

GTE BOP STUDY AND ANALYSIS

“Balance of performance (abbreviated BoP) is a regulation and mechanism that maintains parity between competing vehicles by adjusting limits on a car's parameters, such as horsepower, weight, engine management, and aerodynamics to prevent a single manufacturer from becoming dominant in a racing class or series.”

The aim of this paper is to study and understand the current rF2 GTE BoP. All 5 cars (Ferrari, Porsche, Chevrolet (C7R), BMW, Aston Martin) have been compared using raw numbers and formulas.

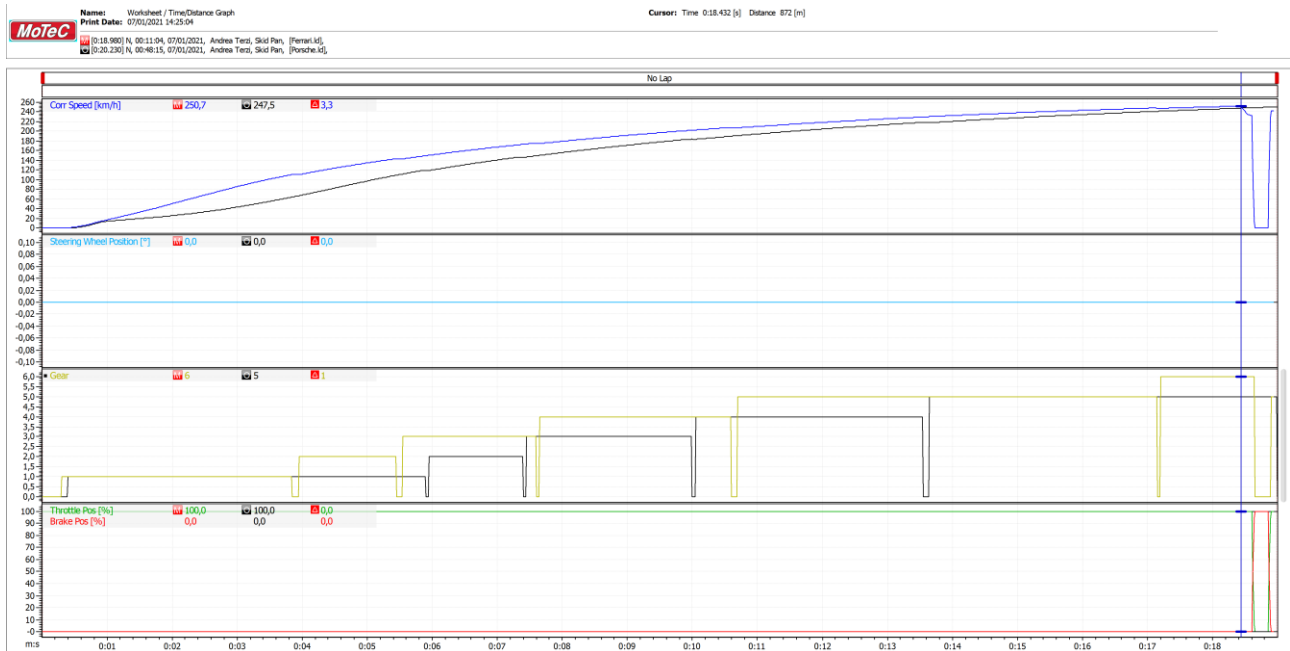
Cars were set to be in the most similar conditions. Lowest front height combined with lowest springs and wing were used to bring the car to their limit of aero-efficiency and top speed. Wing 1 (minimum) is also the most used configuration in top competitions so it is the most significant configuration to measure.

No measures were performed on driver-dependant data (such as top speed in a short straight, pure acceleration, corner Gs) to avoid human influence on final results.

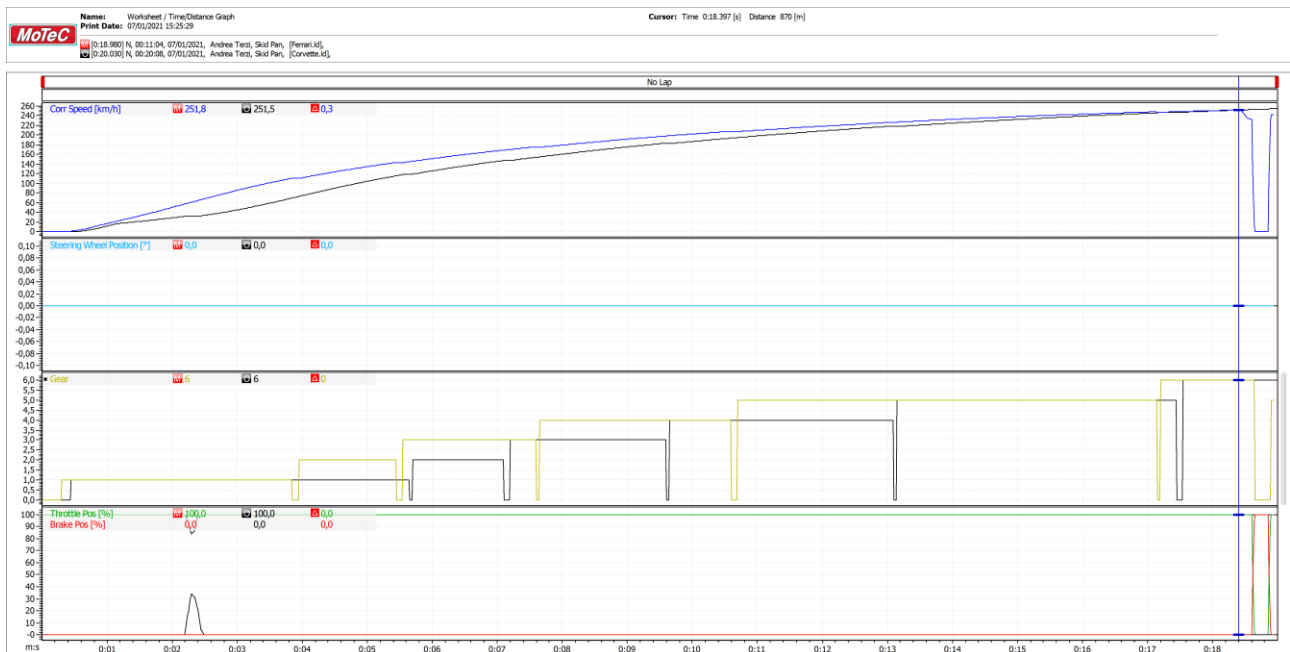
Ferrari 488 is used as reference for every single graph display, as using the same car for every compare makes it easier to understand data differences.

DRIVER INPUT

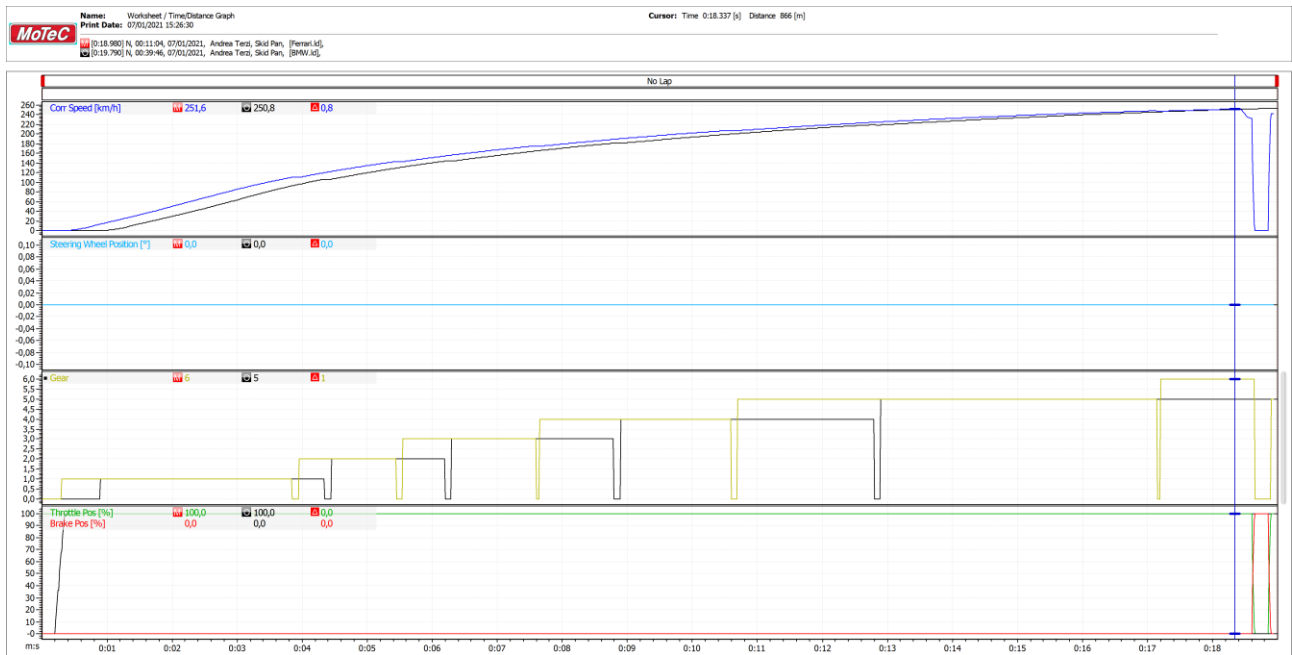
Some simple graph to show what was done. Nothing to note here since this is pure raw data.



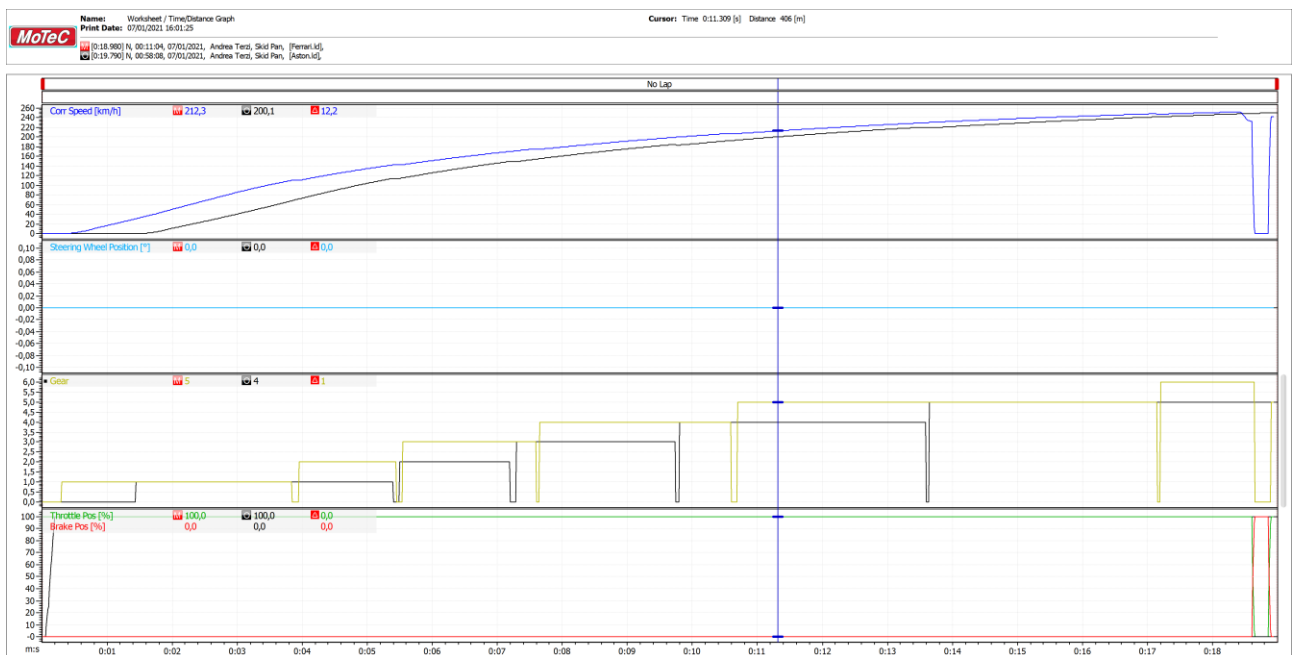
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)



Ferrari (colored) vs BMW (black)

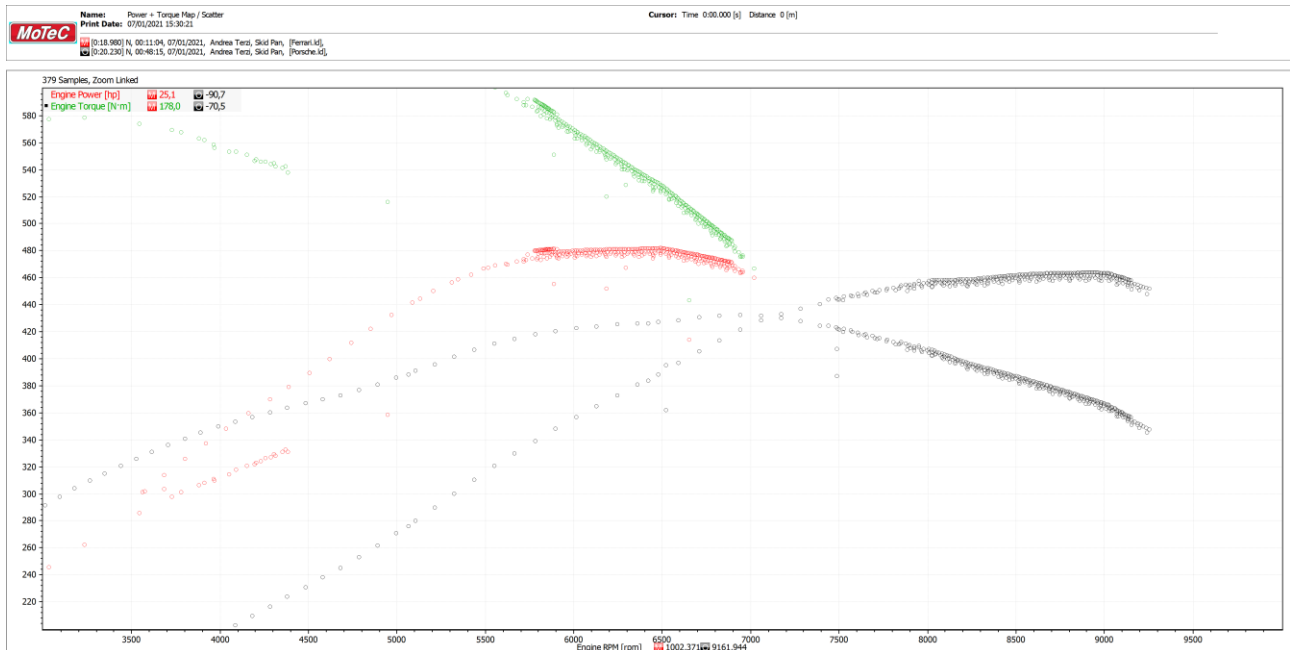


Ferrari (colored) vs Aston (black)

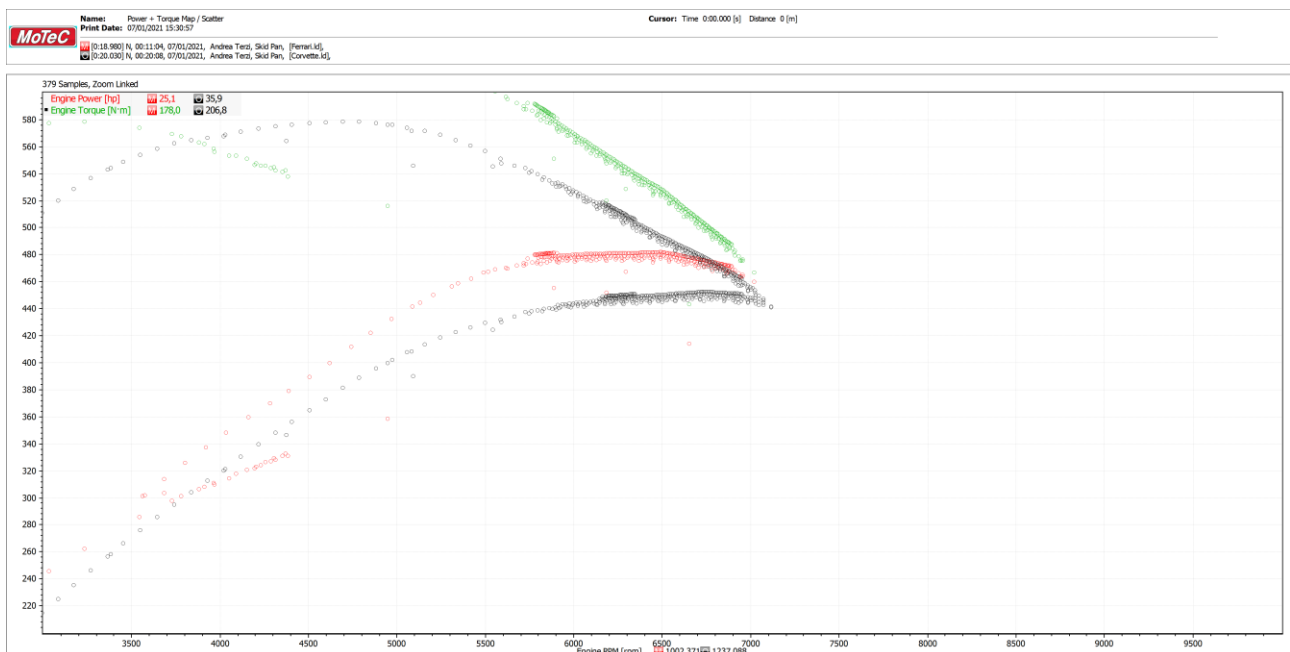
ENGINE SPEC

These graphs aim to display different performances between engines. Scatter plot are used to better display engine power, torque and fuel flow characteristics. Power is derived from torque+rpm channels, fuel flow is Fuel Level channel derivative.

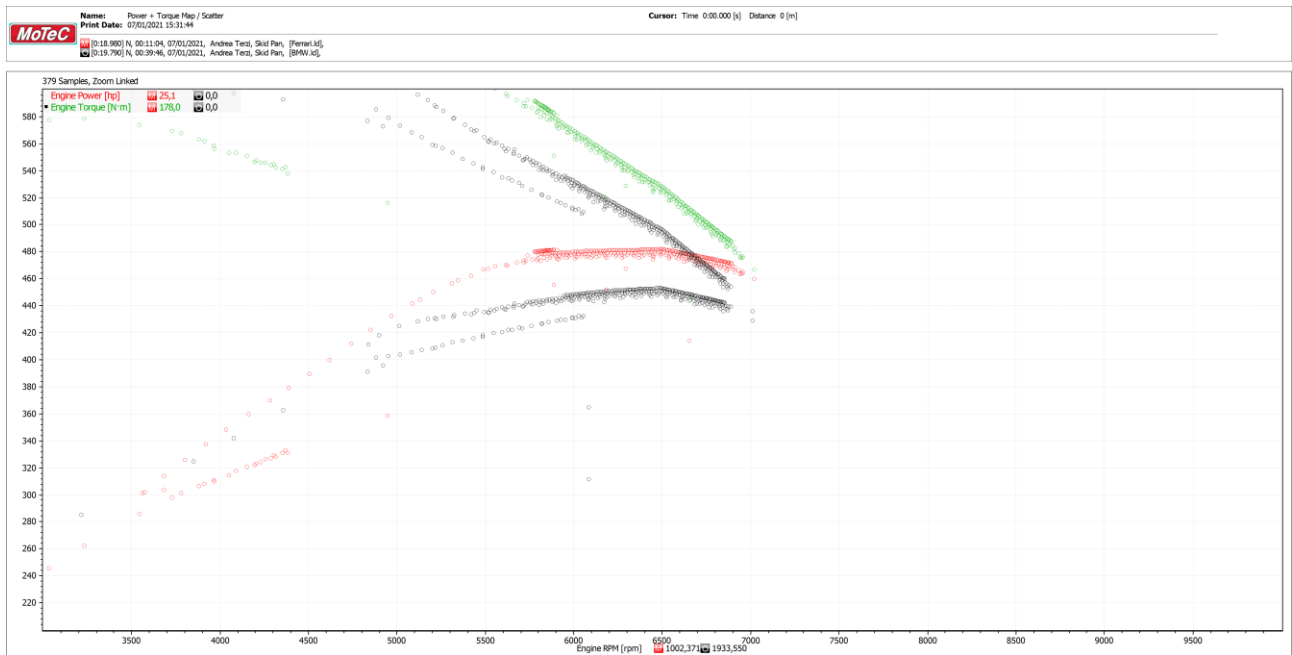
POWER + TORQUE



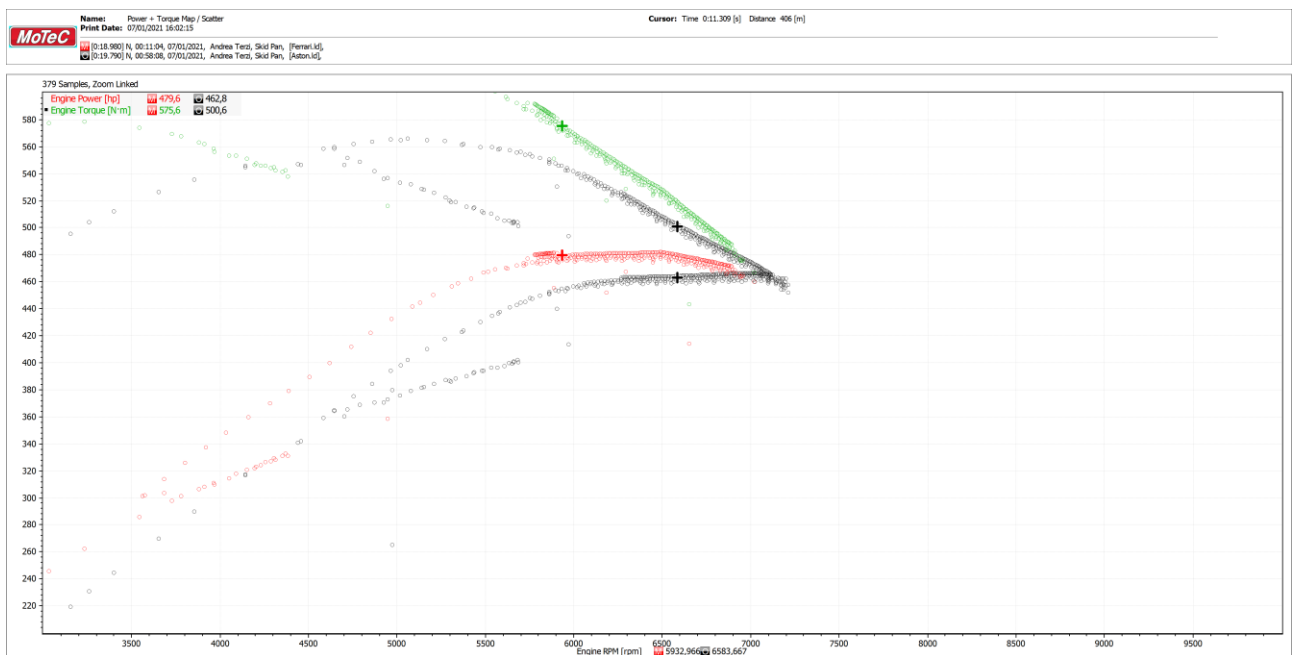
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)

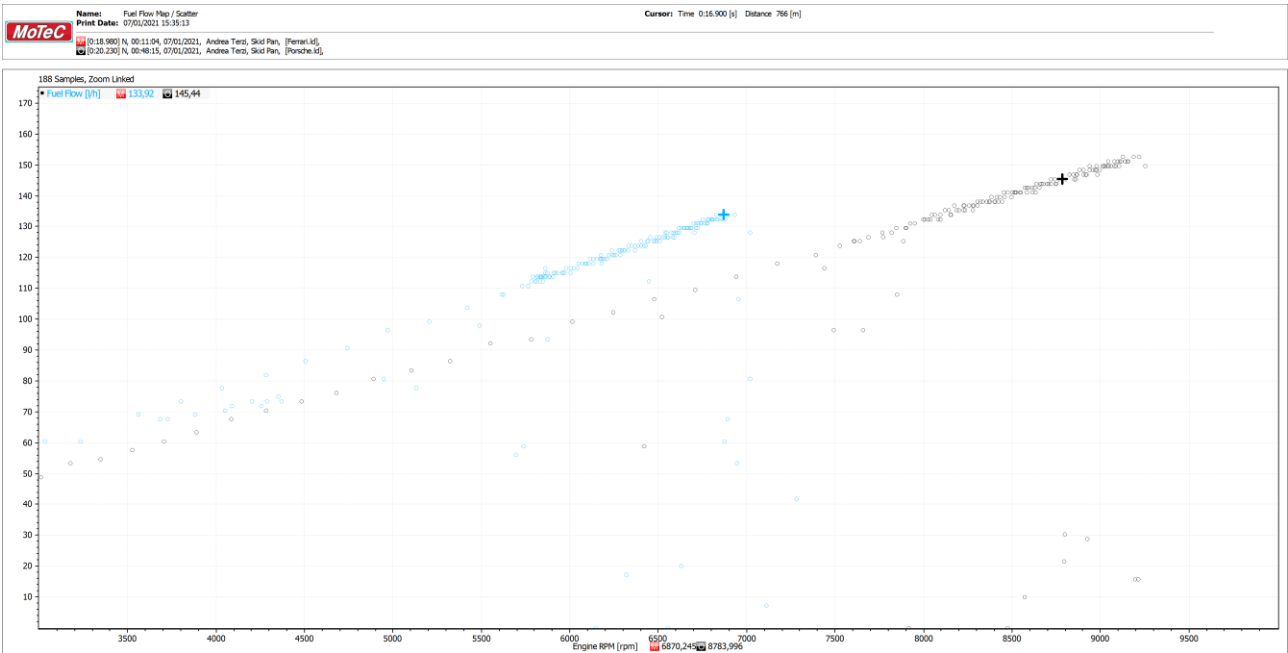


Ferrari (colored) vs BMW (black)

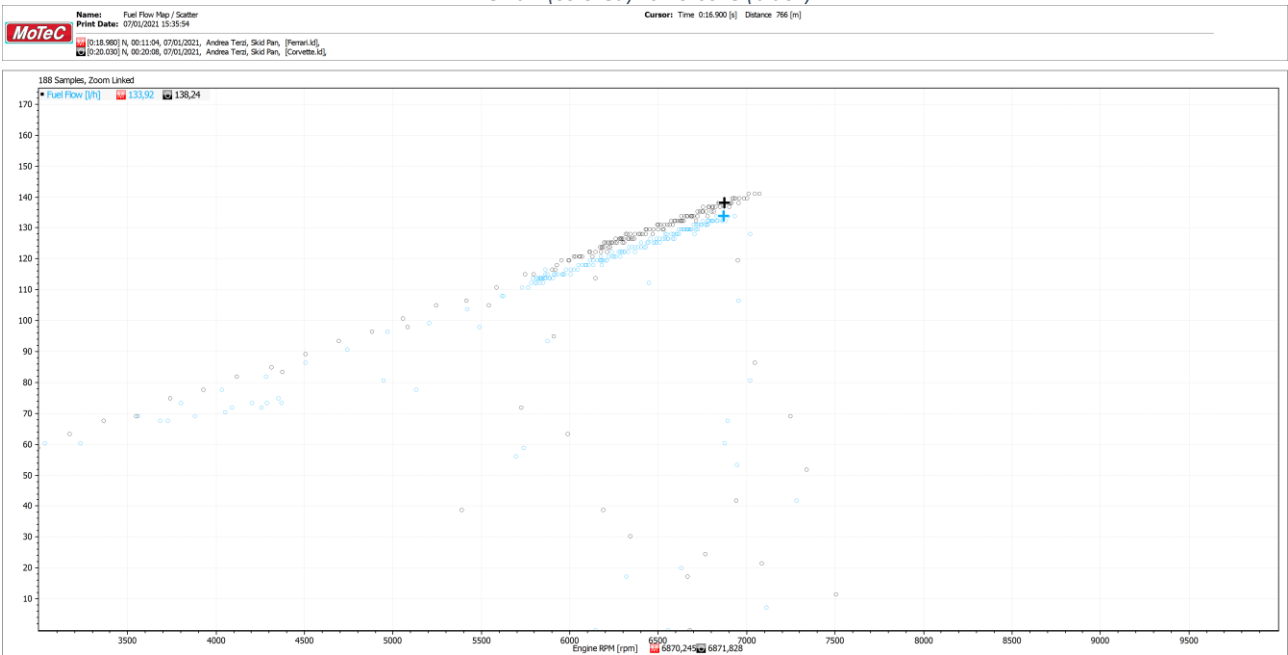


Ferrari (colored) vs Aston (black)

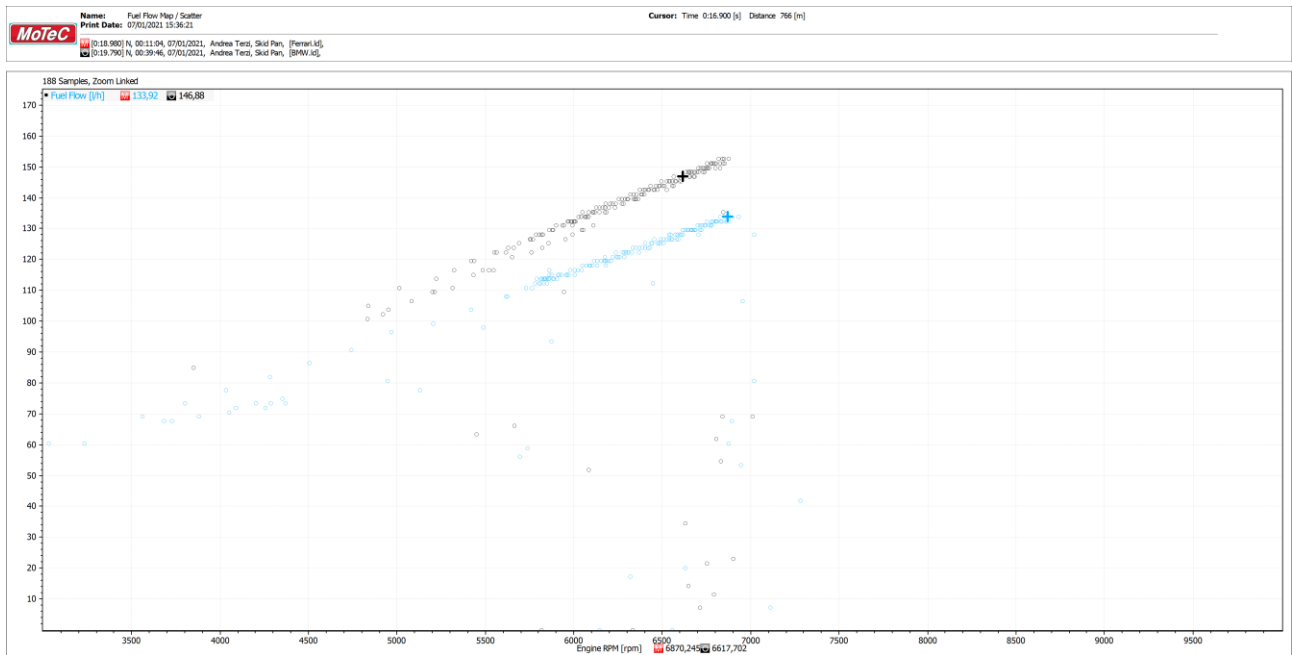
FUEL FLOW



Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)



Ferrari (colored) vs BMW (black)

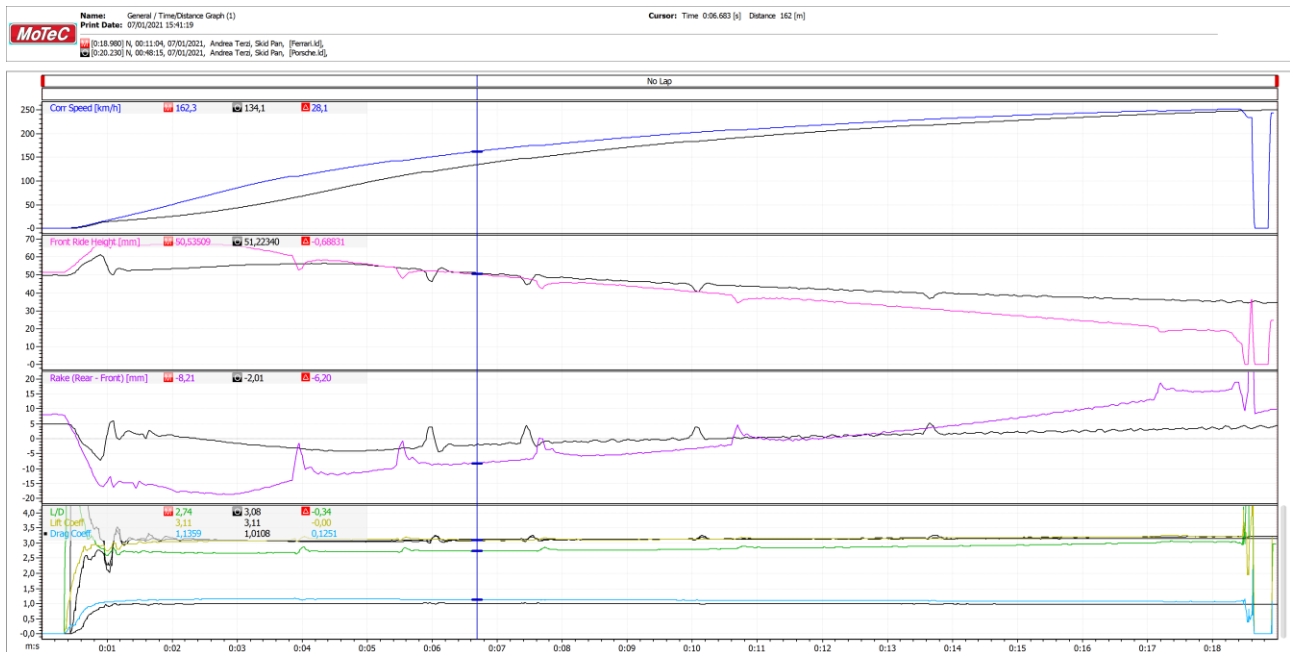


Ferrari (colored) vs Aston (black)

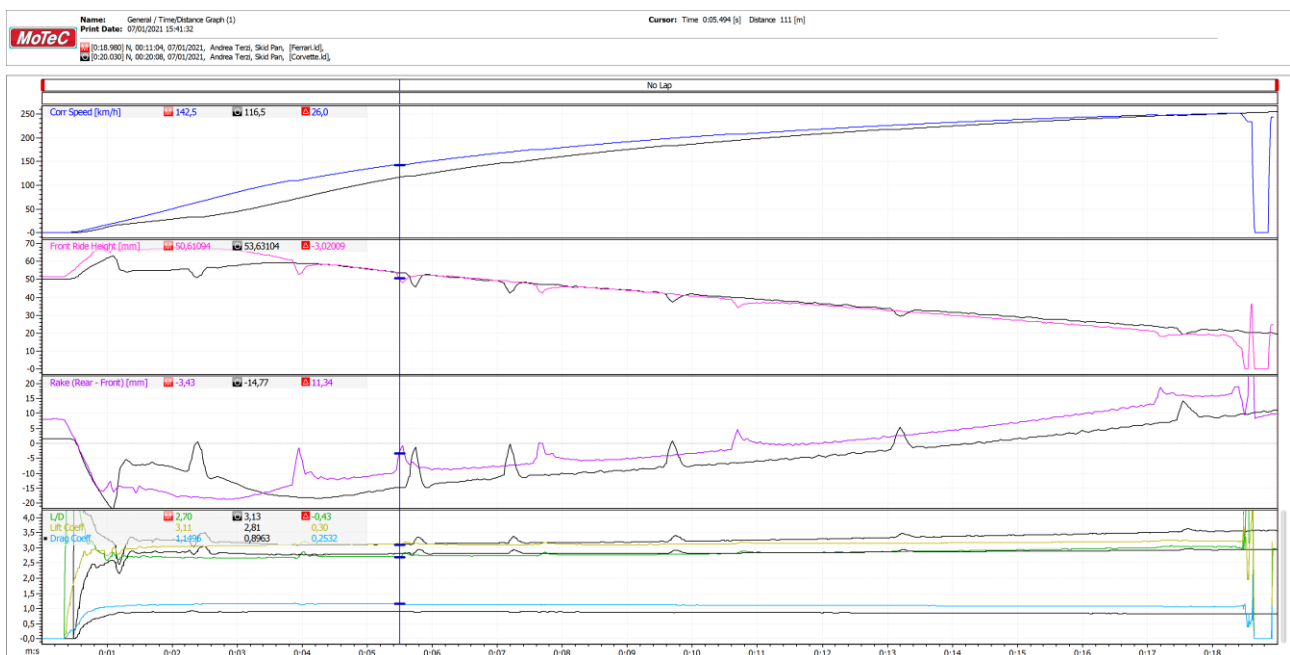
AERO

These graphs aim to show different performances of aero platform between cars. CdA, CIA and L/D are calculated as per common formulas and used to better show aero characteristics independently from speed. Scatter plot are used to display relationship between coefficients and aero platform conditions to ensure result clearness. Aero balance was considered to discuss about effective driveability of such aero platform configuration on the specific car. Please note Motec channels named Cd and Cl are in fact CdA and CIA.

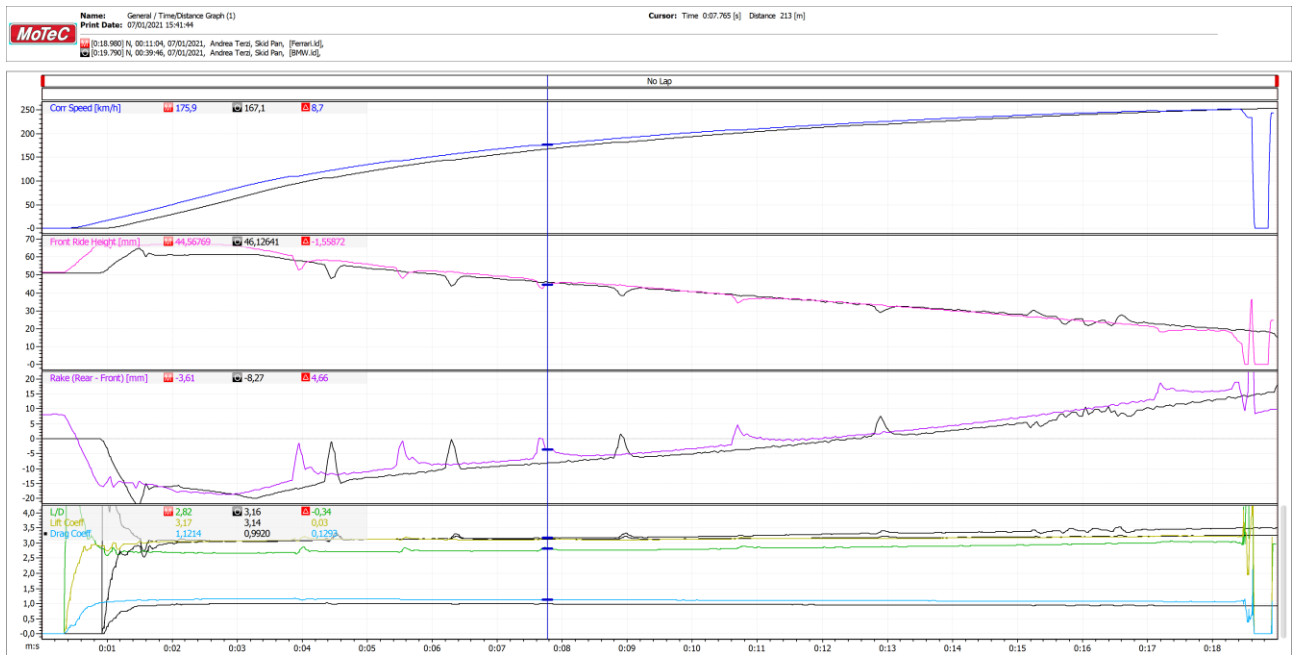
GENERAL



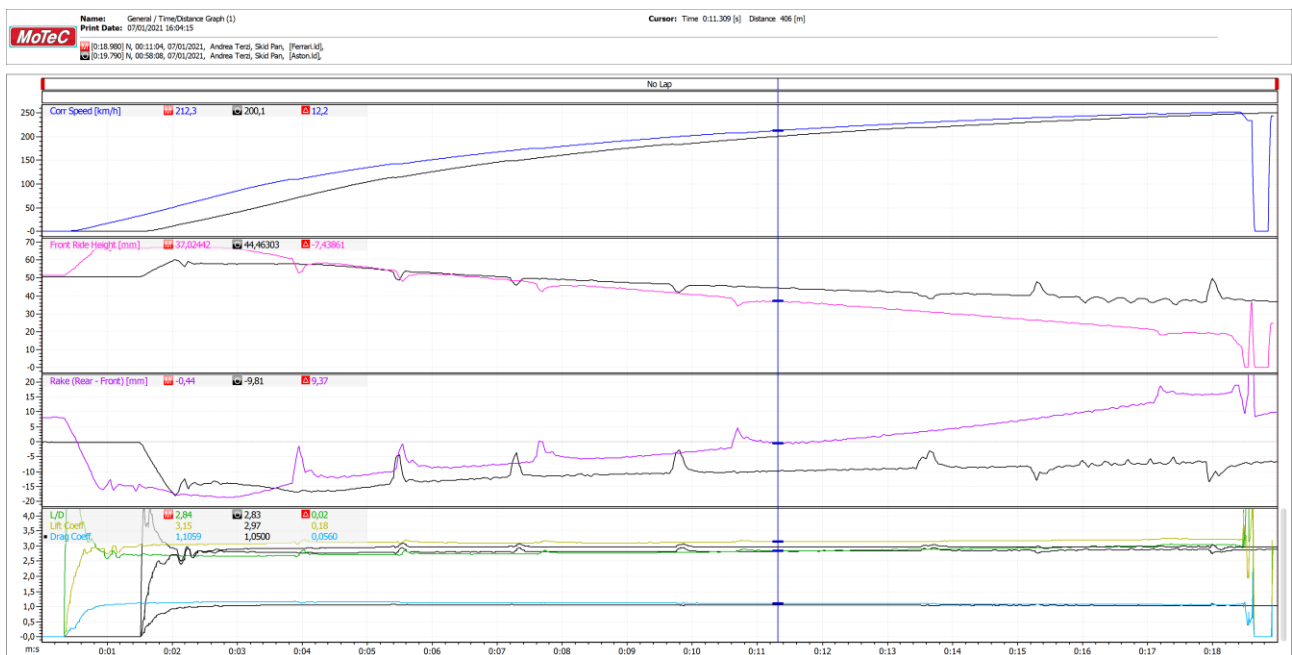
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)

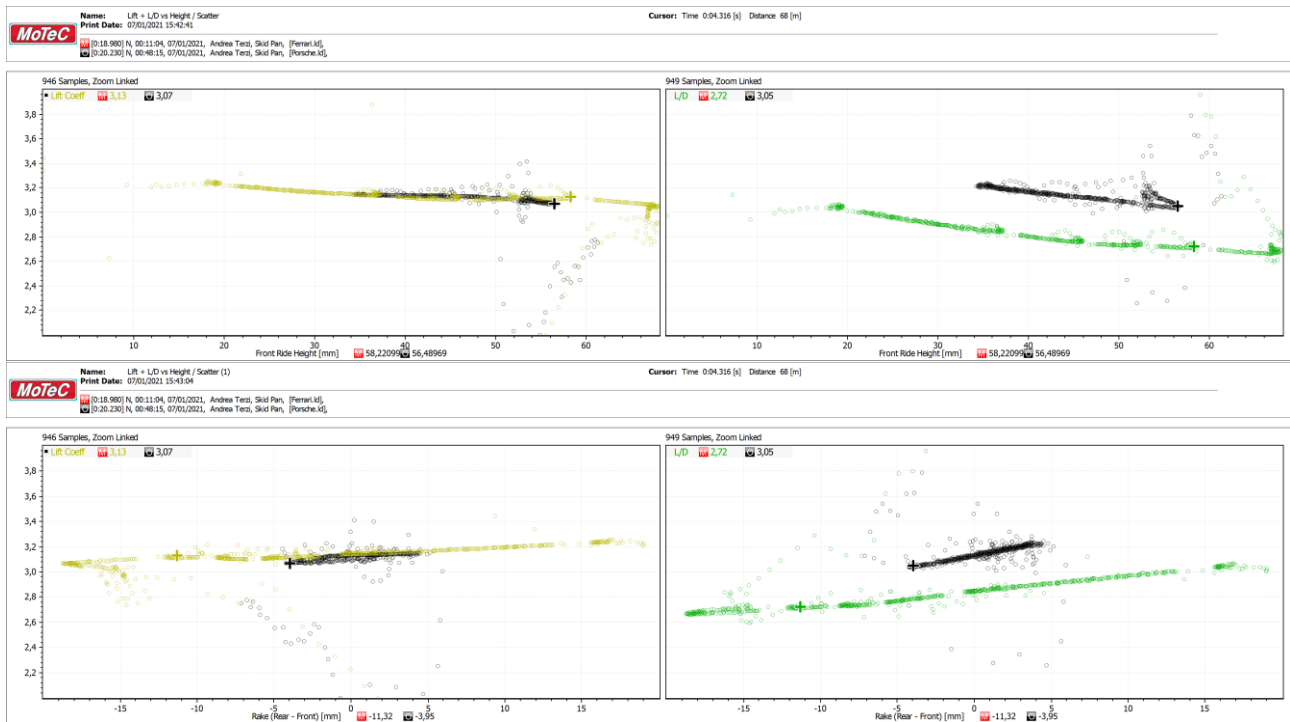


Ferrari (colored) vs BMW (black)

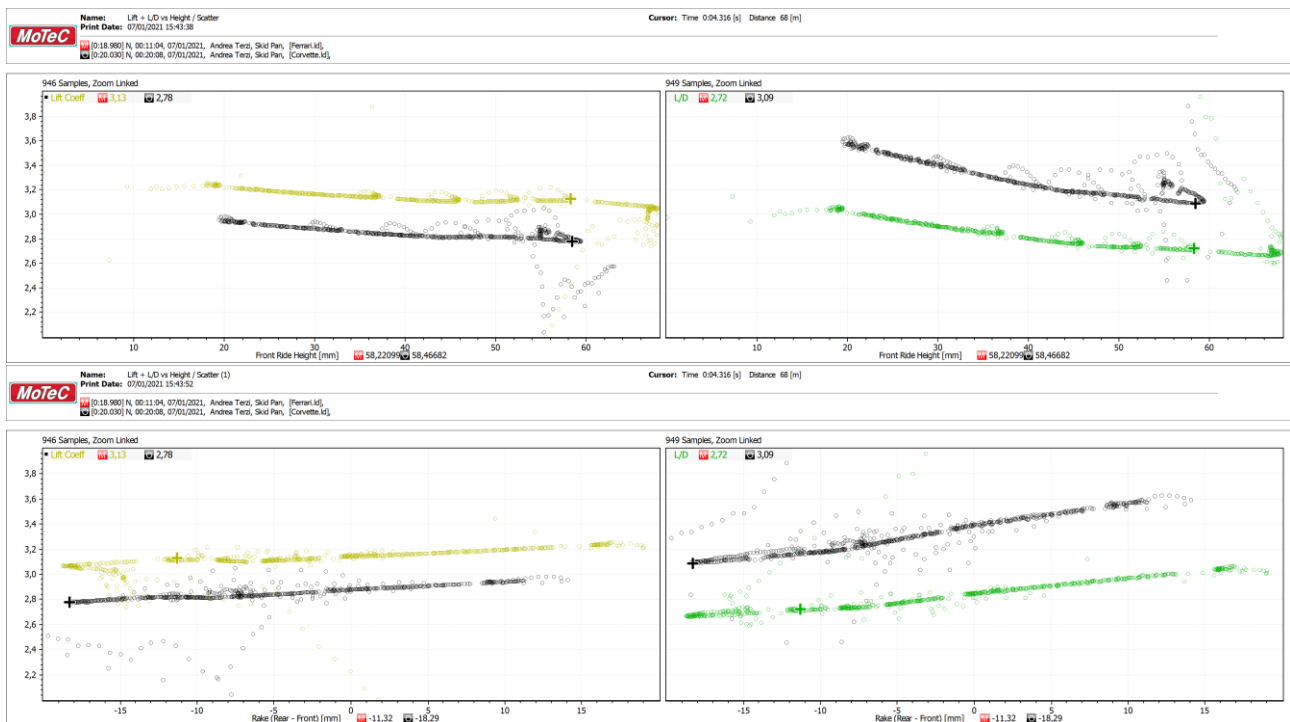


Ferrari (colored) vs Aston (black)

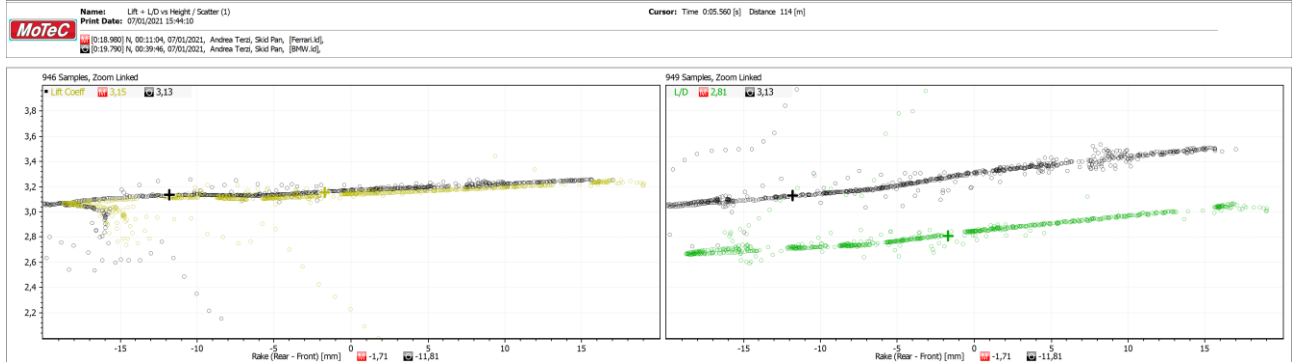
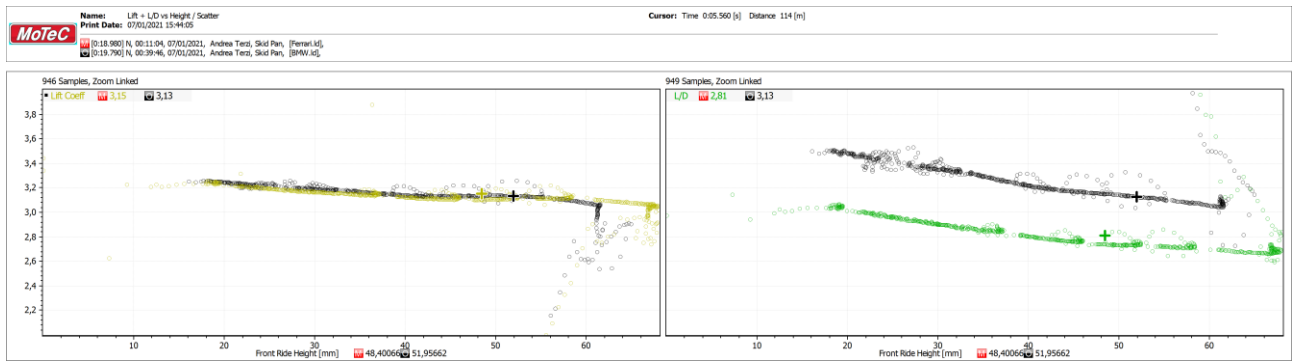
LIFT AND L/D



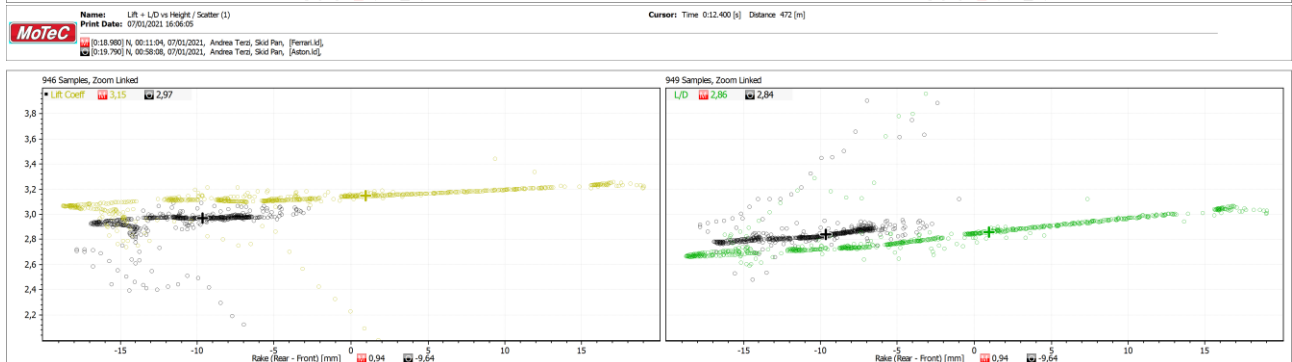
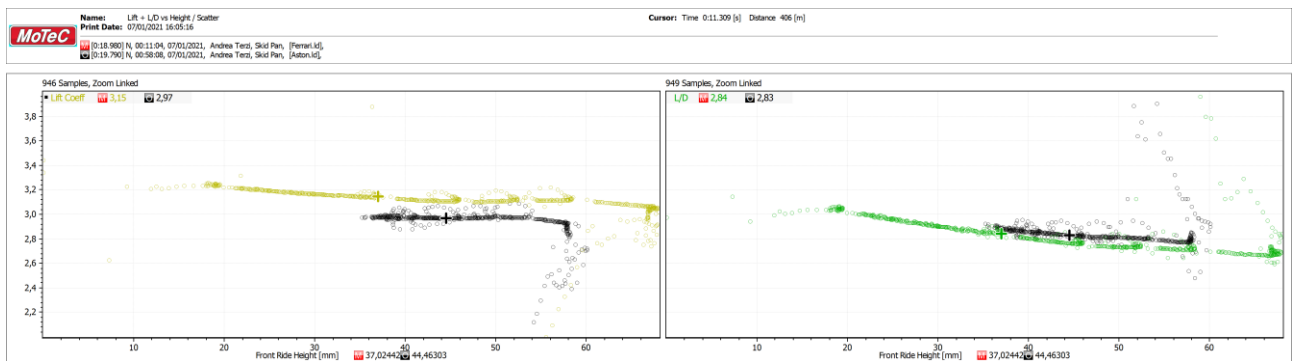
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)

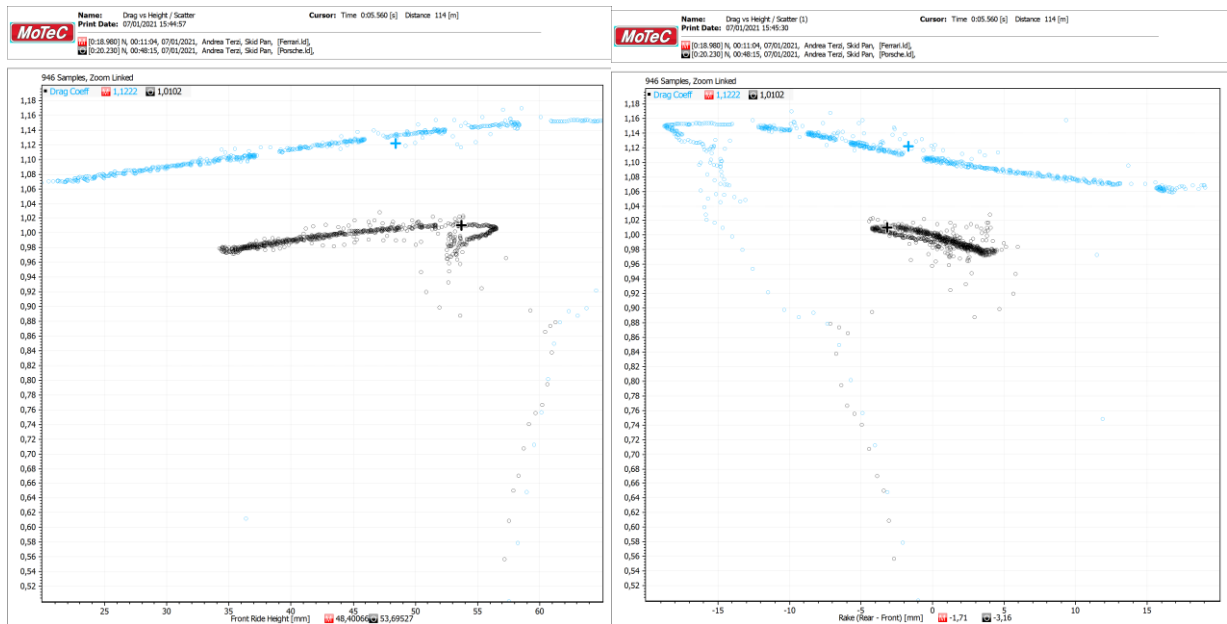


Ferrari (colored) vs BMW (black)

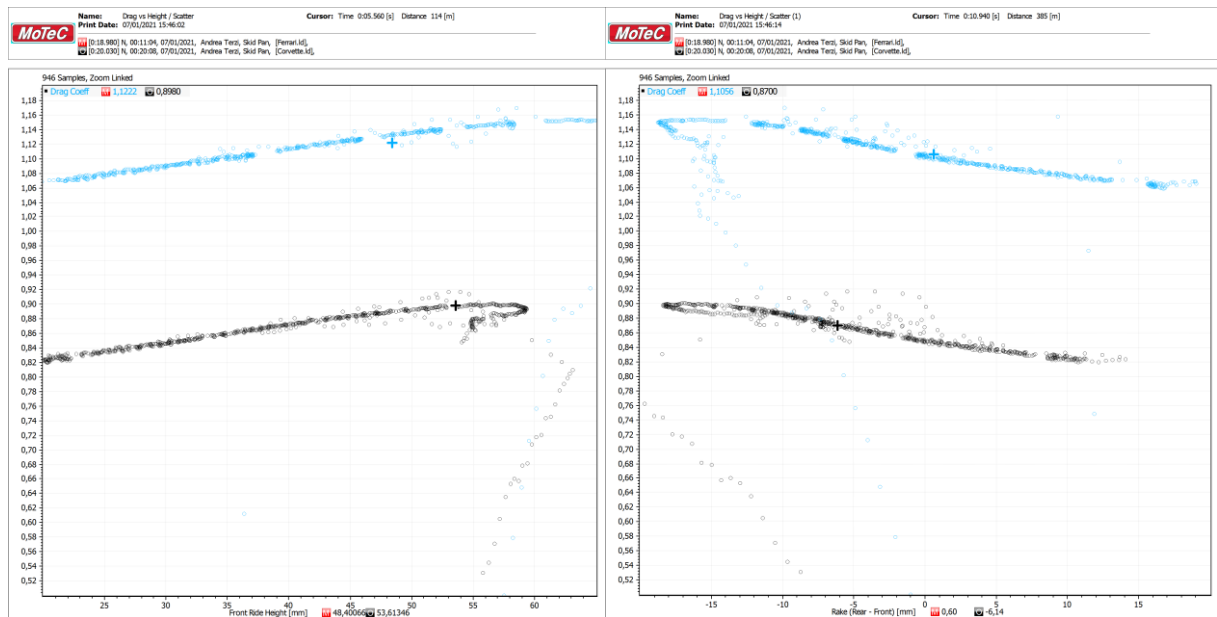


Ferrari (colored) vs Aston (black)

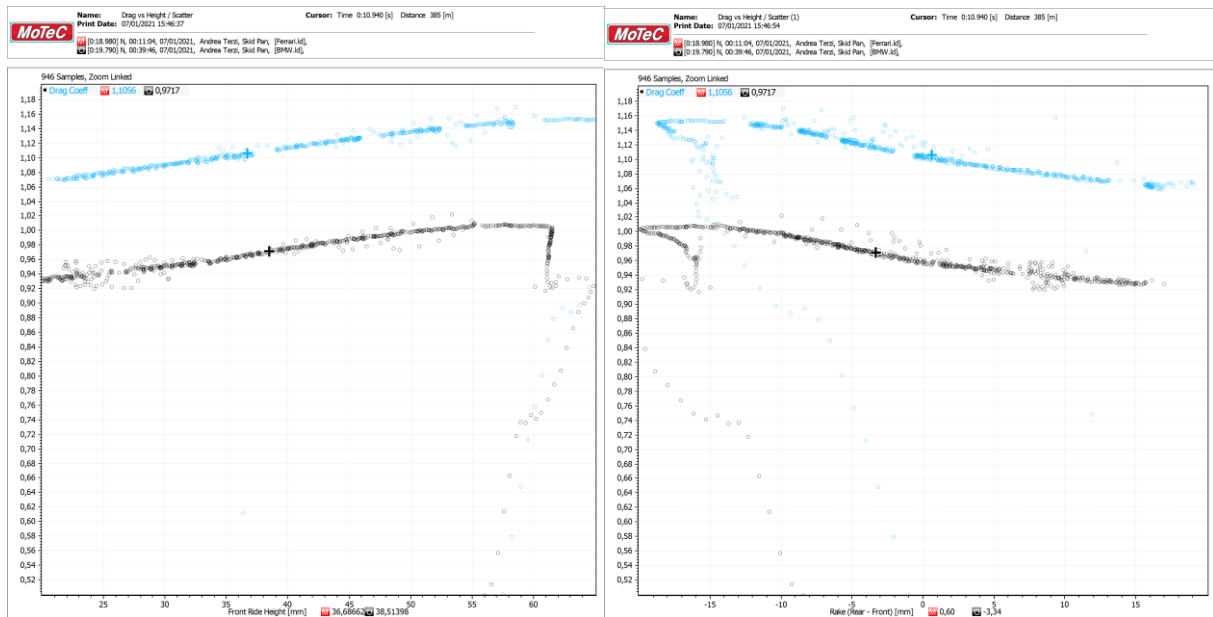
DRAG



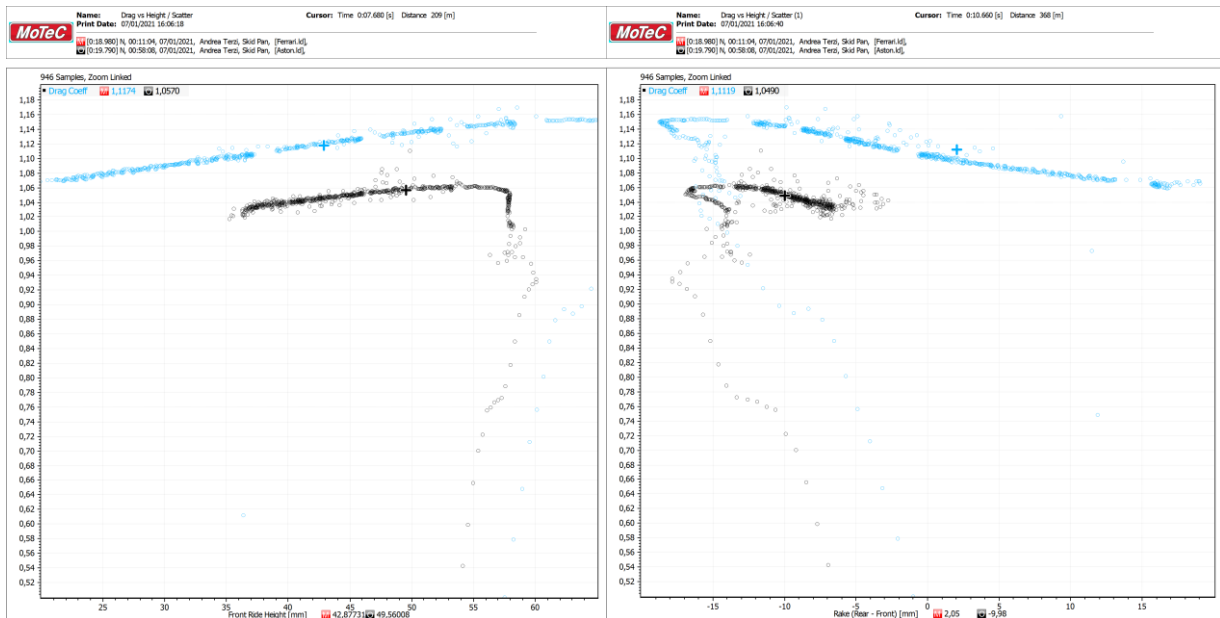
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)

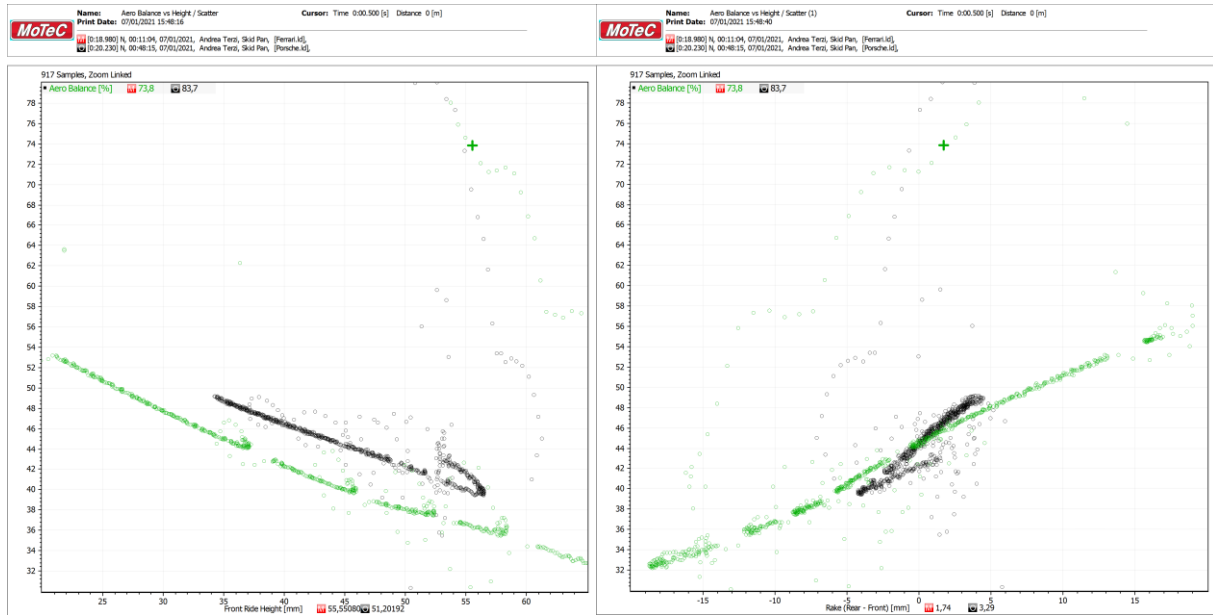


Ferrari (colored) vs BMW (black)

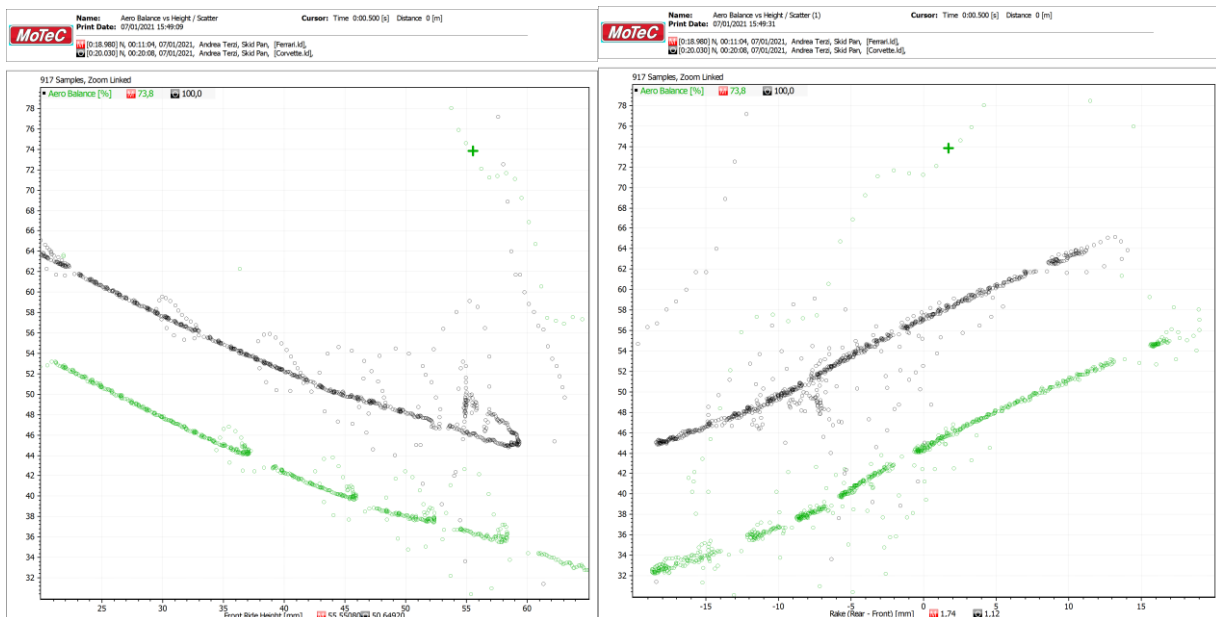


Ferrari (colored) vs Aston (black)

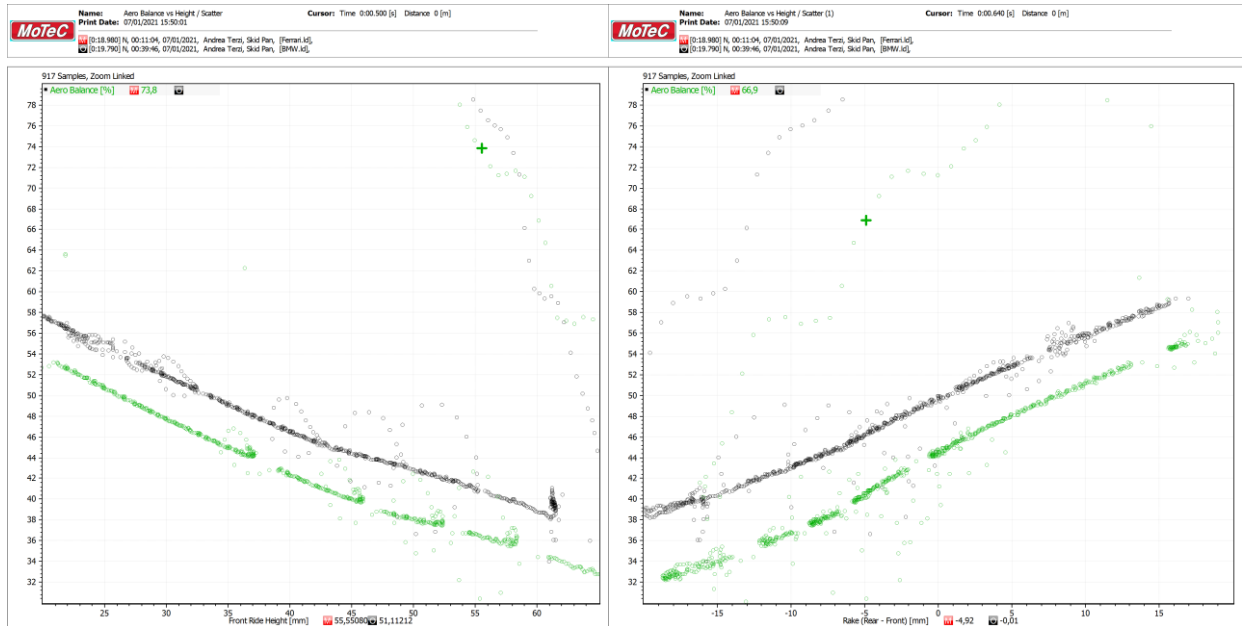
AERO BALANCE



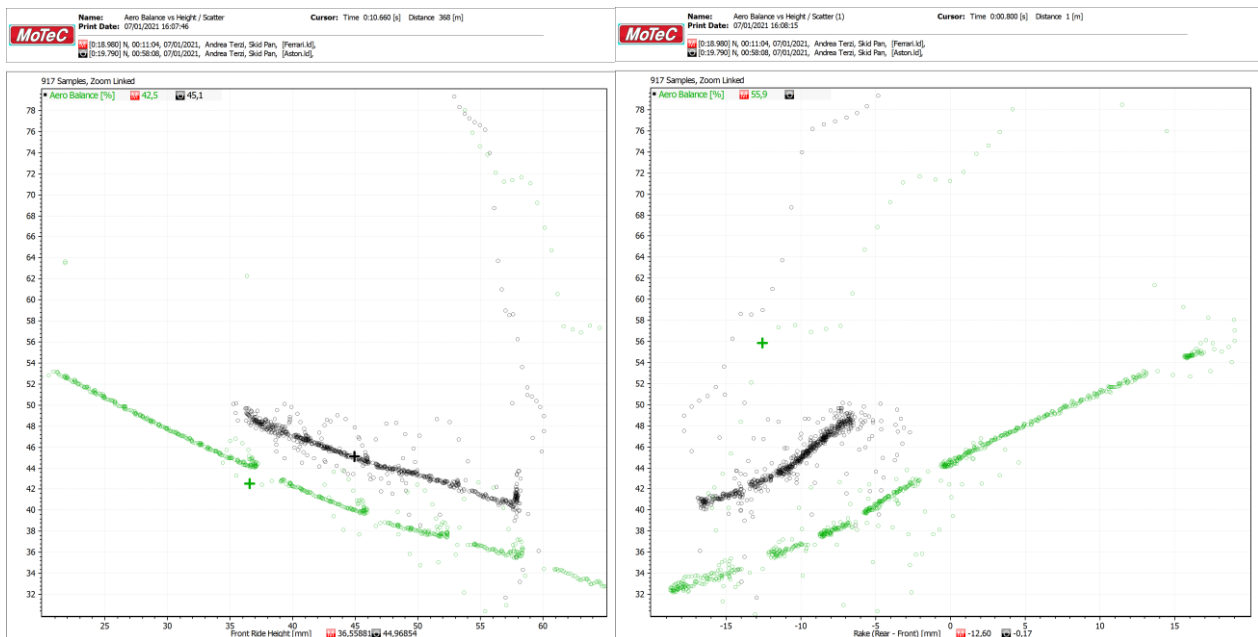
Ferrari (colored) vs Porsche (black)



Ferrari (colored) vs Corvette (black)



Ferrari (colored) vs BMW (black)



Ferrari (colored) vs Aston (black)

CAR SPECS

	Ferrari	Porsche	Corvette	BMW	Aston	
Power	482	464	453	453	466	hp
Tank	87	100	93	99	100	lt
Weight	1355	1335	1320	1325	1323	kg
CIA (average)	3,15	3,13	2,86	3,16	2,97	
CdA (average)	1,11	0,99	0,87	0,97	1,05	
L/D (average)	2,84	3,16	3,29	3,26	2,83	
Fuel Flow @ Max Power	127	149	136	145	151	lt/h

Raw specs

	Ferrari	Porsche	Corvette	BMW	Aston	
Power/Weight	0,35572	0,347566	0,343182	0,341887	0,35223	hp/kg
Tank/Flow*60min	41,10236	40,26846	41,02941	40,96552	39,7351	min
Power/CdA	434,2342	468,6869	520,6897	467,0103	443,8095	hp/pure
CIA/weight	2,32E-03	2,34E-03	2,17E-03	2,38E-03	2,24E-03	pure/kg
(L/D)/weight	2,09E-03	2,37E-03	2,49E-03	2,46E-03	2,14E-03	pure/kg

Performance characteristics

	Ferrari	Porsche	Corvette	BMW	Aston	
Power/Weight	100,0%	97,7%	96,5%	96,1%	99,0%	hp/kg
Tank/Flow*60min	100,0%	98,0%	99,8%	99,7%	96,7%	min
Power/CdA	83,4%	90,0%	100,0%	89,7%	85,2%	hp/pure
CIA/weight	97,5%	98,3%	90,8%	100,0%	94,1%	pure/kg
(L/D)/weight	84,1%	95,1%	100,0%	98,7%	85,8%	pure/kg
AVG Performance Index	93,0%	95,8%	97,4%	96,8%	92,2%	

Performance Index related to best in class

CONCLUSION

Performance indexes show hierarchy of S397 GTE with latest BoP. It is now clear to see where every single car acts the best and the worse, and how a car can be dominant in the whole package or in the single characteristic.

Changing car specs to get closer performance indexes between cars brings to the following result:

	Ferrari	Porsche	Corvette	BMW	Aston	
Power	482	464	453	453	466	hp
Tank	86 (-1)	101 (+1)	92 (-1)	98 (-1)	102 (+2)	lt
Weight	1345 (-10)	1335	1325 (+5)	1345(+20)	1315(-8)	kg
CIA	3,15	3,13	2,86	3,16	2,97	
CdA	1,06(-5.4%)	1.00(+1%)	0,90(+3.5%)	0,97	1.00(-4.8%)	
L/D	2,97	3,13	3,18	3,26	2,97	
Fuel Flow @ Max Power	127	149	136	145	151	lt/h

	Ferrari	Porsche	Corvette	BMW	Aston	
Power/Weight	0,358364	0,347566	0,341887	0,336803	0,354373	hp/kg
Tank/Flow*60min	40,62992	40,67114	40,58824	40,55172	40,5298	min
Power/CdA	454,717	464	503,3333	467,0103	466	hp/pure
ClA/weight	2,34E-03	2,34E-03	2,16E-03	2,35E-03	2,26E-03	pure/kg
(L/D)/weight	2,21E-03	2,34E-03	2,40E-03	2,42E-03	2,26E-03	pure/kg

	Ferrari	Porsche	Corvette	BMW	Aston	
Power/Weight	100,0%	97,0%	95,4%	94,0%	98,9%	hp/kg
Tank/Flow*60min	99,9%	100,0%	99,8%	99,7%	99,7%	min
Power/CdA	90,3%	92,2%	100,0%	92,8%	92,6%	hp/pure
ClA/weight	99,7%	99,8%	91,9%	100,0%	96,1%	pure/kg
(L/D)/weight	91,2%	96,8%	99,0%	100,0%	93,2%	pure/kg
Performance Index	96,2%	97,2%	97,2%	97,3%	96,1%	

Written by:

Andrea Terzi, Riccardo Corazzari