with histograms (1)



Left front	Low speed	High speed
Bump	28.0 %	21.0 %
Rebound	25.8 %	25.1 %

Right front	Low speed	High speed
Bump	34.1 %	17.3 %
Rebound	27.0 %	21.6 %

Left bump low speed is too stiff

Right low speed bump is too stiff

Right damper is stiffer than left damper

Damper histogram with initial bump/rebound settings

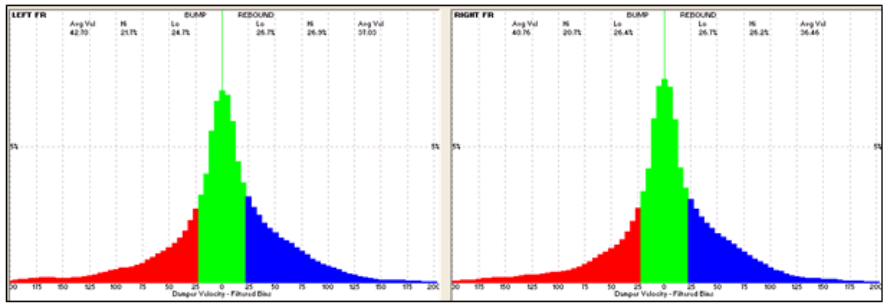
Example of gain made using damper histogram analysis

Damper Histogram with modified damper settings

Setting dampers with histograms (2)

Set-up modification : 2 clicks softer in right low speed bump

1 click softer in left low speed bump

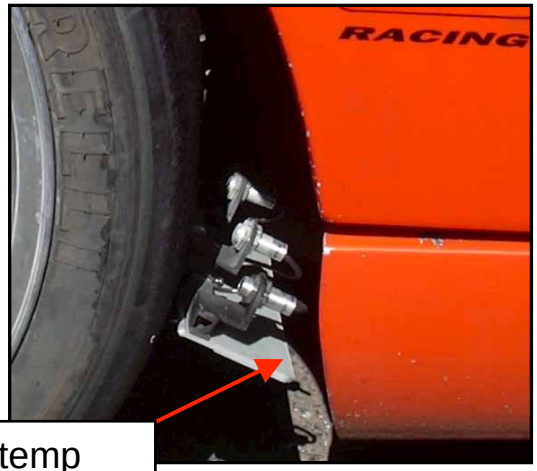


Left front	Low speed	High speed
Bump	24.7 %	21.7 %
Rebound	26.7 %	26.9 %

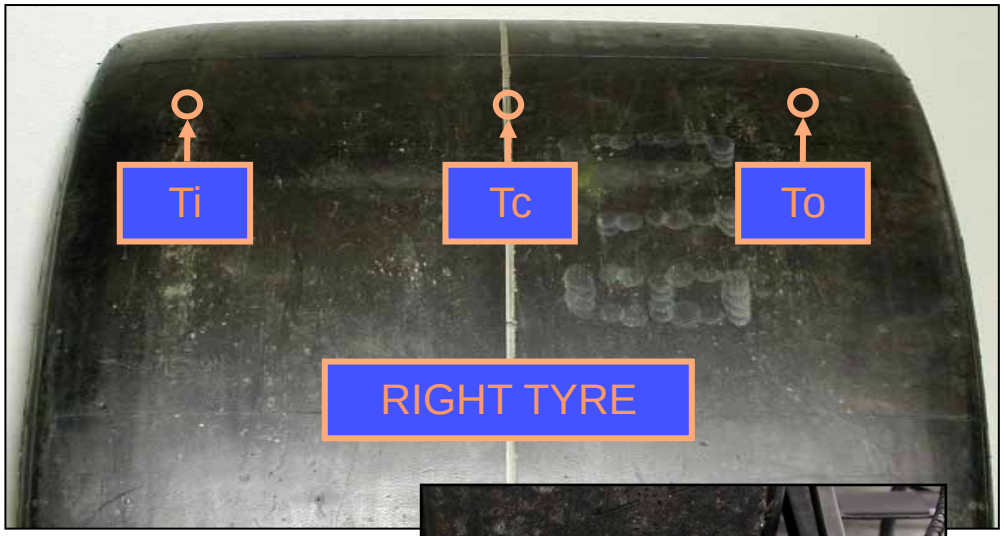
3/10 sec. Gain with this setting!!

Right front	Low speed	High speed
Bump	26.4 %	20.7 %
Rebound	26.7 %	26.2 %

Tyre Temp Sensors

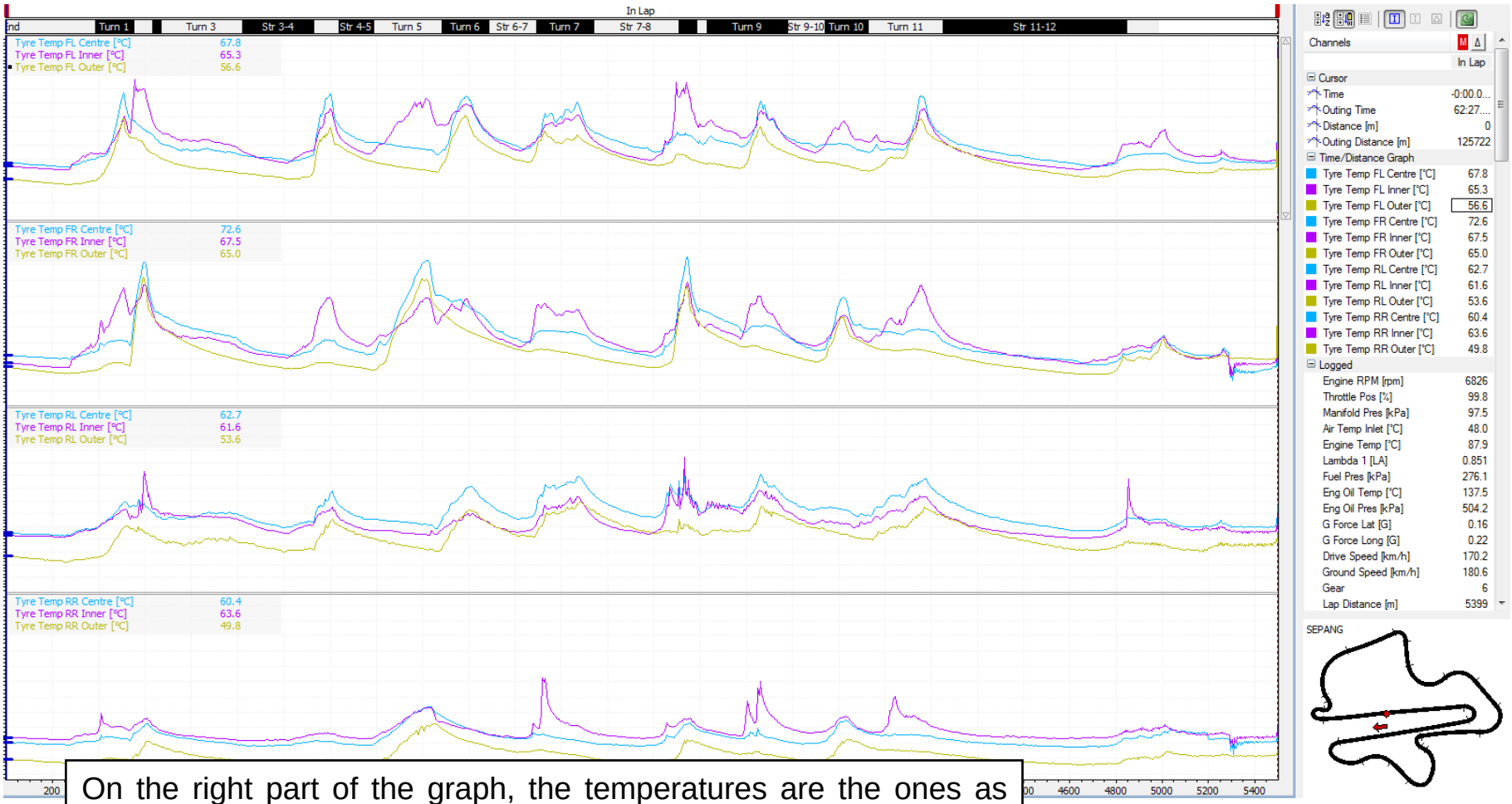


IR temp Sensor installation



Example of tyre Temp installation

Tyre Temp Sensors



On the right part of the graph, the temperatures are the ones as seen in the pits when the car stops. On the left part of the graph, you get an idea of what is really happening on the track.

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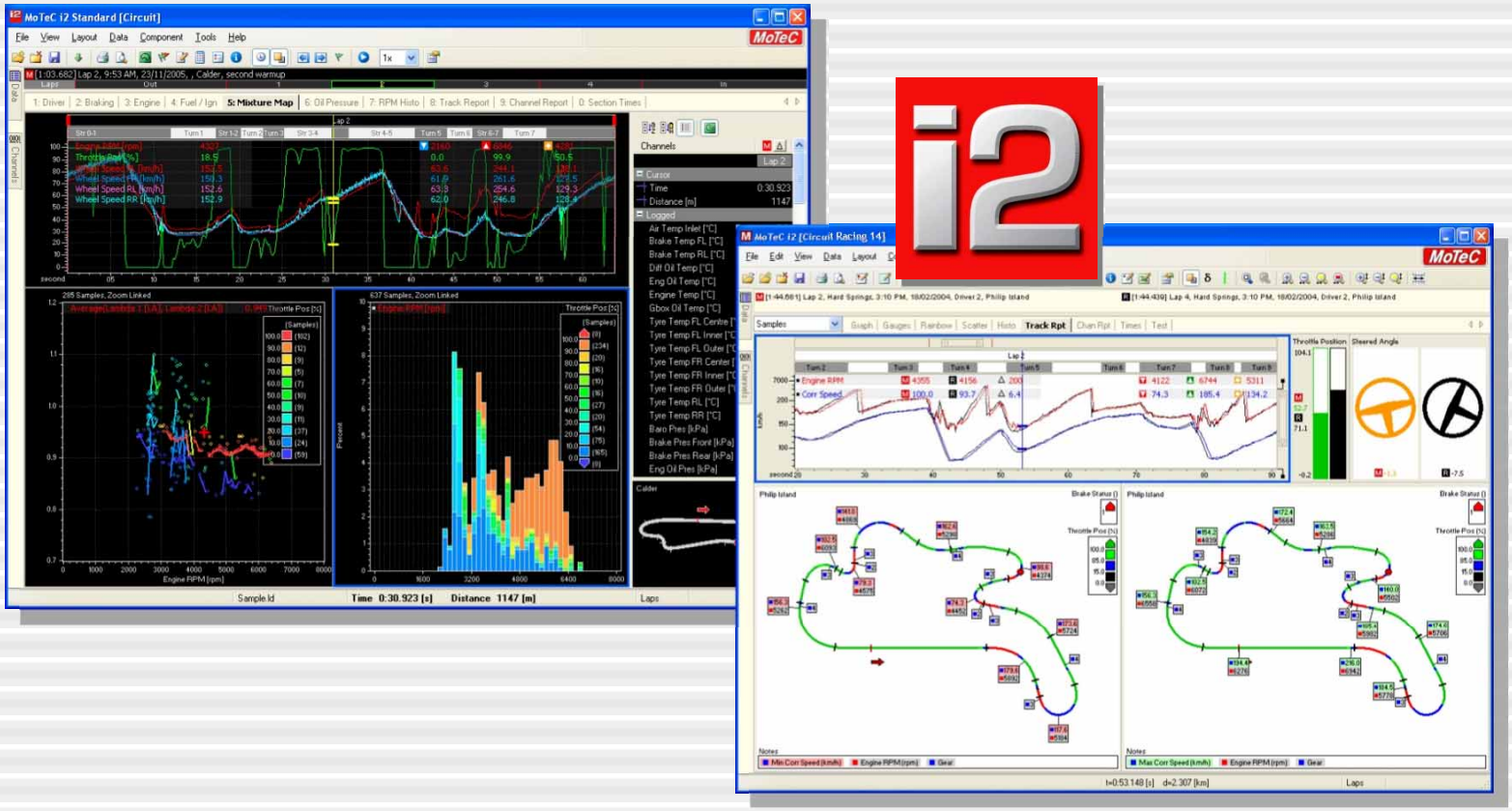
Data Maintenance



Weekend Checklist

Start of Weekend

- Update Details Editor

  Event – General comments about meeting or test session.

  Venue – Track name and the directory to which log files will be placed (very important).

  Vehicle – Update any changes since the vehicle last ran, including gear ratios.

- Check Sensors

  Use Monitor Active Channels or scrolling through the Warm-up page on the dash to check that all sensor values are appropriate for that sensor and fix any that are wrong.

- Zero Sensors

  If required zero G Sensors, Suspension Sensors, Steering, etc.

- Logging

  Check that logging templates loaded are appropriate for the day. For instance a template configured for race logging with slower rates and fewer channels than practice logging might be loaded from the previous race.

- Venue Dependant Variables

  Load new Reference Laps for Lap Time Gain/Loss change.

- Beacons and Lap Times

  Make sure that the Beacon Receiver is on the correct side of the car, or GPS coordinates are correct.

Before/After each session

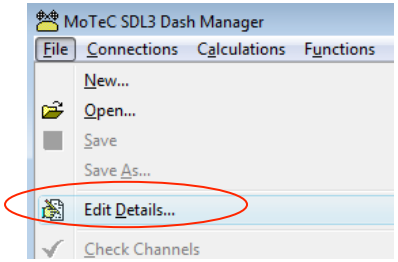
- Details Editor

  Update any changes made to the vehicle and enter details about the session (practice, qualifying, race, etc.).

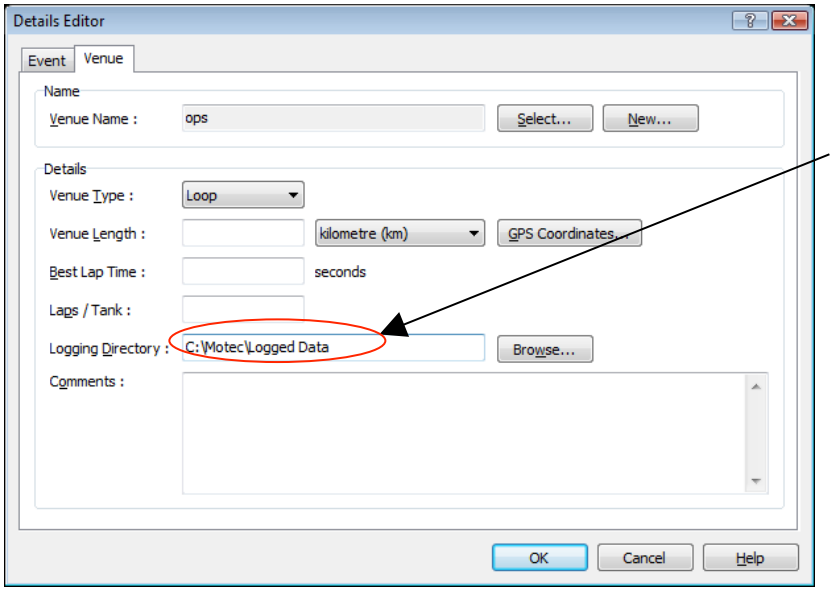
At the end of the day

- Make sure that you collect your Beacon Transmitter.

Organising Log Files

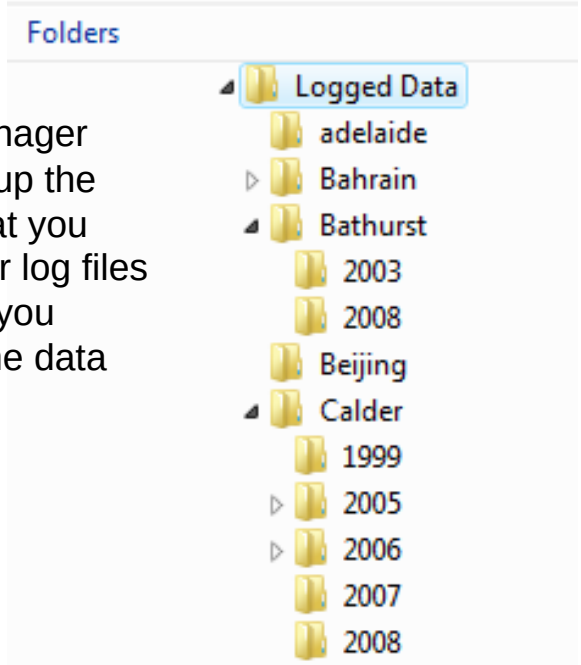


- Organising your logged data into specific folders for events so you can access them quickly



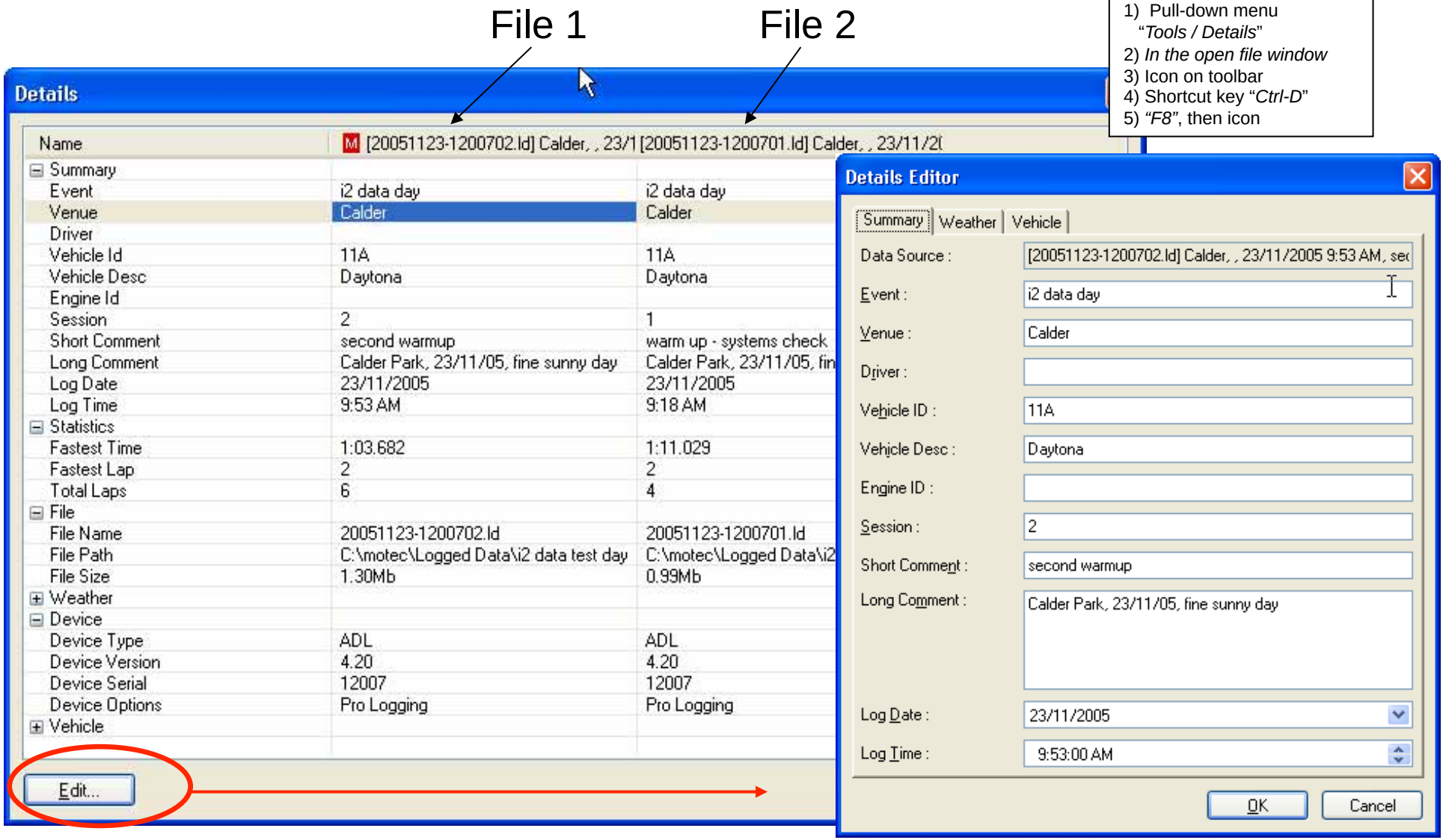
In Dash Manager you can setup the directory that you want all your log files to go when you download the data

Organise by Venue and Year



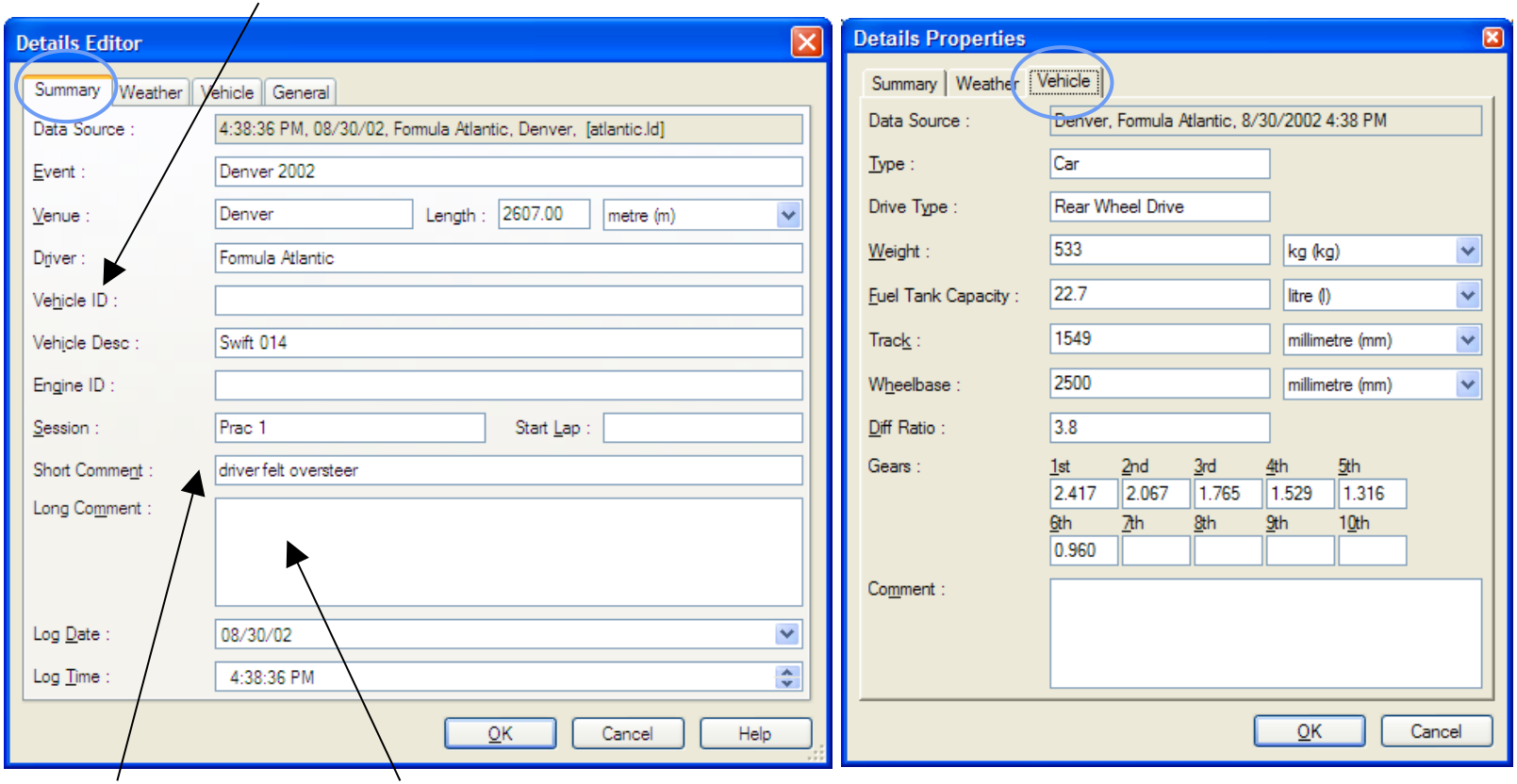
View / Edit Details

5 ways to Edit Details:
1) Pull-down menu
"*Tools / Details*"
2) *In the open file window*
3) Icon on toolbar
4) Shortcut key "*Ctrl-D*"
5) *"F8"*, then icon



Edit Details

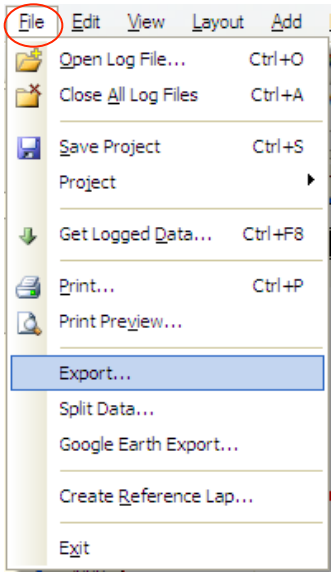
Chassis # or Car #, used for the name of the Excel setup sheet.

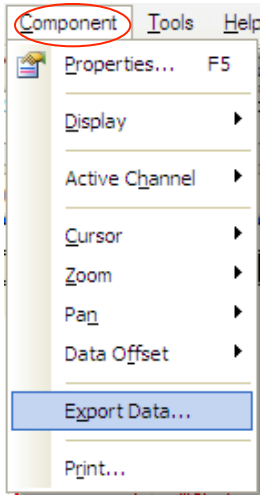


Shows in open window

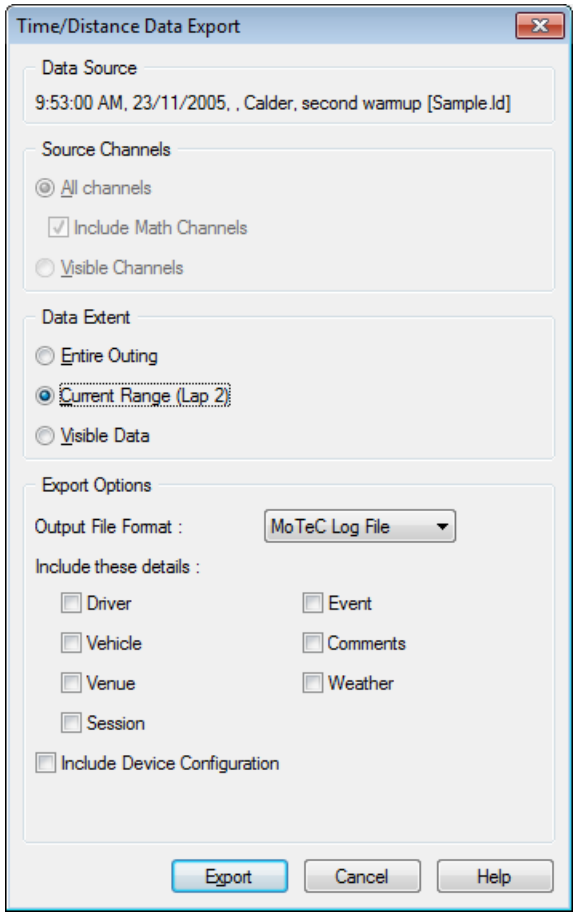
Doesn't show in open window

Exporting Data



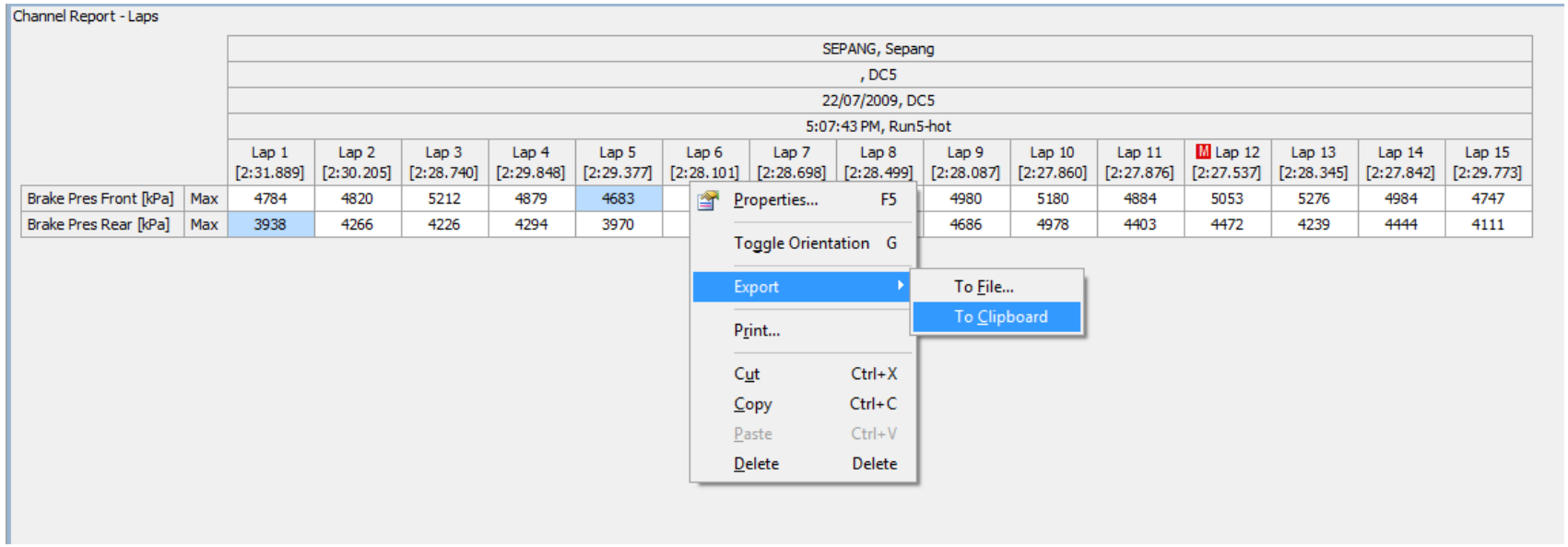


- Export to Matlab, .csv file or to the clipboard for use in Excel, etc.
- For “Component” export, only the channels shown get exported.
- For “File” export, all channels get exported.
- All data is exported at the same rate.



Exporting to .ld file allows you to share your data with another competitor but only the channels you have graphed.

Exporting Channel Report Data



Creating a Summary Sheet

- Export the channel reports and paste in Excel.

RACE REPORTS2002.xls [Read-Only]

	A	B	C	D	E	F	G	H	I
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					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

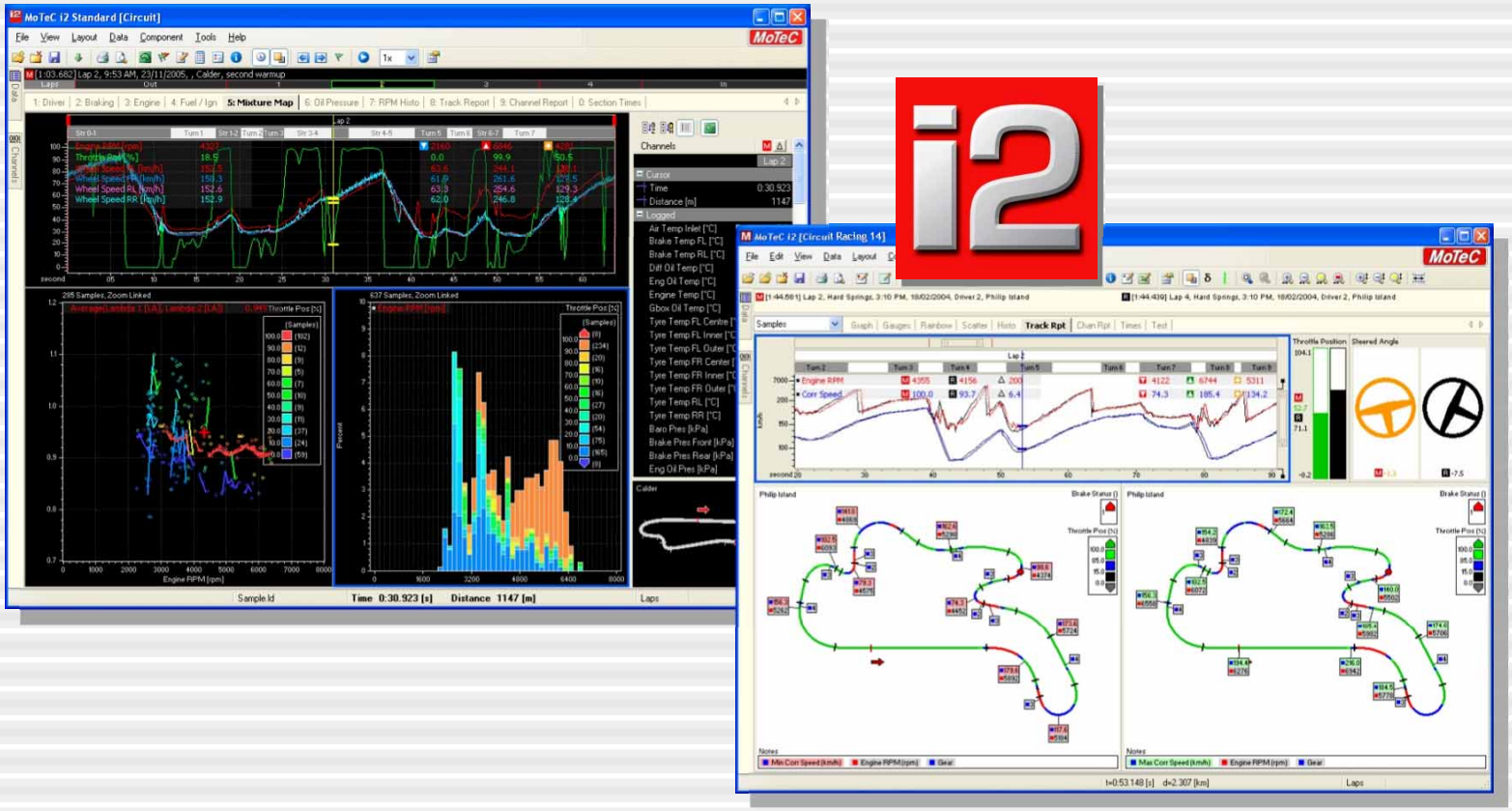
The Final Chapter

- If you need assistance, feel free to drop us a line at support@motec.com.au
- If you have suggestions on possible improvements, or feature requests, email us at the same address, and we can look into it for you
- Can be found wandering the paddock
- Eager to hear new applications
- In the extremely unlikely event that you have a dash hardware or software crash, we would like to hear from you with the information so that we can continue to improve the product.

Any Questions??

MoTeC

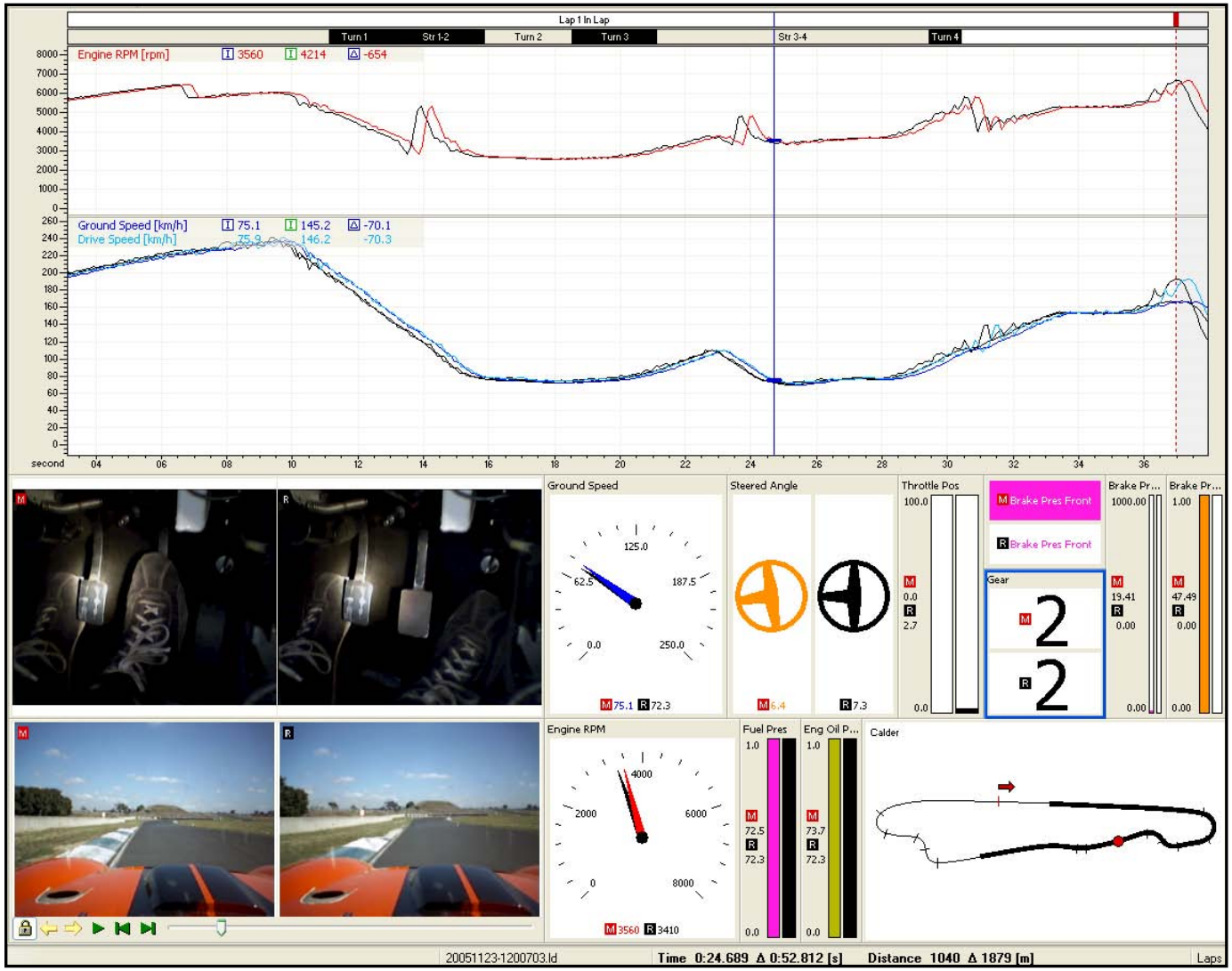
Appendix



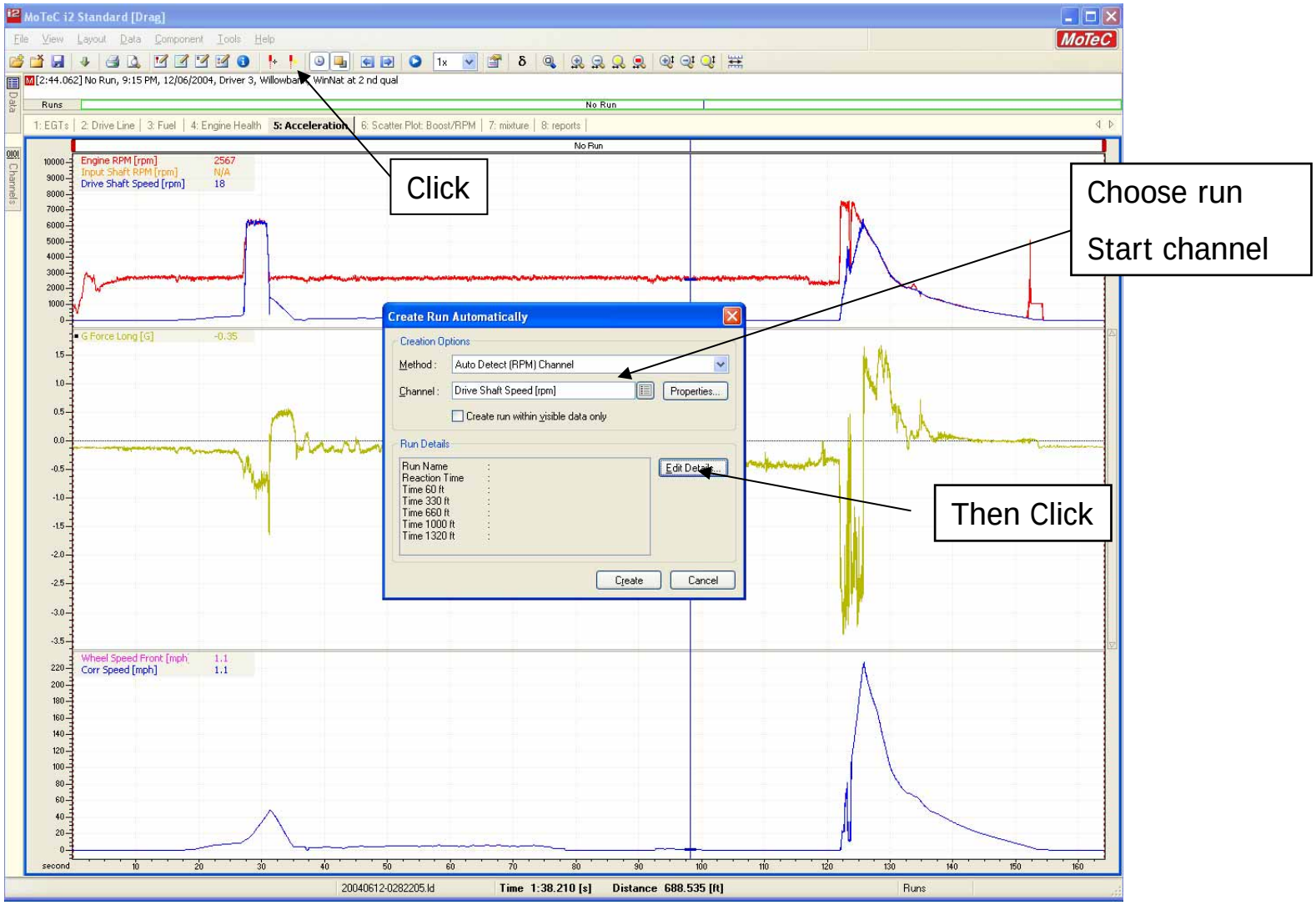
Tyre Temps Quick Guide

T_{INSIDE}	<	T_{CENTRE}	<	$T_{OUTSIDE}$	Not enough camber, or too much toe in.
T_{INSIDE}	<	T_{CENTRE}	>	$T_{OUTSIDE}$	Tyre pressure too high.
T_{INSIDE}	<	T_{CENTRE}	=	$T_{OUTSIDE}$	Not enough camber, or tyre pressure too high and too much toe in.
T_{INSIDE}	>	T_{CENTRE}	<	$T_{OUTSIDE}$	Tyre pressure too low.
T_{INSIDE}	>	T_{CENTRE}	>	$T_{OUTSIDE}$	Too much camber, or too much toe out.
T_{INSIDE}	>	T_{CENTRE}	=	$T_{OUTSIDE}$	Too much camber, or tyre pressure too low and too much toe out.
T_{INSIDE}	=	T_{CENTRE}	<	$T_{OUTSIDE}$	Not enough camber, or tyre pressure too low and too much toe in.
T_{INSIDE}	=	T_{CENTRE}	>	$T_{OUTSIDE}$	Too much camber, or tyre pressure too high and too much toe out.
T_{INSIDE}	=	T_{CENTRE}	=	$T_{OUTSIDE}$	OK

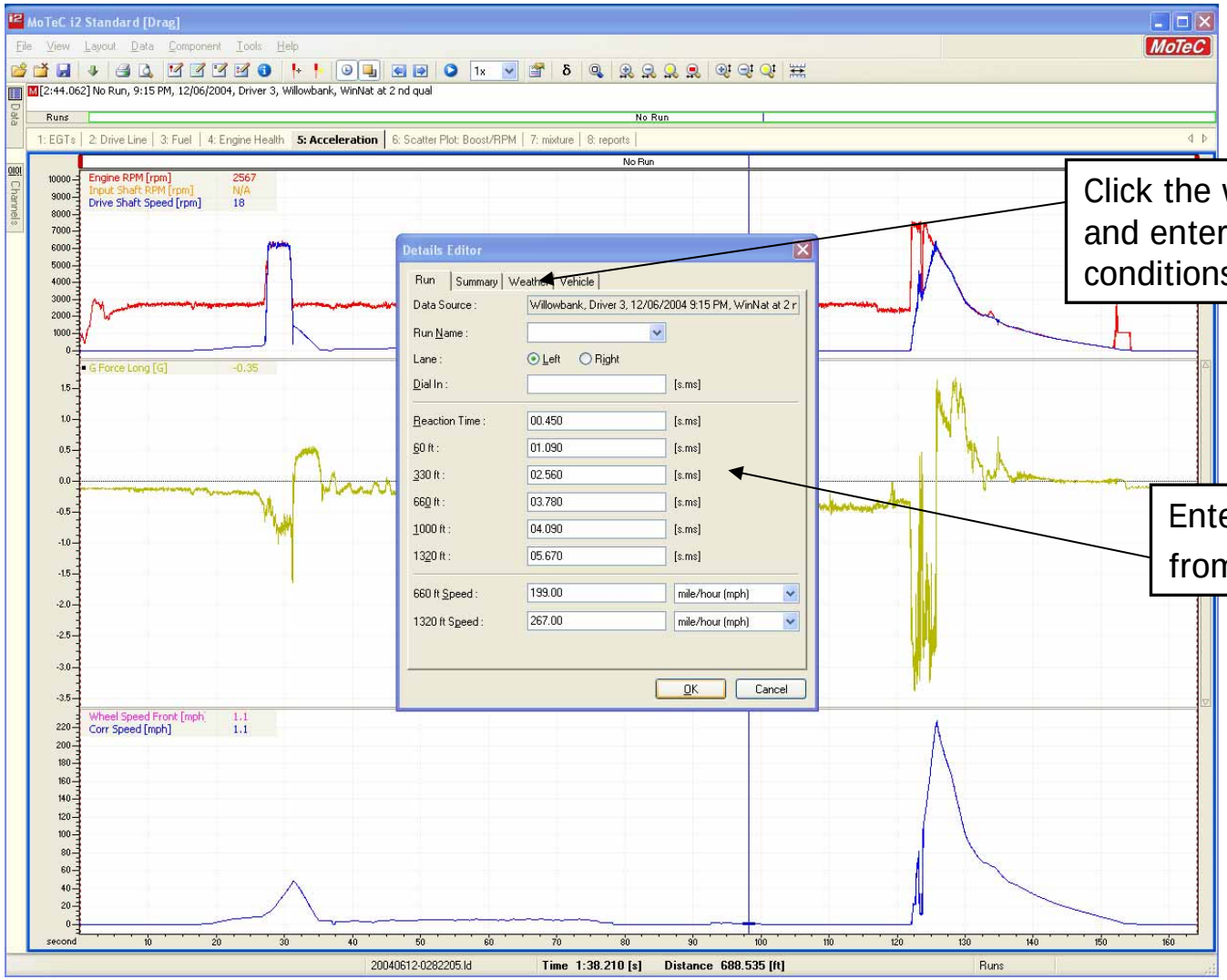
Add a Video


Lap 1 In Lap
Turn 1
Str 1-2
Turn 2
Turn 3
Str 3-4
Turn 4
Engine RPM [rpm]
Ground Speed [km/h]
Drive Speed [km/h]
second
Ground Speed
Steered Angle
Throttle Pos
Brake Pres Front
Gear
Engine RPM
Fuel Pres
Eng Oil P...
Calder
20051123-1200703.ld
Time 0:24.689 Δ 0:52.812 [s]
Distance 1040 Δ 1879 [m]
Laps

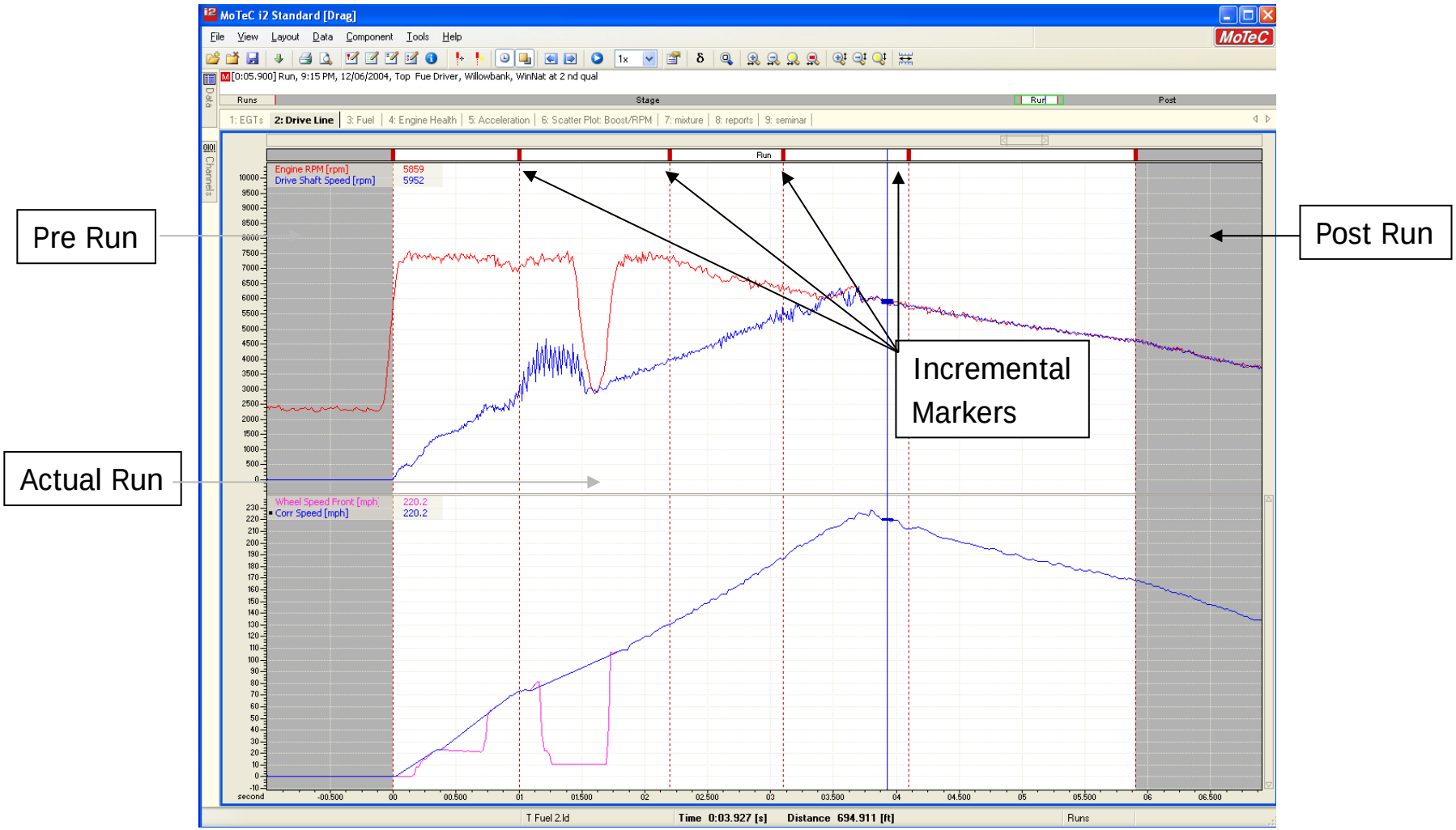
Drags: Auto Run Insertion 1



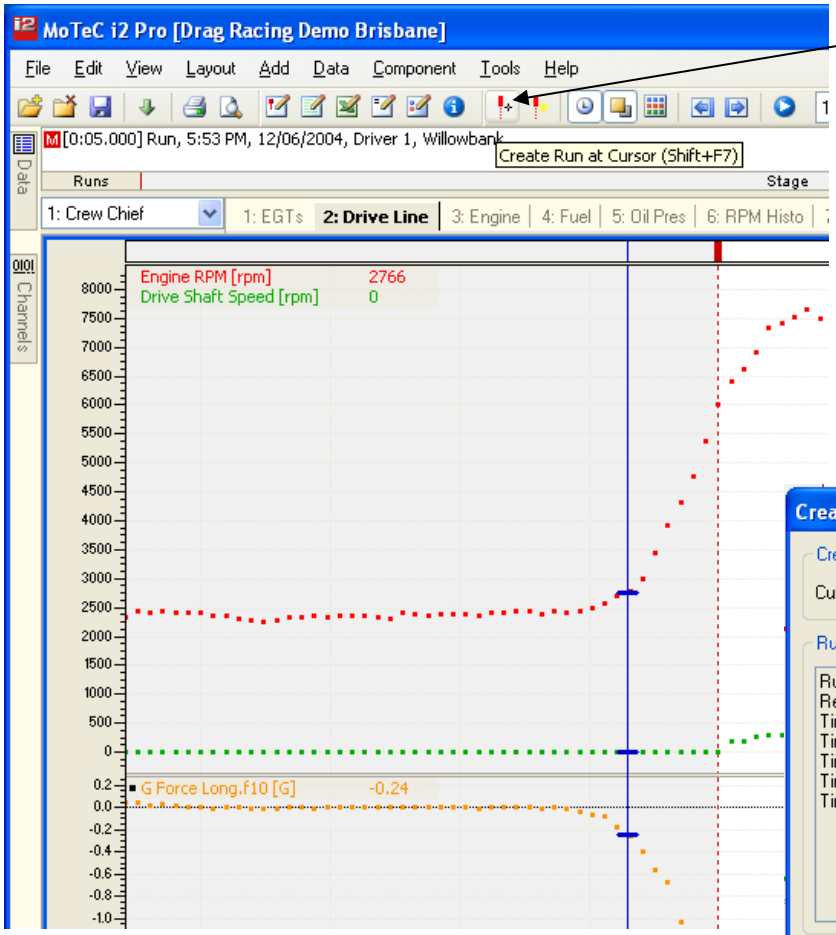
Drags: Auto Run Insertion 2



Drags: Run Display

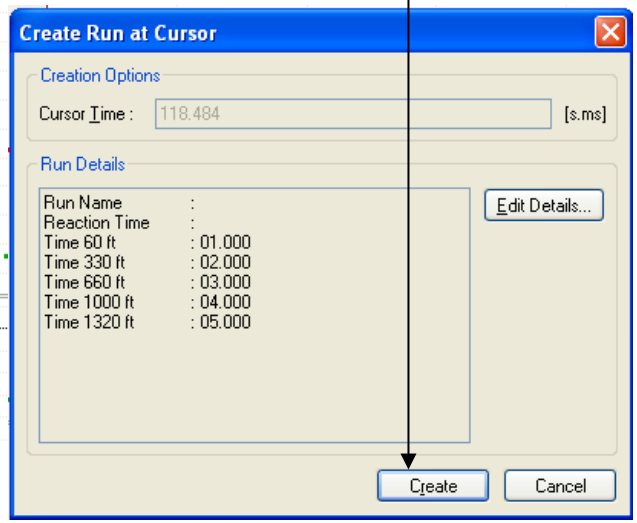


Drags: Manual Run Insertion



Click Create Run at Cursor

If 60ft times etc are the same Click Create



Advanced Features

- Gating
- User Sections
- Alias Editor
- Channel Mapping

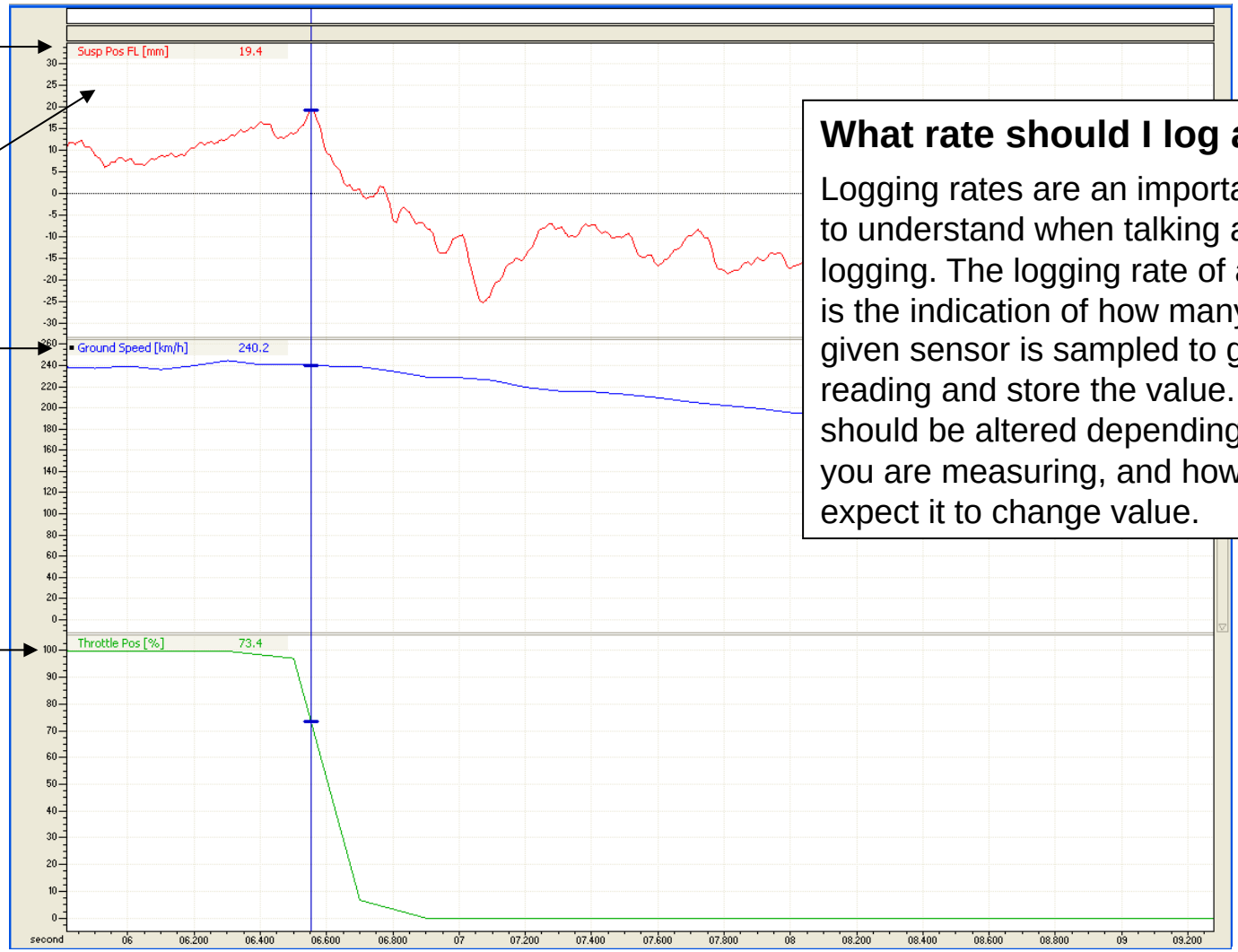
Logging Rates

100hz log rate

Same channel at 5hz log rate

10hz log rate

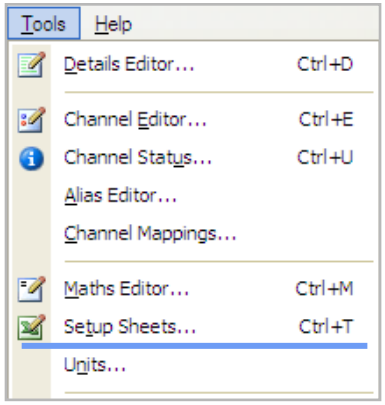
5hz log rate



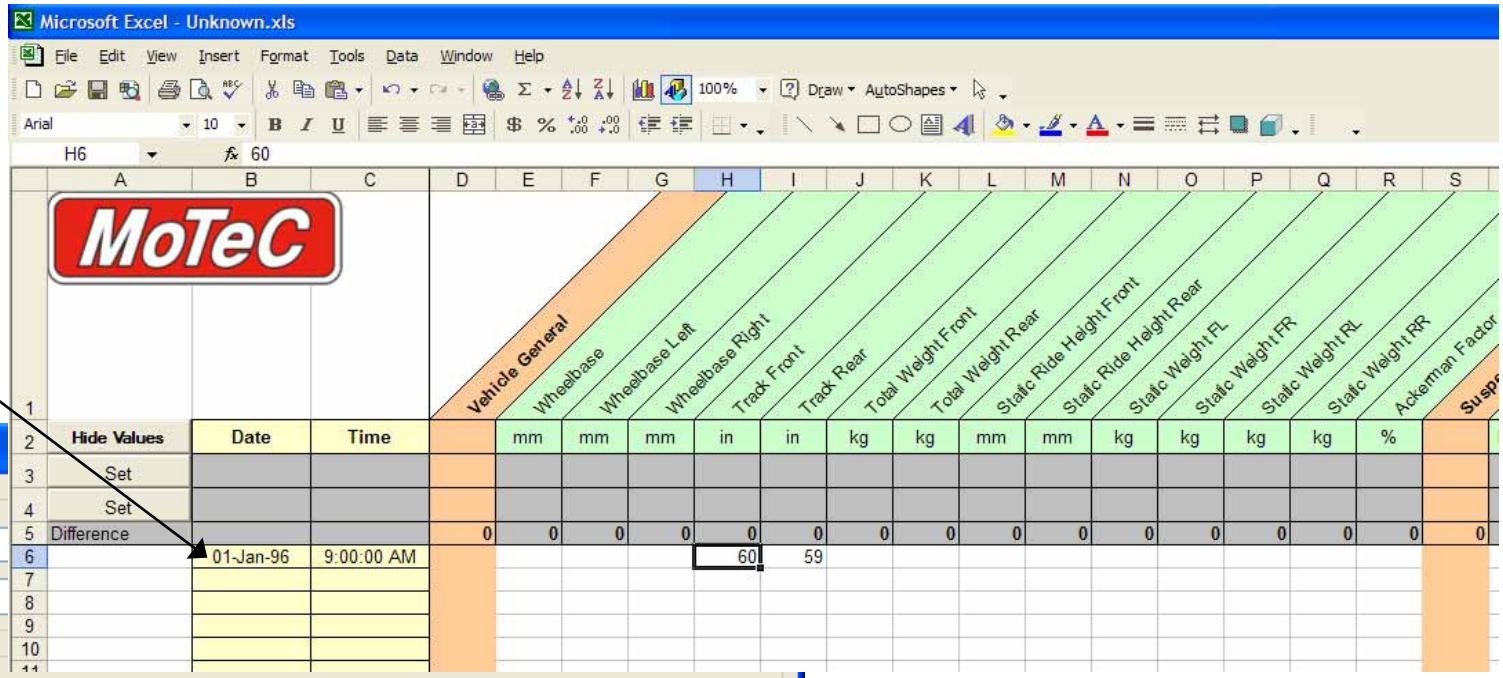
What rate should I log at?

Logging rates are an important concept to understand when talking about data logging. The logging rate of a channel is the indication of how many times a given sensor is sampled to get its reading and store the value. This rate should be altered depending on what you are measuring, and how fast you expect it to change value.

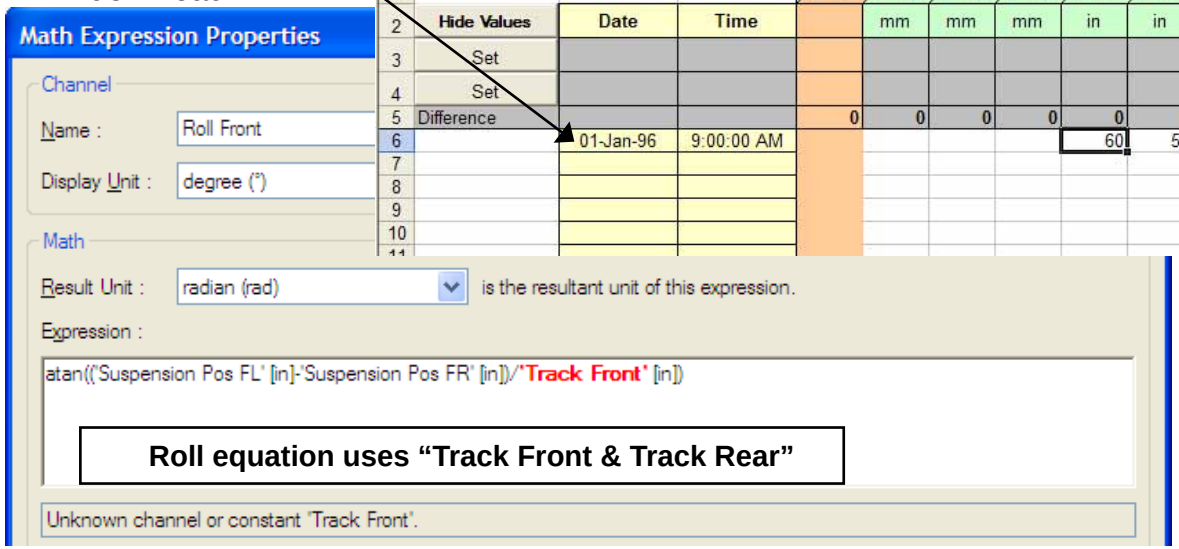
Setup Sheets



- Excel sheet for importing constants to be used in math equations, which can vary by session. This file can be located anywhere, just make sure you enable macros. Exit Excel once changes are complete.



You must enter the date & time of your download.

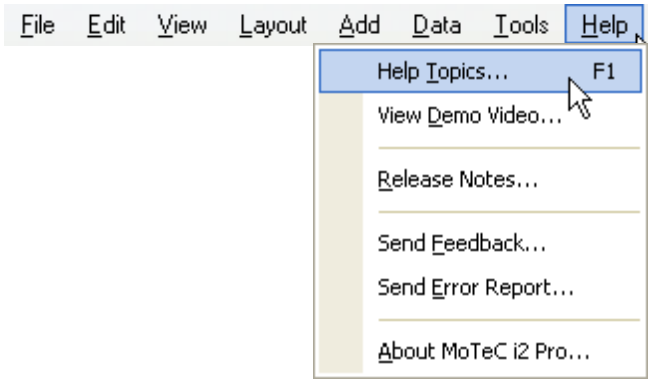


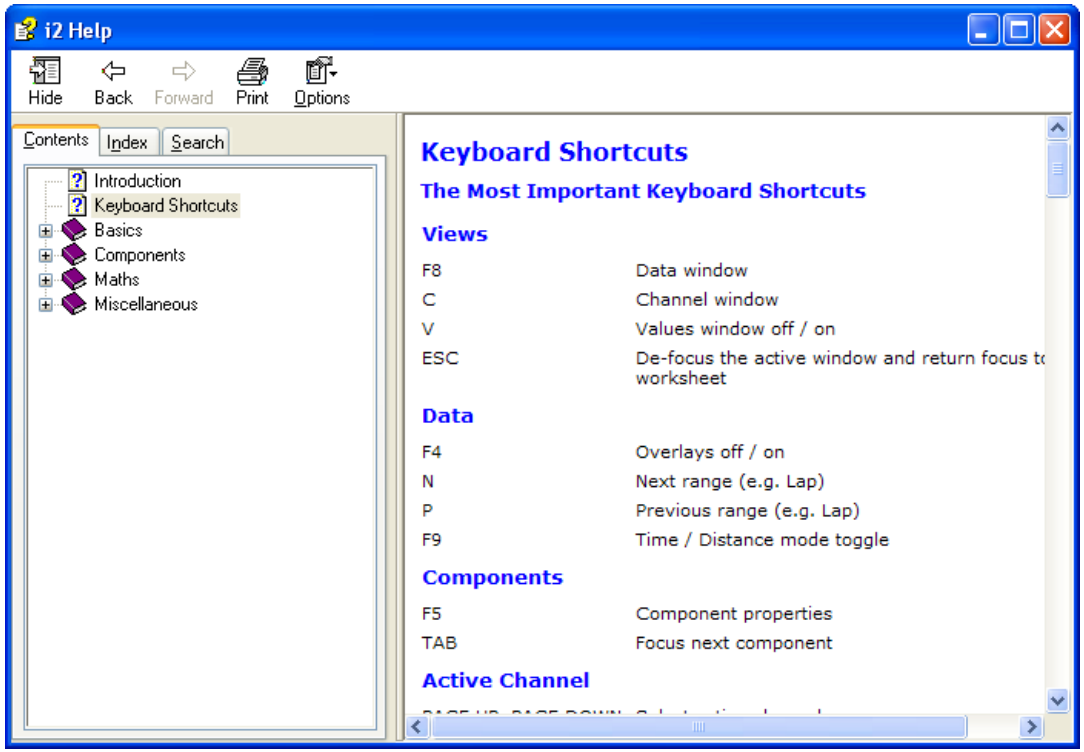
You can delete columns which aren't in use. You can create your own columns, names and select units.

You can leave blanks where the value doesn't change from session to session.

Keyboard Shortcuts

See the Help File for a complete list of Keyboard Shortcuts





Keyboard Shortcuts

Keyboard Shortcuts

The Most Important Keyboard Shortcuts

Views

F8	Data window
C	Channel window
V	Values window off / on
ESC	De-focus the active window and return focus to the worksheet

Data

F4	Overlays off / on
N	Next range (e.g. Lap)
P	Previous range (e.g. Lap)
F9	Time / Distance mode toggle

Components

F5	Component properties
TAB	Focus next component

Active Channel

PAGE UP, PAGE DOWN	Select active channel

Graph

LEFT / RIGHT ARROW	Cursor movement
CTRL + LEFT / RIGHT ARROW	Fast cursor movement
UP / DOWN ARROW	Horizontal zoom in / out
F2	Horizontal zoom full out
W	Horizontal zoom to default (e.g. 1 Lap)
SHIFT + LEFT / RIGHT ARROW	Pan left / right
F3	Variance off / on
E	Status and Errors off / on
G	Overlapped / Tiled

Windows

ALT+Letter	Activate a main menu item that has the letter underlined. Or, if a dialog window is active, focus an item or activate a button with a label that has the letter underlined.
TAB	Move to the next item
SHIFT+TAB	Move to the previous item
ENTER	Activate the default button
ESC	Close or cancel an open window
ARROW Keys	Move up and down in a list, select a dropdown item, select an option button
SPACEBAR	Activate a button or toggle a check box select / clear
CTRL+TAB	Next page on a tabbed window
SHIFT+CTRL+TAB	Previous page on a tabbed window

File

CTRL+O	Open log file
CTRL+A	Close all log files
CTRL+S	Save project
CTRL+F8	Unload logged data

General

CTRL+P	Print worksheet
F1	Help

Edit

CTRL+X	Cut component
CTRL+C	Copy component
CTRL+V	Paste component
DELETE	Delete component

Keyboard Shortcuts 2

Views

F8	Data window
C	Channel window
V	Values window off / on
ESC	De-focus the active window and return focus to the worksheet

Data

F8	Select Lap / Outing / Run (shows Data window)
F9	Time / Distance mode toggle
F4	Overlays off / on
J	Single colour for main (shows all channels in the same colour for the main data)
P	Previous range (e.g. Lap)
N	Next range (e.g. Lap)
CTRL+F	Select fastest lap in current file
Q	Swap Main and Overlay 0
F2	Horizontal zoom full out
W	Horizontal zoom to default (e.g. 1 Lap)
A	Animate Start / Stop

Data Window

ENTER	Make the selected item Main
CTRL+ENTER	Make the selected item Overlay 0
ALT+ENTER	Make the selected item an Overlay

Layout

F7	Select worksheet
CTRL+F7	Activate Layout Manager
0..9	Select corresponding worksheet
CTRL+0..9	Select corresponding workbook
F11	Previous worksheet
F12	Next worksheet
CTRL+F11	Previous workbook
CTRL+F12	Next workbook

Tools

CTRL+D	Details editor
CTRL+E	Channel editor
CTRL+U	Channel status
CTRL+M	Maths editor
CTRL+T	Setup sheets

Active Channel

PgUP, PgDn	Select active channel
CTRL+H	Hide active channel
CTRL+Delete	Remove active channel
CTRL+SHIFT+M	Edit active channel maths (if maths channel)
CTRL+SHIFT+S	View active channel status (if maths channel)
CTRL+SHIFT+F	Filter active channel
CTRL+SHIFT+O	Scale and offset active channel
CTRL+SHIFT+Z	Zero at cursor active channel
CTRL+N	Properties of active channel

Keyboard Shortcuts 3

Components General

F5	Component properties
Tab	Focus next component
SHIFT+Tab	Focus previous component
L	Channel legend off / on
K	Colour channel legend off / on
G	Cycle layout (Overlap / Tiled)
S	Cycle display style
ALT+0..9	Corresponding colour band off / on
Delete	Delete selected component

GRAPH

Graph Display

E	Status and Errors off / on
F3	Variance off / on
L	Show channel legend off / on
M	Show measurements off / on
G	Overlapped groups off / on
S	Toggle trace style

Graph Zoom

Keyboard

UP / DOWN ARROW	Zoom in / out
F2	Zoom full out
W	Zoom to default (e.g. 1 Lap)
Z	Zoom to datum and main cursors
ALT+UP / DOWN ARROW	Vertical zoom in / out
ALT+F2	Vertical zoom full out

Mouse

Double-click, move, click	Horizontal zoom
ALT + Double-click, move, click	Vertical zoom
CTRL + Double-click, move, click	Window zoom
Double-click on the horizontal scroll bar	Horizontal zoom full
Double-click on the vertical scroll bar	Vertical zoom full

Graph Pan

Keyboard

SHIFT + LEFT / RIGHT ARROW	Pan left / right
SHIFT + UP / DOWN ARROW	Pan up / down (if vertically zoomed)
F	Pan forward
B	Pan back
H	Centre on cursor

Mouse

Click + drag on the horizontal axis	Horizontal pan
Click + drag on the vertical axis	Vertical pan
Click + drag on the horizontal scroll bar	Horizontal pan
Click + drag on the vertical scroll bar	Vertical pan

Keyboard Shortcuts 4

Graph Cursor

Keyboard

LEFT / RIGHT ARROW	Cursor movement
CTRL + LEFT / RIGHT ARROW	Fast cursor movement
SHIFT+F7	Place beacon at cursor (if Circuit Project)
	Place run at cursor (if Drag Project)
	Place stage at cursor (if Rally Project)
Y	Cursor style
HOME	Cursor to left of screen
END	Cursor to right of screen

Graph Datum Cursor

Keyboard

D	Datum cursor off / on
SPACEBAR	Place datum cursor
X	Swap datum and main cursor

Graph Alignment Offsetting

Keyboard

O	Offsetting axis off / on
CTRL+SHIFT+ARROW	Offset the main lap (offset axis must be on)
ALT+SHIFT+ARROW	Offset the ref lap (offset axis must be on)

Mouse

Drag the main or ref offsetting axis