



## Power vs Control Challenge - September 2003

### Challenge summary;

- To firstly compare similar costed pure power improvements against pure suspension improvements. Then to see what changes would occur when we improve the alternate aspect mildly on each car within a similar cost budget.

- Vehicles chosen were WRX GD (MY03) due to easy availability of parts and vehicles on test fleet.

- MRT Performance supplied their M-Power project vehicle which was initially tested in round 1 with pure power mods delivering 45 kW more power (than standard) at the wheels. Fitted with MRT's "Power XB" kit at \$3795 fitted. See MRT Performance for exact details, specifications and current prices for this. (Exception was extra Whiteline strut bracing on each car)

- Whiteline Automotive supplied their P-Rex III project vehicle which was initially tested in round 1 with pure suspension mods. Fitted with

- Whiteline "Handling Pack" at \$839. - Adjustable swaybars and critical alignment products. (Refer attached fact sheet for more details)

- Whiteline "Group 4" Adjustable springs and shocks at \$3390 - New range of height and rate adjustable true 40mm mono-tube coil overs. (Refer attached fact sheet for more details)

- Total cost including fitting was  $\$839 + \$3390 + \$560 = \$4789$ .

- Price comparison of round 1 performance modifications where M-Power with \$3795 of power upgrades and P-Rex III with \$4789 in suspension and handling improvements.**

- M-Power in round 2 was upgraded with Whiteline "Sports Pack - Control" costed at \$1810 plus \$350 fitting (total \$2160). This includes matched lowered Whiteline Control grade springs and Whiteline adjustable rate sports shocks. A Whiteline alignment was done and most appropriate settings used.

- P-Rex III in round 2 was upgraded with MRT's "Power XA" kit which delivered 20kw more power at the wheels at a fitted price of \$1695. See MRT Performance for exact details, specifications and current prices for this.

- Price comparison of round 2 performance modifications where M-Power with a total \$5955 of power and suspension upgrades and P-Rex III with \$6484 worth of improvements.**

- Money spent on chassis and suspension equals more grip and more speed.**

# Power vs Control Challenge - September 2003

Performance Aspect		Units	M-Power Round 1	P-Rex III Round 1	M-Power Round 2	P-Rex III Round 2	Sti MY99 Base	WRX MY03 Base
<b>Fastest lap - difference from std WRX</b>		Seconds	-2.30	-2.17	-2.87	-3.54	-1.52	
<b>0-100 kmh time</b>		Seconds	6.10	6.05	5.58	5.70	5.69	6.65
<b>Mean high lateral G's</b>		G force	0.89	0.93	0.92	0.93	0.89	0.87
<b>Highest speed</b>		kmh	171.2	169.8	173.9	174.8	173.8	168.7
<b>Turn 1 mid - average max speed</b>		kmh	78.1	79.8	81.2	83.9	79.8	74.7
<b>Turn 3 mid - average max speed</b>		kmh	89.7	90.5	91.1	91.6	89.9	88.6
<b>Turn 6 to 7 - average time</b>		seconds	9.3	9.0	8.8	8.7	9.2	9.5
<b>Turn 8 exit - average max speed</b>		kmh	82.3	79.0	82.9	83.7	81.9	77.8

## Power vs Control Challenge - Results Summary

\*Refer to track map for turn references

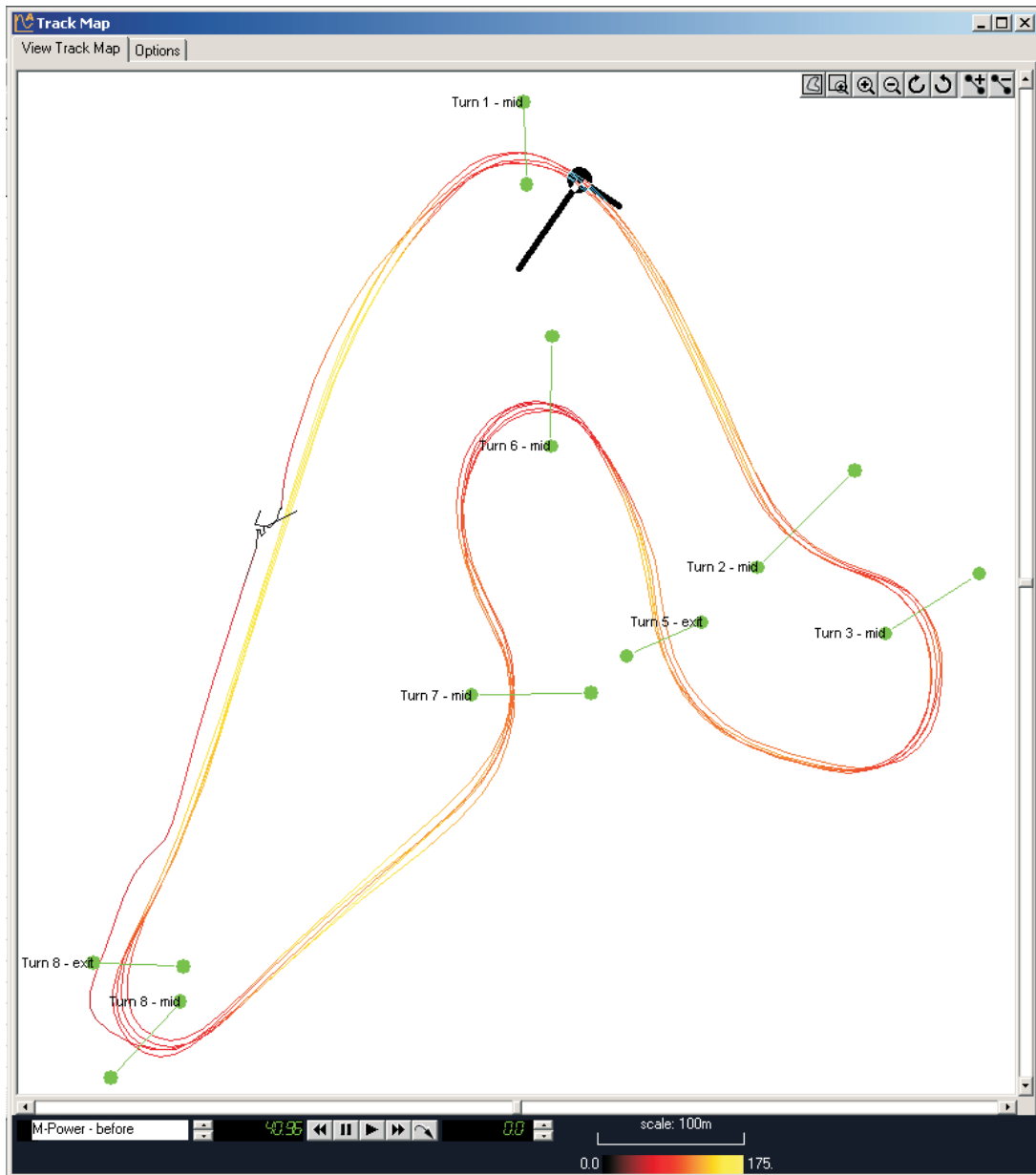
Best "Round 1" result in yellow

Best "Round 2" result in pink

### Highlights of results summary;

- Fastest lap in round 1 - MRT's M-Power @ 2.30 seconds faster than base WRX MY03
- Fastest lap in round 2 - Whitelines P-Rex III @ 3.54 seconds faster than base WRX MY03
- Fastest 0-100 km/h time in round 1 - Whitelines P-Rex III @ 6.05 seconds
- Fastest 0.100 km/h time in round 2 - MRT's M-Power @ 5.58 seconds
- Best mean high lateral G's in all cases - P-Rex III at 0.93 for both. (Measure of maximum sustainable mean G's. Not absolute as this is subject to false spikes.)
- Highest top speed in round 1 - M-Power @ 171.2 km/h
- Highest top speed in round 2 - P-Rex III @ 174.8 km/h
- P-Rex III has highest cornering speed and shortest incremental times in all cases except turn 8 exit.
- Round 1 saw 45 kW (35%) more power overcome state of the suspension setup in lap times but only through acceleration between corners. Even with standard power, P-Rex III had consistently higher corner speeds only to be overcome on the straight. Particularly evident in results of average time taken between turns 6 and 7 where chassis is more important.
- More power with out other changes does not automatically equate to faster standing start acceleration times. M-Power could not deliver the 35% more power with standard suspension.
- With better suspension in round 2, M-Power could realise it's power superiority in 0-100 km/h time .

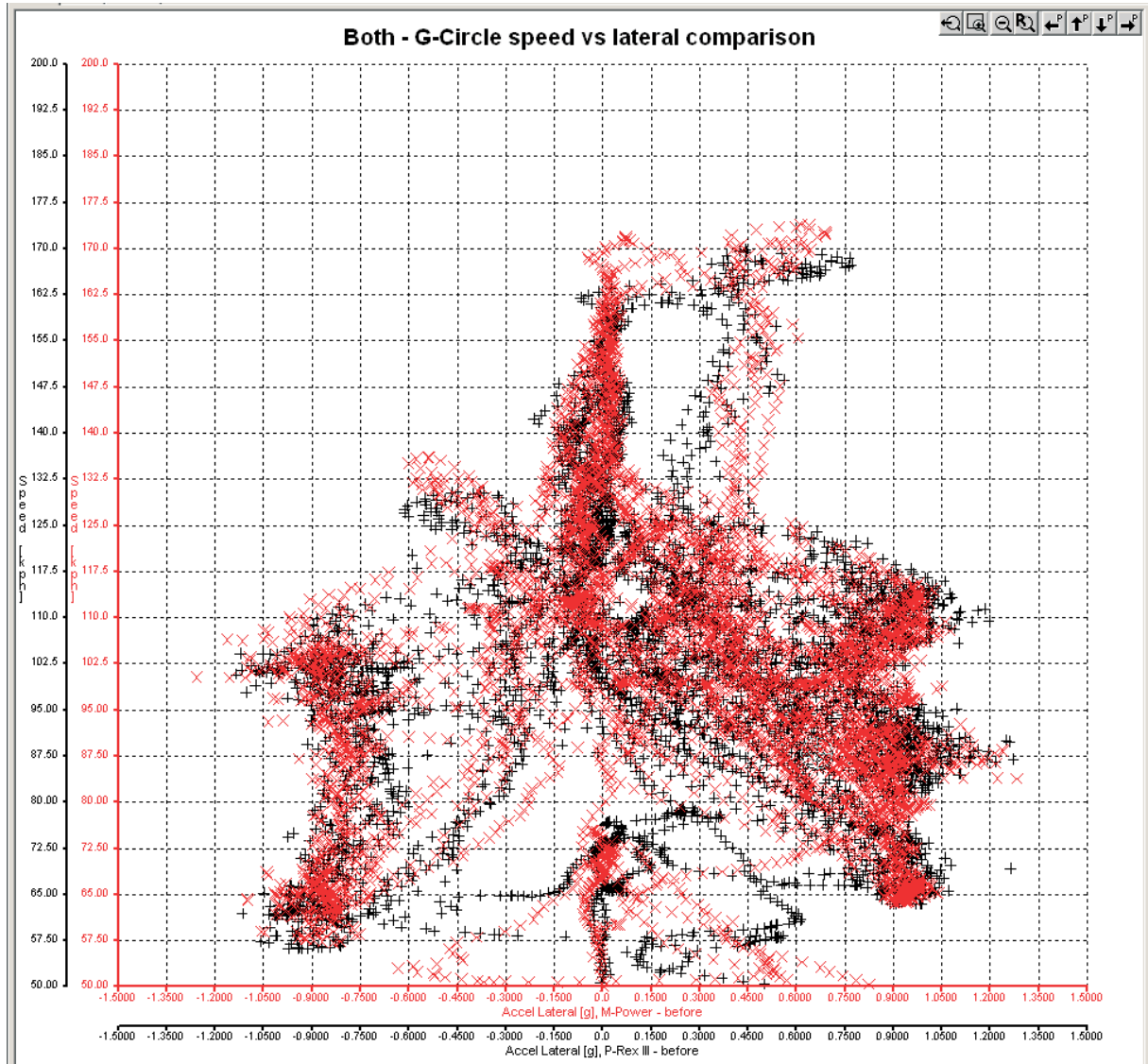
# Power vs Control Challenge - September 2003



Track map of Wakefield Park from screen shot of Whiteline data logger showing;

- Turns referenced in results. IE, Turn 1-mid is mid corner or apex or turn 1 after straight
- Vehicle position shown as black circle after turn 1. Forward reaching black line indicates longitudinal (acceleration) G force vector magnitude. Side reaching black line indicates latitudinal (cornering) G force vector magnitude. In this instance car is accelerating hard while still cornering hard on corner exit.
- Green lines indicate track markers used by software to reference measurement comparisons. IE, max speed at Turn 7 - mid or shortest time between Turn 3 and Turn 5.

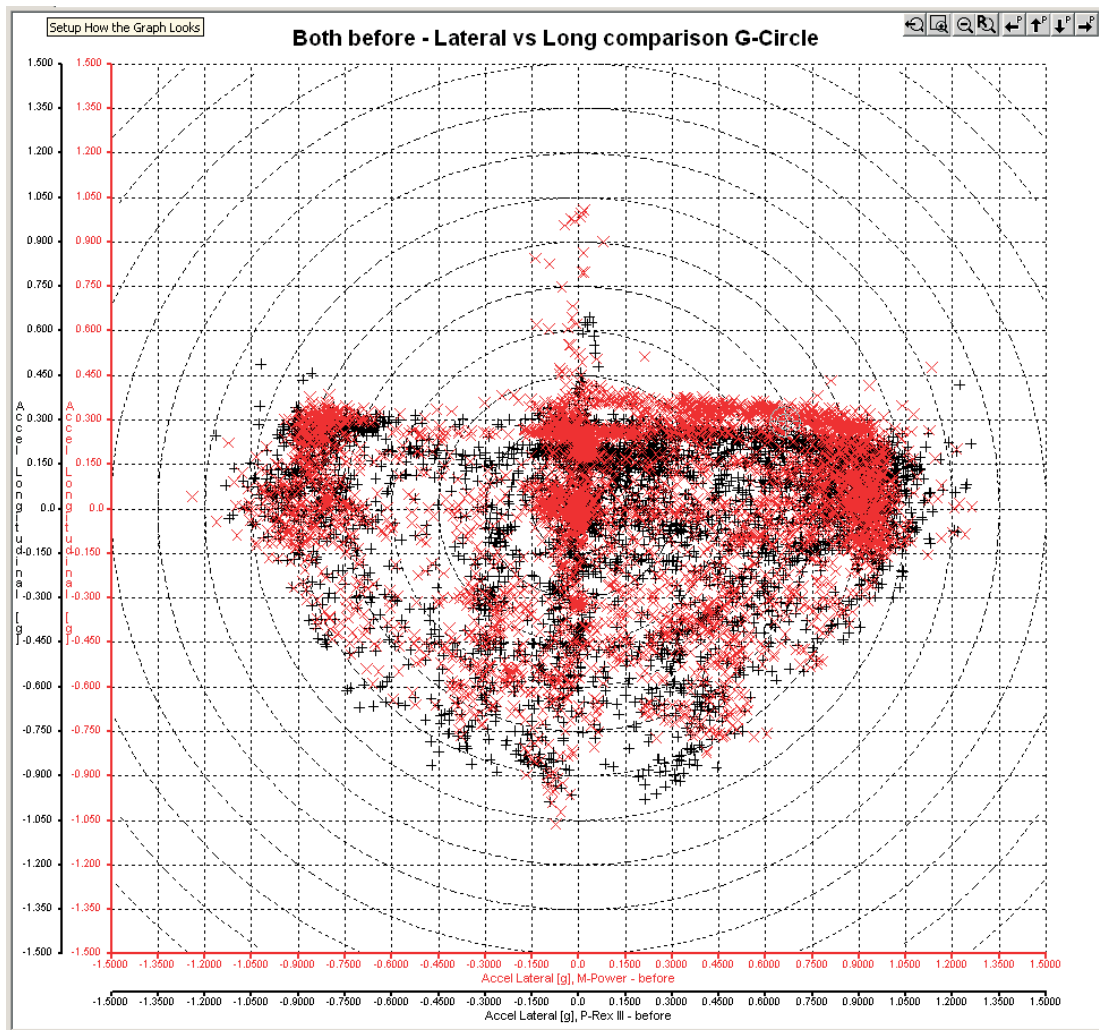
# Power vs Control Challenge - September 2003



G-Circle graph file "1\_G\_speed\_vs\_long\_before"

- G-circle graph showing Speed (Y axis) with Lateral G force (X axis). Crosses indicate individual digital samples of data. Speed scale start from zero where as G force scale centres on zero to show left and right hand corners. Useful for viewing general trends and overall picture. Note circuit is clockwise so greater absolute lateral G's found on right hand side of graph zero.
- This graph compares M-Power (red) and P-Rex III (black) in round 1 or "before" configuration.
- M-Power clearly has higher overall speed than P-Rex III.
- P-Rex III has higher absolute lateral G readings however with more samples or density of black crosses in extreme lateral G zone.

# Power vs Control Challenge - September 2003



G-Circle graph file "2\_G\_Lat\_vs\_long\_compare\_before"

- G-circle graph showing Longitudinal G force (Y axis) against Lateral G force (X axis). Crosses indicate individual digital samples of data. Both scales centre on zero to show data either side of centre. For Long scale, samples above zero indicate degree of acceleration where as samples below show braking deceleration. For Lat scale, samples to left of zero show left hand corners and vice versa. Useful for viewing general trends and overall picture. Note circuit is clockwise so greater absolute lateral G's found on right hand side of graph zero.

- This graph compares M-Power (red) and P-Rex III (black) in round 1 or "before" configuration.

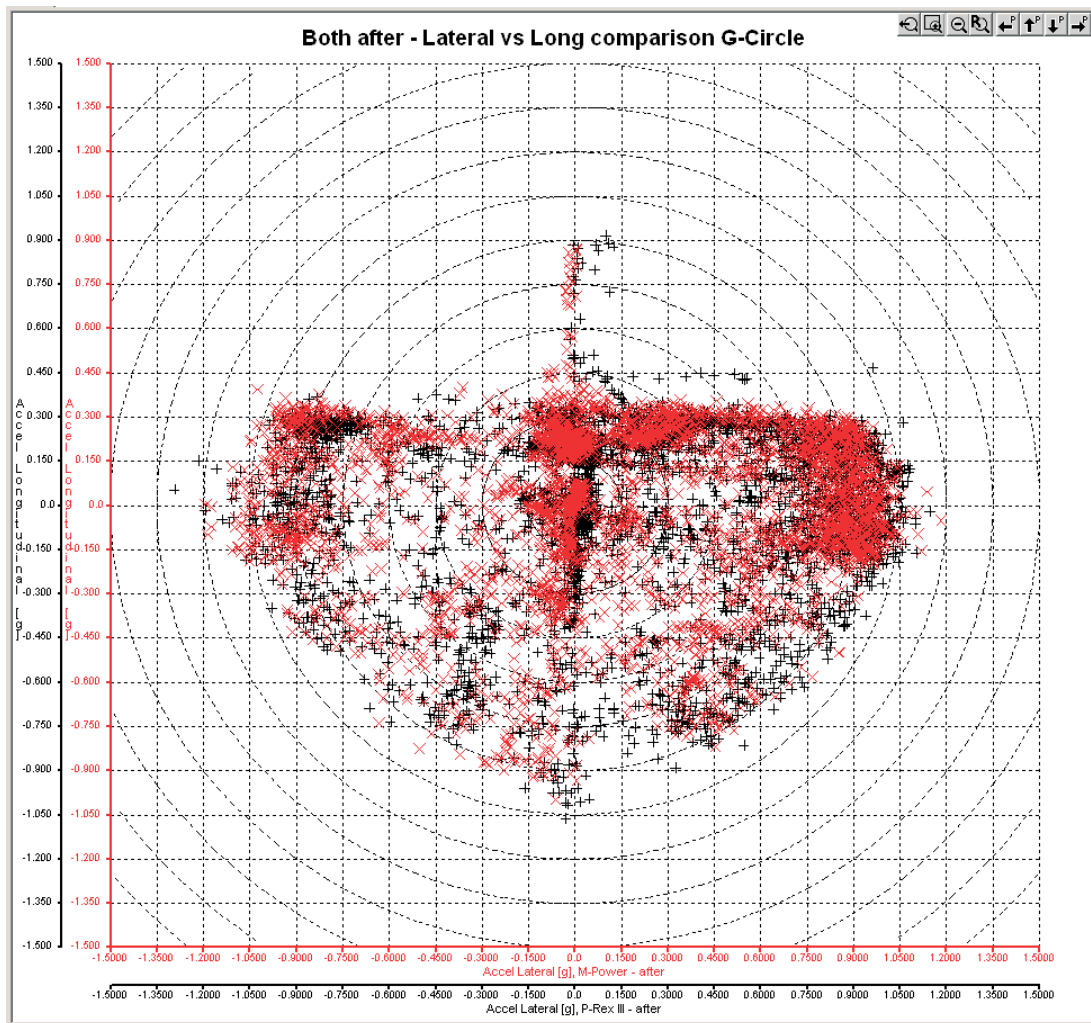
- M-Power clearly has higher much higher acceleration with greater red clusters.

- P-Rex III has higher absolute lateral G readings however with more samples or density of black crosses in extreme lateral G zone.

- Note location of clustering of samples around longitudinal zero point. In rough terms, assuming same driver and style, lateral G sample clusters above Long zero indicate understeer bias, below indicates oversteer. Best to straddle the zero point for neutral.

- Important to note dramatic amount of clustering above zero for M-Power car showing predictable understeer bias of standard car in stock suspension configuration. Extra power only exacerbates outcome. P-Rex III is closer to zero though still understeer bias by choice (Whiteline)

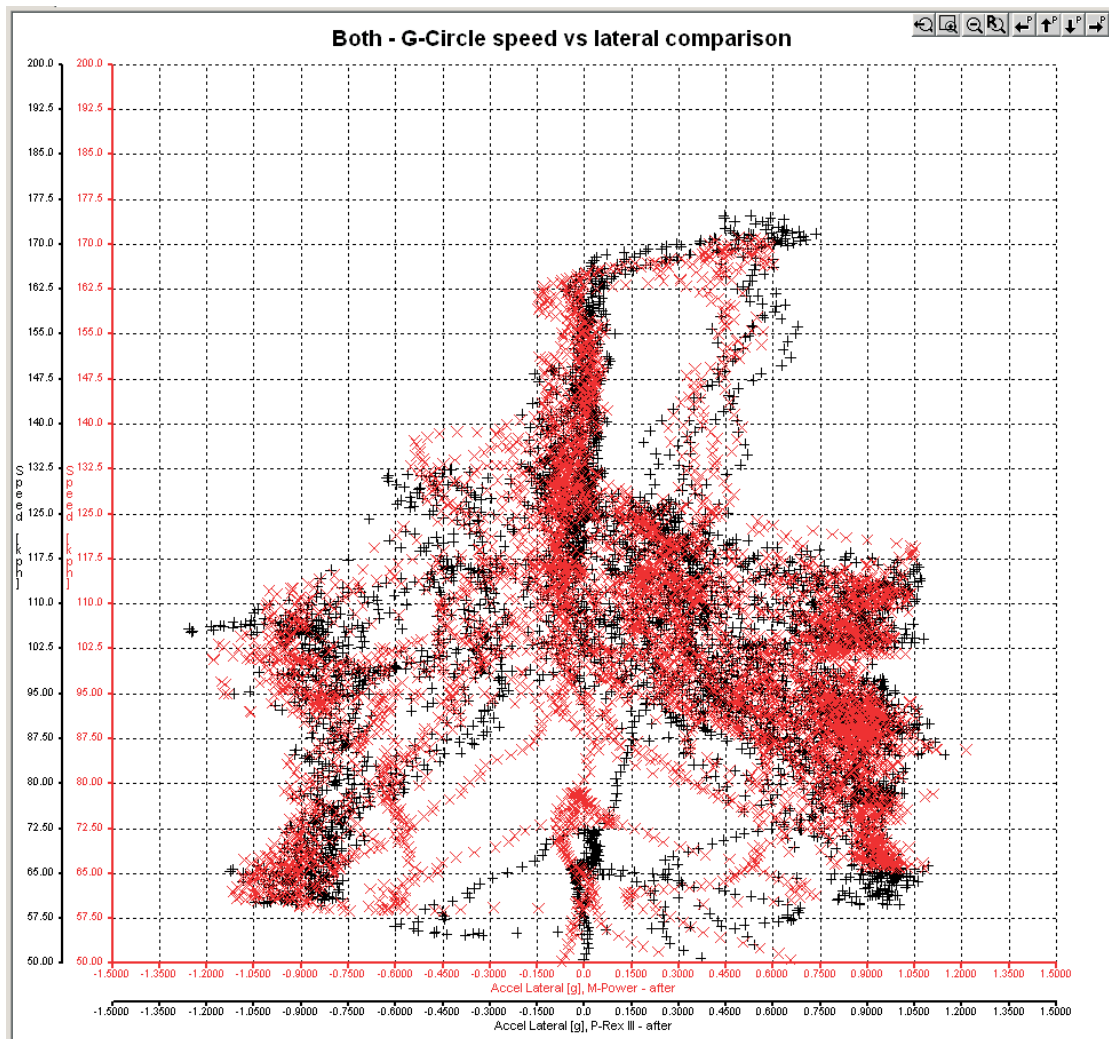
# Power vs Control Challenge - September 2003



G-Circle graph file "3\_G\_Lat\_vs\_long\_compare\_after"

- This graph compares Long vs Lat G forces between M-Power (red) and P-Rex III (black) in round 2 or "after" configuration.
- Overall both patterns are now a lot closer though there are still many subtle differences.
- Acceleration is now much closer matched with high longitudinal G's though P-Rex III has more high acceleration samples to right of lateral G zero point indicating higher cornering G capacity at speed.
- P-Rex III still has higher absolute lateral G readings with more samples or density of black crosses in extreme lateral G zone.
- Note M-Power is still understeering more than P-Rex III indicating lack of bigger swaybars and changes to under/oversteer bias. (M-Power car deliberately NOT fitted with swaybars to reflect general market preoccupation with springs and shocks. IE, M-Power is typical of what most people would do when upgrading their suspension.)

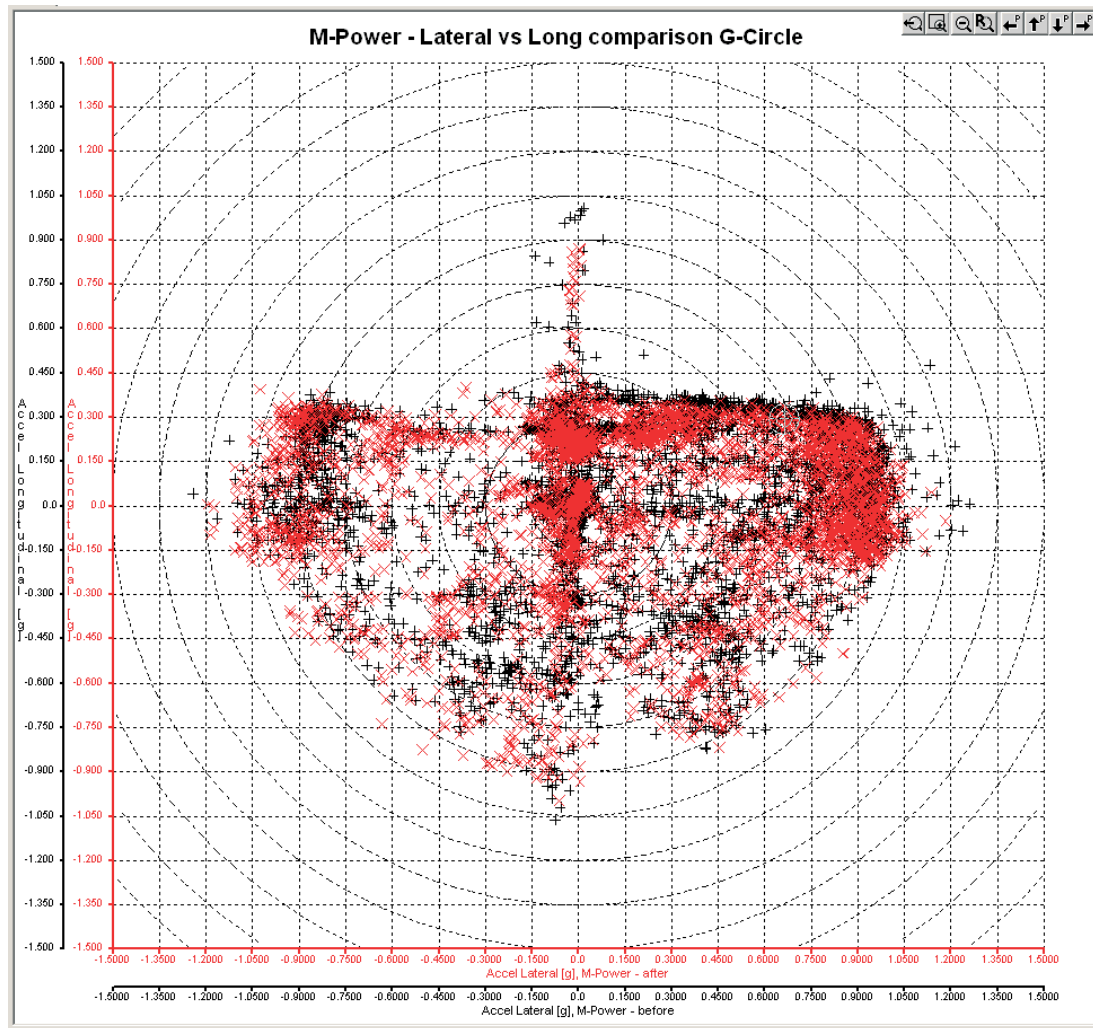
# Power vs Control Challenge - September 2003



G-Circle graph file "4\_G\_speed\_vs\_long\_after"

- G-circle graph showing Speed (Y axis) with Lateral G force (X axis) in round 2 or "after" configuration.
- Overall both patterns are now a lot closer though there are still many subtle differences.
- P-Rex III has higher overall top speed because of higher corner exit speeds. This is important as power alone is not enough to overcome slower cornering speeds to deliver higher overall speeds.
- M-Power can develop higher instantaneous lateral G's due to more power and acceleration.
- P-Rex III generates more sustainable high lateral G's.
- M-Power data spread is broader or less dense in all cases compared with P-Rex III which indicates greater overall chassis control. Specifically note shape of red data (M-Power) in hard acceleration.

## Power vs Control Challenge - September 2003

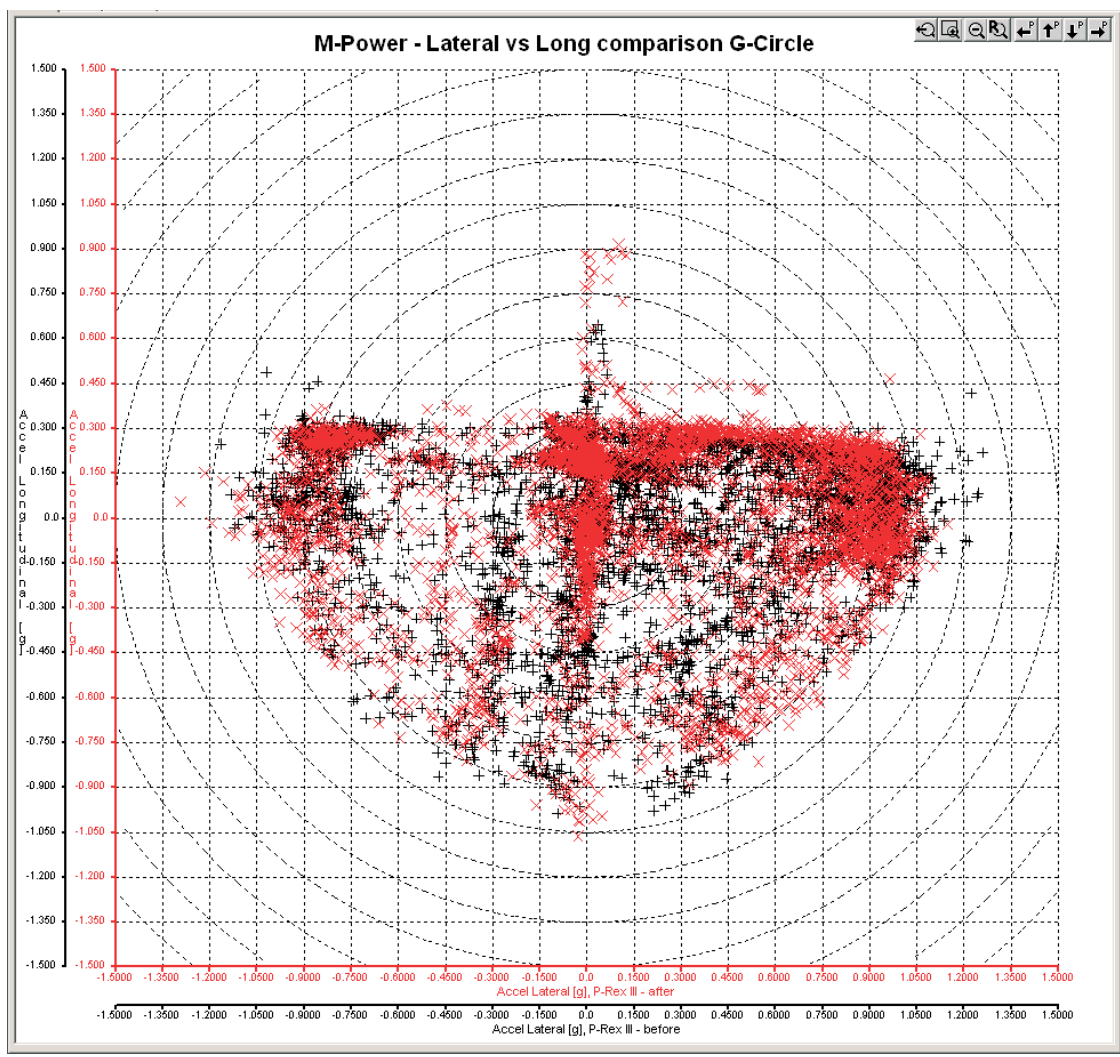


G-Circle graph file "5\_G\_Lat\_vs\_long\_M-Power"

- This graph compares Long vs Lat G forces between M-Power (red) in "after" configuration and M-Power (black) in "before" configuration.
- Note M-Power is much closer to neutral and is understeering a lot less than "before".
- Overall cluster patterns are a lot denser in "after" configuration showing more control overall.
- Though "before" configuration had higher absolute G force values, this is often as a result of radical or inconsistent driving indicating relative lack of power or chassis control. That is, not a reflection of the driver's ability but more a case of what they have to do to try to maximise speed and outcome. This is why we ignore outright maximum G values and concentrate on sustainable G's as evidenced by "mean high lateral G" result in results table.
- Driver feedback was consistent with data. Car was easier to drive fast, more fluid with extra power being more useable.
- This is contrary to what many people perceive, "being" fast is "looking" fast. Not so.



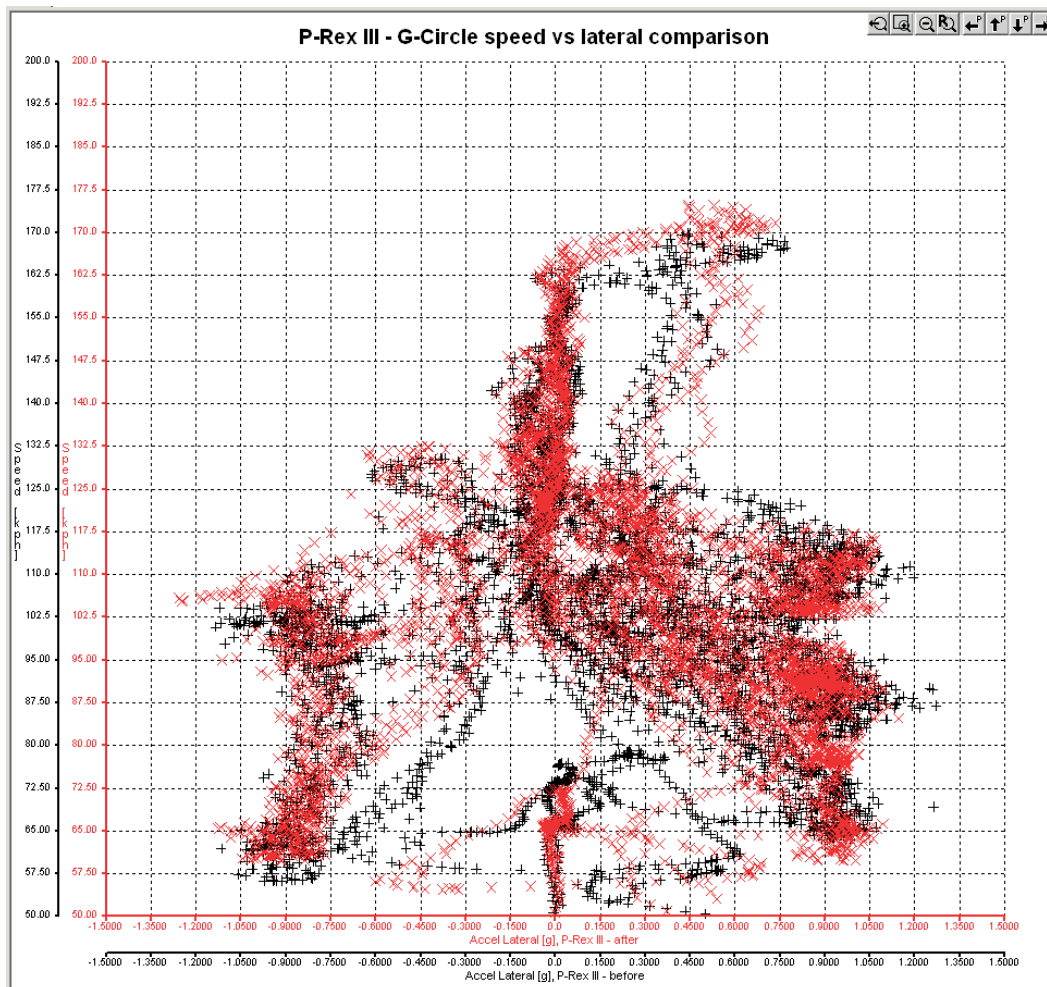
# Power vs Control Challenge - September 2003



G-Circle graph file "6\_G\_Lat\_vs\_long\_P-Rex\_III"

- This graph compares Long vs Lat G forces between P-Rex III (red) in "after" configuration and P-Rex III (black) in "before" configuration.
- P-Rex III clearly has much more acceleration thanks to MRT Power XA kit.
- Though "before" configuration had higher absolute G force value's, this is often as a result of radical or inconsistent driving indicating relative lack of power or chassis control . That is, not a reflection of the drivers ability but more a case of what they have to do to try to maximise speed and outcome. This is why we ignore outright maximum G values and concentrate on sustainable G's as evidenced by "mean high lateral G" result in results table.
- Driver feedback was consistent with data. Car was easier to drive fast, more fluid and did not need to force higher corner entry speeds to benefit higher exit speeds as a result of lack or power.
- More understeer in "after" configuration reflects unoptimised setup for higher power. Chassis setup was unchanged after power upgrade. Would need shock and swaybar tweaking to optimise power upgrade.

# Power vs Control Challenge - September 2003

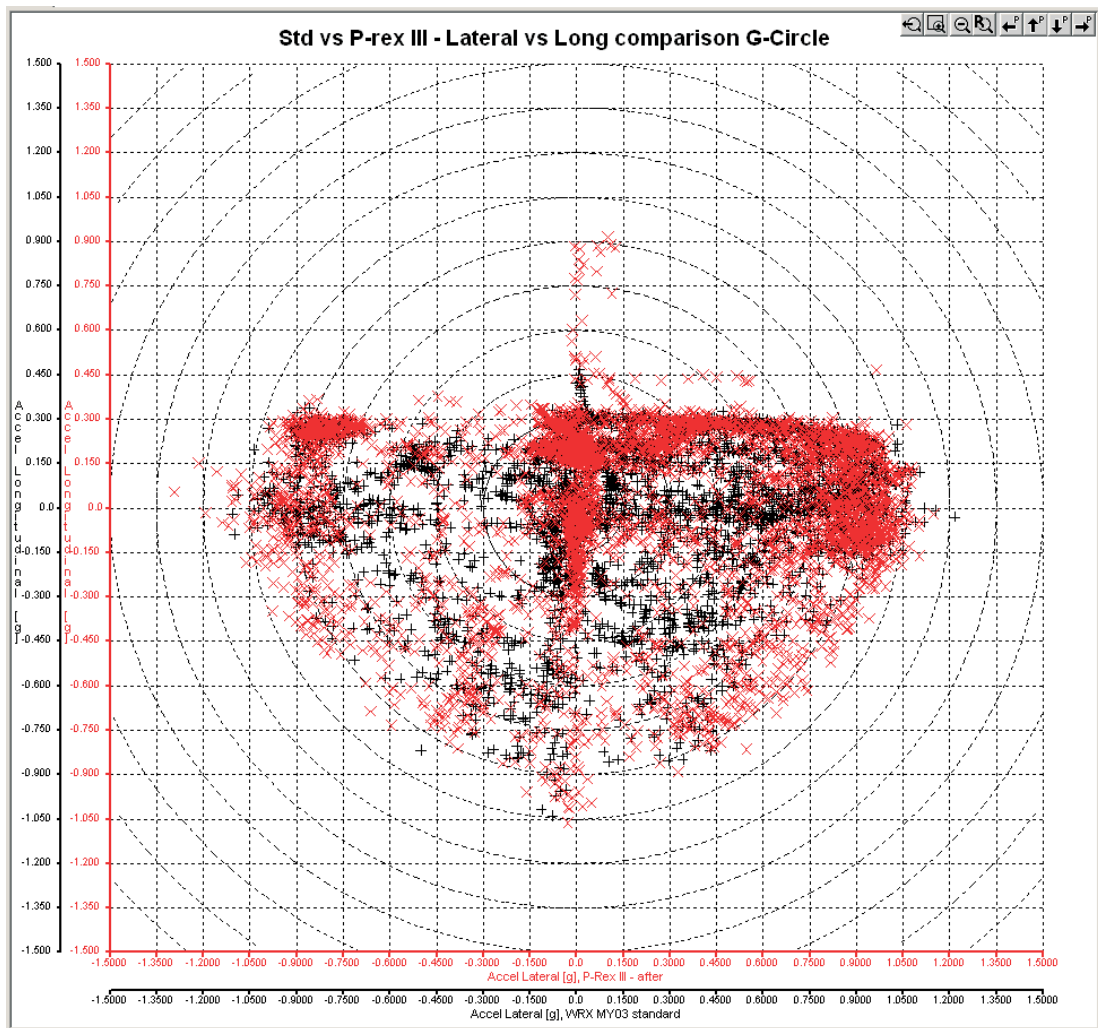


G-Circle graph file "7\_G\_speed\_vs\_long\_P-Rex\_III"

- G-circle graph comparing Speed (Y axis) with Lateral G force (X axis) between P-Rex III (red) in "after" configuration and P-Rex III (black) in "before" configuration.
- P-Rex III clearly has more useable speed more often after fitment of MRT's XA Power kit.
- Data spread is denser after power kit upgrade which indicates greater overall control.
- Note higher lateral G's with speed around 130 to 160 km/h zone indicating faster speeds in high speed corners.
- Driver comments reflect this and fact that chassis setup can handle more power still.



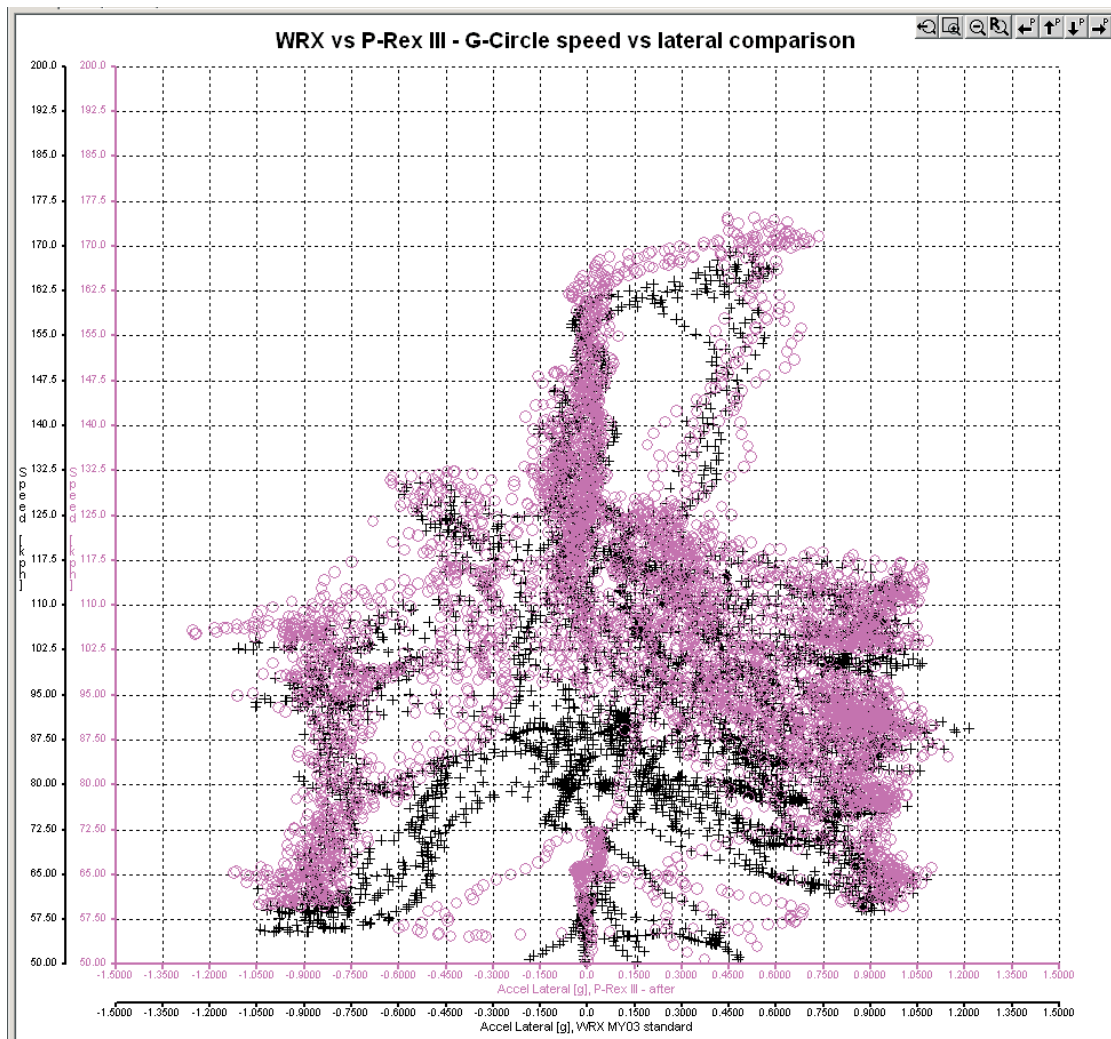
# Power vs Control Challenge - September 2003



G-Circle graph file "8\_G\_Lat\_vs\_long\_compare\_WRX\_vs\_P-Rex\_III"

- This graph compares Long vs Lat G forces between P-Rex III (red) in "after" configuration and the standard MY03 WRX.
- P-Rex III clearly has higher G's in both acceleration and cornering.
- All data patterns are denser indicating more control and precision.
- Unfortunately understeer bias is of similar magnitude but this reflects lack of chassis optimisation after power upgrade. Round 1 tune was more neutral and should be used as a base.

# Power vs Control Challenge - September 2003



G-Circle graph file "9\_G\_speed\_vs\_long\_compare\_WRX\_vs\_P-Rex\_III"

- G-circle graph comparing Speed (Y axis) with Lateral G force (X axis) between P-Rex III (pink) in "after" configuration and the standard MY03 WRX (black).
- P-Rex III clearly has more outright speed after fitment of MRT's XA Power kit, up to 7kmh more on the straight.
- Data spread is denser after power kit upgrade which indicates greater overall control.
- Note higher speeds and higher lateral G's in 130 to 160 km/h zone indicating faster speeds in high speed corners.
- On balance, patterns have moved up and to the right in general indicating more speed and grip.

# Power vs Control Challenge - September 2003

Chassis and suspension parts used

## Car Kit - Subaru WRX GD MY03 10/02 on

Turbo sedan only. Excluding Sti and wagon.



P-Rex III

23/10/2003

M-Power

ABN 68 073 002 034

Fitting labour estimate(2)

Kit part number

Kit price (2)

Handling Pack	Sports Pack		The Works	
All	Low	Superlow	Low	Superlow
<b>KSUB05H</b>	<b>KSUB05S</b>	<b>KSUB06S</b>	<b>KSUB05X</b>	<b>KSUB06X</b>
<b>\$837.00</b>	<b>\$1,810</b>	<b>\$1,810</b>	<b>\$2,499</b>	<b>\$2,499</b>
<b>3.5 hours</b>	<b>5 hours</b>	<b>5 hours</b>	<b>8 hours</b>	<b>8 hours</b>

STANDARD KIT CONTENTS				Use part numbers above to get latest prices on kits and parts. Contact nearest Whiteline dealer or go to <a href="http://www.whiteline.com.au/store">www.whiteline.com.au/store</a> to check prices online.			
Product	Loc.	Description	Qty per kit				
<b>Springs(1)</b>	Front	Control low - 365mm	1		80066		80066
		Flatout superlow - 350mm	1			83028A	83028A
	Rear	Control low - 355mm	1		73194		73194
		Flatout superlow - 340mm	1			73195	73195
<b>Shocks(5)</b>	Front	Adjustable rebound insert (excl Sti)	2		1301012	1301012	1301012
	Rear	Adjustable rebound insert (excl Sti)	2		1302812	1302812	1302812
<b>Swaybars(12)</b>	Front	22mm Blade adjustable	1	BSF33Z		BSF33Z	BSF33Z
	Rear	22mm Blade adjustable (excl US Sti)	1	BSR36Z		BSR36Z	BSR36Z
<b>Align &amp; other</b>	Front	Caster/anti-lift kit (3)	1	KCA359		KCA359	KCA359
		Camber adj. bolt kit		OEM		OEM	OEM
	Rear	Camber adj. bolt kit	1	KCA414		KCA414	KCA414
OPTIONS				These items not included in package but available separately.			
<b>Shocks/springs</b>	F & R	WL Premium height adjustable kit (5)	1		1K4006	1K4006	1K4006
	F & R	AST 50mm full adjustable race kit		P-Rex III	Call	Call	Call
<b>Swaybars(12)</b>	Front	H/duty 22mm fixed	1	BSF33		BSF33	BSF33
		Extra h/duty 24mm fixed (8)	1	BSF33X		BSF33X	BSF33X
		Extra h/duty 24mm Blade adj.(8,9)	1	BSF33XZ		BSF33XZ	BSF33XZ
		H/duty steel s/bar links-OE plastic type(6)	1	KLC20A		KLC20A	KLC20A
		H/duty steel s/bar links-OE ball type(6)	1	KLC23		KLC23	KLC23
		Extra h/duty s/bar alloy links-OE plastic(6)	1	KLC30		KLC30	KLC30
		Extra h/duty s/bar alloy links-OE ball(6)	1	KLC32		KLC32	KLC32
		H/duty 22mm fixed excl. US Sti	1	BSR36		BSR36	BSR36
		Extra h/duty 24mm fixed (7,8,9) excl US STI	1	BSR36X		BSR36X	BSR36X
		Extra h/duty 24mm Blade adj.(7,8,9)	1	BSR36XZ		BSR36XZ	BSR36XZ
	Rear	Heavy duty s/bar links (6)	1	KLC19		KLC19	KLC19
		Extra h/duty s/bar alloy links (6)	1	KLC26		KLC26	KLC26
		Heavy duty s/bar mounts(7)	1	KBR20-Size		KBR20-Size	KBR20-Size
<b>Align &amp; other</b>	Front	Additional camber adj. bolt kit -RACE(8)	1	KCA414		KCA414	KCA414
		Caster/anti-lift kit - Comfort (3)	1	KCA362		KCA362	KCA362
		Caster/anti-lift kit - Motorsport 90D (3)	1	KCA319M		KCA319M	KCA319M
		Caster bush kit only - adds +0.5 deg static	1	KCA375		KCA375	KCA375
		Upper alloy strut brace-rr mount	1	KSB554		KSB554	KSB554
	Rear	Upper alloy strut brace-large TMIC	1	KSB599		KSB599	KSB599
		H/duty steering rack mount kit	1	KSR202		KSR202	KSR202
		Subframe lock kit (10) - excl Sti	1	KSB750		KSB750	KSB750
		Toe lock kit	1	KCA377		KCA377	KCA377
		Front of rear diff support lock kit (8)	1	KSB751		KSB751	KSB751
		Control arm-adjustable toe (11)	1	KTA107		KTA107	KTA107
Control arm-adjustable toe/camber (11)	1	KTA109		KTA109	KTA109		
Upper alloy strut brace	1	KSB511		KSB511	KSB511		
<b>XRD - options</b>				<b>Whiteline "eXtreme Race Development" products suitable for RACE USE ONLY (8)</b>			
Front	RACE swaybar - 25 to 28mm	1	X3003		X3003	X3003	
	RACE anti-lift/caster kit (3)	1	KCA319M		KCA319M	KCA319M	
	Front upper camber kit-race (8)	1	Call		Call	Call	

Refer next page for recommended wheel alignment specs and foot note details.

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Chassis and suspension parts used

SUGGESTED WHEEL ALIGNMENT SETTINGS			Camber	Caster(3)	Toe
Optimum starting setting designed for use with Whiteline kit.			Deg	Deg	mm/side
<b>Front</b>	Touring		-1.0	Max	0.0
	Sport		-1.50	Max	0.0
	Race		-2.0 to -3.0	Max	0.0
<b>Rear</b>	Touring		-0.75	n/a	1mm out
	Sport		-1.00 to -1.25	n/a	0 to 1.5mm out
	Race		-1.5 to -2.5	n/a	0-1.5mm out

(1)-Height measurement in mm from centre of wheel to guard (CWTCG), +/- 1.5%. Superlow applications with extra rear load can use standard low. Heights only available when using Whiteline specified shock absorbers and may vary with model and options.

(2)-Special kit price in A\$ including GST. Fitting hours are an estimated guide including wheel alignment. May only available be when purchasing and fitting kit with same dealer. All prices quoted valid till 30/6/2004 but subject to change without notice.

(3)-KCA359 provides extra +0.5 deg static caster and +1.0 deg dynamic. Includes spacer for OE front lower collision brace. KCA362 "Comfort" version option uses 70D bush. KCA319M "Race" version uses plain alloy mount and ultra low compliance 90D bush. Not designed to work with front lower collision brace. Order KCA360 spacer kit to refit lower brace. Alignment settings suggested as a starting point and guide.

(4)-Options: These items not included in package but available as separate item.

(5)-Insert installation will require cutting of existing strut tube to locate insert, externally adjustable gas twin tube with sport valving. Specially tuned for improved bump travel. 1K4006 is height and rate adjustable coil-over kit using high performance 40mm piston non-inverted mono tube strut. Specially designed for road use featuring low maintenance shaft and external top rate adjustment.

(6)-KLC20A steel or KLC30 alloy links replace stock plastic/rubber type. Choose according to your stock/OE configuration. Can use KLC23 steel or KLC32 alloy to replace stock/OE front steel ball end style links. KLC19 steel and KLC26 alloy links replace stock plastic/rubber type. Excludes North American GD Sti.

(7)-Extra heavy duty rear swaybar mounts improve swaybar response and should be used for large diameter or adjustable swaybars used on higher settings as factory mounts can fail prematurely. Available in 19/20/22/24mm size, eg. KBR20-22 is part # to suit 22mm diameter swaybar

(8)- Whiteline XRD race products and extra heavy duty options must be used with extreme care. Certain performance modifications like differential changes can dramatically affect vehicle behaviour making certain parts unsuitable. Other parts should not be used unless additional chassis strengthening has been provided and the user accepts that Whiteline can not be responsible for resultant damage to the vehicle, particularly in race use. Should only be used after consultation with a reputable suspension tuner. Contact Whiteline for more details. ( www.whiteline.com.au )

(9)- Extra heavy duty blade adjustable swaybars available are primarily designed for race use. Not designed for road use at anything but lightest setting as fitment may result in unpredictable behaviour, cracking and failure of suspension mounts. Contact Whiteline prior to ordering for more information and advice on suggested component modifications & strengthening prior to fitment. Also refer note 7, 8.

(10)- Subframe lock kit will increase NVH and is designed for weekend race use and accurate alignment setting. It should be used during wheel alignment to precisely locate rear subframe and can be easily installed and removed for track work. Not suitable for North American STi.

(11)- KTA107 kit contains 2x front arms and 4x low compliance poly bushes for rear arms. Use for extra toe adjustment and better precision. KTA109 kit contains 4x complete replacement arms for camber and toe adjustment. Will increase NVH.

(12)- Rear swaybars and certain other components are not designed to suit North American MY03 (2004) Sti. Refer Whiteline detailed application guide for correct part numbers where appropriate.

## P-Rex III

See [www.whiteline.com.au](http://www.whiteline.com.au) for more details