Daimler Surveillance Panel Meeting Minutes

At ASTM D02 on December 9, 2019

2:00 PM – 4:00 PM CST

Call Participants:

Lubrizol - Patrick Joyce (Chairman), John Loop, Bill O'Ryan, George Szappanos
Southwest Research Institute – Jose Starling (Secretary), Travis Kostan, Robert Warden, Mike Lochte, Mike Van Hecke
Intertek –Josh Ward, Andrew Smith, Juan Vega
Daimler - Suzanne Neal
Afton – Bob Campbell
Infineum - David Brass, Elisa Santos, Jim Gutzwiller
Chevron Oronite – David Lee
TEI – Derek Grosch, Mark Sutherland, Dan Lanctot
TMC – Sean Moyer
Haltermann Solutions – Prasad Tumati
Ford – Mike Deegan, Ron Romano
Idemitsu – Junya Iwasuki
ExxonMobil – Steven Jetter
Chevron Phillips – Jon VanScoyoc
Total – Valerie Doyen

Discussion

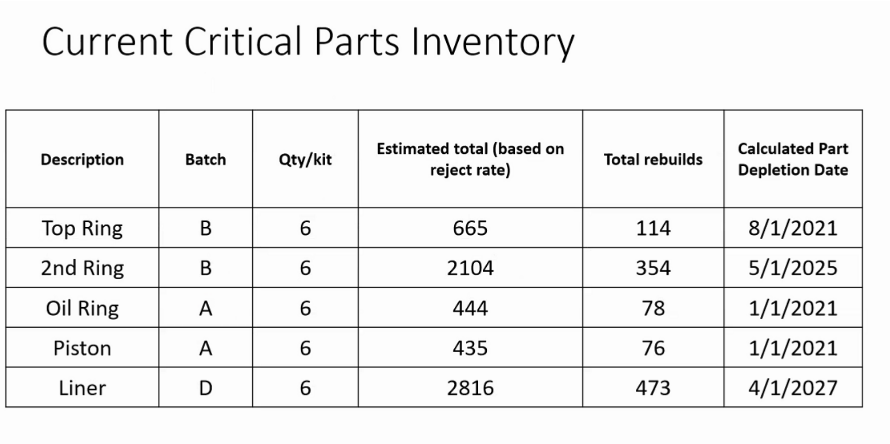
The meeting started with some difficulties with the WebEX call in number despite an early arrival by facilities coordinators to ensure everything was functional. Hotel staff leapt into action in an effort to make the system work. After replacement of phones, wires, and many mis-dials it worked with only a 15 minute delay.

<u>Agenda Items</u>

Critical Parts Inventory – Derek Grosch

Six months of top rings, oil rings, and pistons. Large amount of liners and 2nd rings (2000+). An order will be made to sync up the count of these parts in the next 2-3 months. This is to hopefully avoid depletion of the current parts without new hardware in-hand if delays happen. No major parts updates outside of this. Historic reject rates will be used in factoring in how much will be ordered. The reject percentage has been consistent batch to batch, so it is felt that the numbers will be accurate. See the attached .ppt presentation for exact values of hardware remaining and anticipated depletion date.

If pistons are depleted, what is the plan with coordinating references? Pat had interest in just moving to the new parts and preserving some of the old hardware in the event it is needed for analysis in the future. This is something that has been often mentioned, but not done as a standard rule across test types. The below figure at the time of the meeting was presented by TEI noting remaining hardware count and predicted depletion dates.



Current Critical Parts Inventory

Description	Batch	Qty/kit	Estimated total (based on reject rate)	Total rebuilds	Calculated Part Depletion Date
Top Ring	B	6	665	114	8/1/2021
2nd Ring	B	6	2104	354	5/1/2025
Oil Ring	A	6	444	78	1/1/2021
Piston	A	6	435	76	1/1/2021
Liner	D	6	2816	473	4/1/2027

Alternative Fuel Supplier Requirements – Josh Ward (via phone)

A subgroup has been investigating what the appropriate requirements are for the DD13 Scuffing Test. Josh had been holding off until after the first of the year to begin this effort to avoid conflicting with typical end-of-year hectic timelines. It is anticipated that the effort will resume the first or second week of January ’20. Ideally, this effort would take place early in the year so any efforts can occur quickly. Suzanne asked if there is a broader group looking at the fuel requirements across various surveillance panels. Bob Campbell noted that no cross-panel effort has gotten off the ground on this. The PCMO tests are a bit further along the process, and the final decision still resides at the panel level.

Josh will be sending out a meeting date in January for the sub-group.

Statistical Review – Travis Kostan (Presentation Attached)

With the approval of the Batch D liners, there was a fair amount of interest in looking at how the test has evolved over time. This includes changes that have occurred with the top rings, reference oil reblends, and other LTMS tracked items.

Oil 864 showed a large increase in the number of “mild” tests as the top ring batch moved from A to B. The rate of tests exceeding 100 hours went from ~14% to ~35% when sorting this reference oil by the top ring batch. This includes both 864 and 864-1 oil codes.

The newer top rings have a lower Ra, Rk, Rpk, and Rz value. Additionally the back of ring width and face with are smaller. Although these values were different between the batches, they seem to have been consistent within batch B. The bias for cylinder scuffing on #3 and #4 seems to have gone away and is now more evenly distributed.

The Ra, Rk, Rpk, Rz values have been drifting lower over time in a slow linear manner. TEI noted that a stylus change has occurred, however this would likely have shown as a step change rather than linear trend.

The cylinder which scuffed has become more evenly distributed and there are quite a few more partial scuffs as opposed to 100% scuffed liners.

Various plots were shown to compare hours to scuff with roughness parameters. Most plots showed data grouped by batch, but the batches somewhat separated. It was noted that for each roughness value, the value is an average of 6 cylinders and 3 points of measurement per cylinder for a total of 18 data points averaging into each dot on the graph.

The stylus change over occurred after the top ring batch change. Mark Sutherland thought that it occurred near the batch C Liner introduction.

Elisa Santos had a few comments to add on the plots; she noted that even though we were looking at the plots color coded by the ring batch there were a number of other items changing at the same time. When looking at the data including the stand as a parameter the data doesn't look the same. Travis noted that the investigation was spurred by what appears to be a shift in a mild trend when moving to DD13X to the 864 oil.

Elisa had some data to show highlighting that some of the original matrix stands may have been more severe than later stands that never ran top ring batch A in the matrix, particularly stands B2 and G2. This is further confounded by the introduction of the Batch A 2nd ring and Batch C liners.

Due to the lack of an abundance of reference data, it makes this investigation somewhat difficult. There are very few clean comparisons between stands or oils that don't have some sort of confounding data. While the non-matrix new stand component adds complexity, it doesn't change the fact that there are more mild tests now then their used to be.

There tended to be milder results with lower CCP in phase two. Since this value is an average based on the whole test the makes sense that a result without data from a scuffing event the value would be lower.

The oil ring rail height showed a decline in the measurement mid-2016. This is about the time that a machine change occurred at TEI. Before and after this the values are stable. Oil ring tension showed a slow drift downward as well.

Liner RPK shows a linear trend from 2015 until mid-2016, then an increasing linear trend. This doesn't make a lot of sense since it would be more expected to show up as step changes as the batches changed. Mark Sutherland noted the machine is calibrated once per year.

Top Ring Rpk showed a liner decline, then flattening out at about the same time Liner Rpk started to climb.

It was noted again how difficult this type of analysis is due to the lack of repeated combinations of hardware, stands, and oil. Discussion continued looking at various plots.

Both statisticans agreed that there simply is not enough data for the number of variables we have to do a proper multi-variant analysis and come away with a firm outcome.

At this point the phone system stopped working. Discussion was paused.

Procedure Discussion and Review – Patrick Joyce

The discussion circled around things that might be changed in the procedure to improve the test. This was in response to some comments made at the introduction of the most recent liner batch and coordinated references that happened at the time.

Bob Campbell noted that to him the data is concerning. When an oil from the matrix went from a 7% mild rate to a 35% mild rate. Essentially, the test is not well behaved. The discussion between the statisticians highlighted the need to limit batch changes since it makes things so messy with trying identify root causes later in the test's life.

Patrick noted that there is a plan to bring in 3 new batches of critical parts at the same time. This alignment of hardware quantities is likely a step in the right direction for the future, although it doesn't address the historical data. However there is always a risk that the change of multiple components makes it more difficult to identify which one is responsible for any result shift.

One thing that may need to be done is to set limits on various hardware pieces that are currently measured but not screened.

Travis Kostan asked if it is possible to move as close to the original matrix as possible. For parameters that have a range, can we select parts that measure close to the matrix? David Brass noted that there have been changes in the supplier of some parts, not just the batches. Additionally, oil reblends have occurred that mean the original batch is no longer available.

For the liners there was a shift in the distribution "cut" of parameters we use when moving from the FM product to Mahle's hardware.

It was noted that there is a large supply of the 864-1 oil moving forward. The 864 to 864-1 transition occurred quickly due to it being a matrix oil and there not being clear direction of what the reference oil moving forward was going to be at the time.

Action Items

- Travis Kostan to look at matrix data parts measurements and provide ranges to TEI and Daimler for working with the suppliers of future batches.
- Josh Ward to initiate subgroup in January to define alternative fuel supplier requirements
    - Prior to the time these minutes were issued a solicitation for interest in the group had been sent out.
- Sean Moyer to investigate reference oil changes from the original to the -1 blend.

Safety Item

Pat noted that the most-cited OSHA standard is one related to falls. He urged caution when putting up lights around your house for the holidays. Bad weather and heights can be a deadly combination.

Next Meeting:

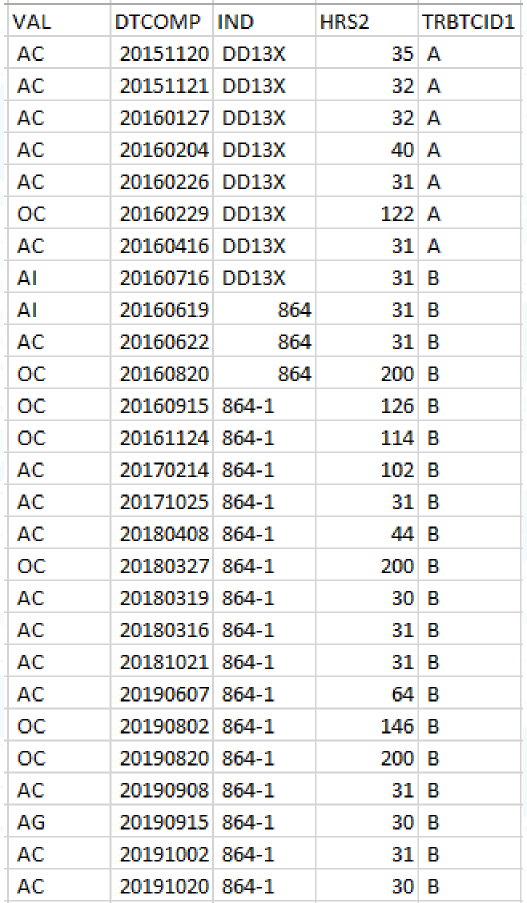
Next meeting date will be set in the future.

DD13 Scuffing Test LTMS Data Review

SOUTHWEST RESEARCH INSTITUTE®

Recap

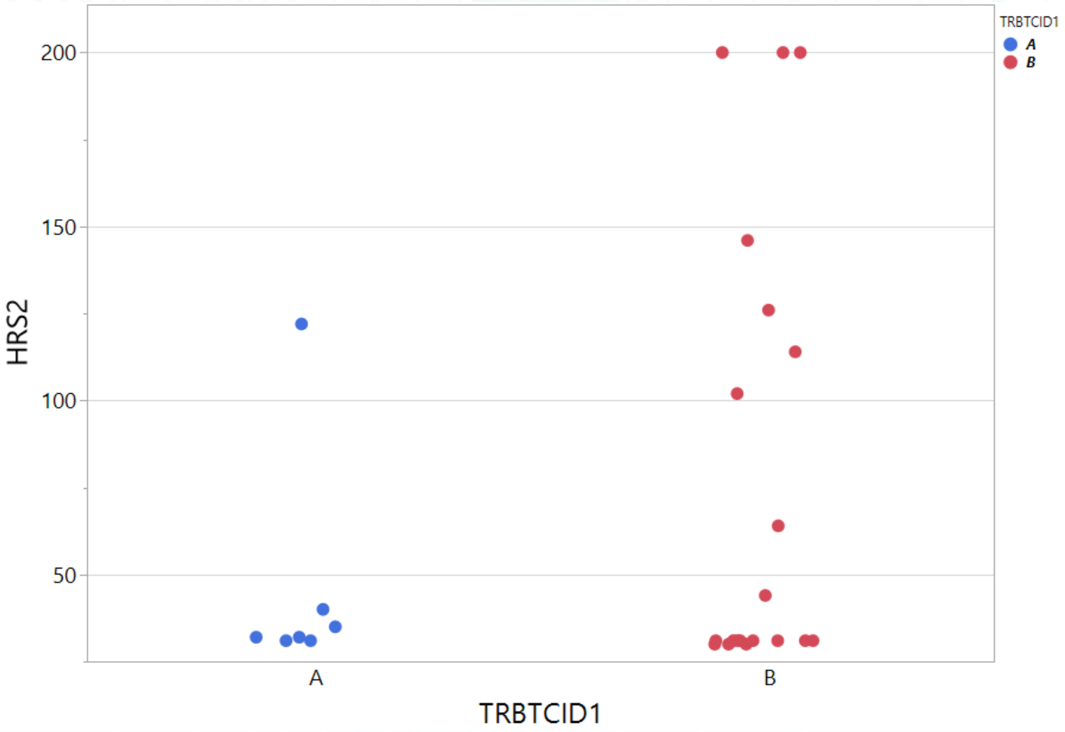
The frequency of oil 864-X (DD13X) mild results began to increase after the precision matrix, around the time of the introduction of the new top rings.



VAL	DTCOMP	IND	HRS2	TRBTCID1
AC	20151120	DD13X	35	A
AC	20151121	DD13X	32	A
AC	20160127	DD13X	32	A
AC	20160204	DD13X	40	A
AC	20160226	DD13X	31	A
OC	20160229	DD13X	122	A
AC	20160416	DD13X	31	A
AI	20160716	DD13X	31	B
AI	20160619	864	31	B
AC	20160622	864	31	B
OC	20160820	864	200	B
OC	20160915	864-1	126	B
OC	20161124	864-1	114	B
AC	20170214	864-1	102	B
AC	20171025	864-1	31	B
AC	20180408	864-1	44	B
OC	20180327	864-1	200	B
AC	20180319	864-1	30	B
AC	20180316	864-1	31	B
AC	20181021	864-1	31	B
AC	20190607	864-1	64	B
OC	20190802	864-1	146	B
OC	20190820	864-1	200	B
AC	20190908	864-1	31	B
AG	20190915	864-1	30	B
AC	20191002	864-1	31	B
AC	20191020	864-1	30	B

1/7 > 100 Hours (14%)

7/20 > 100 Hours (35%)



Executive Summary

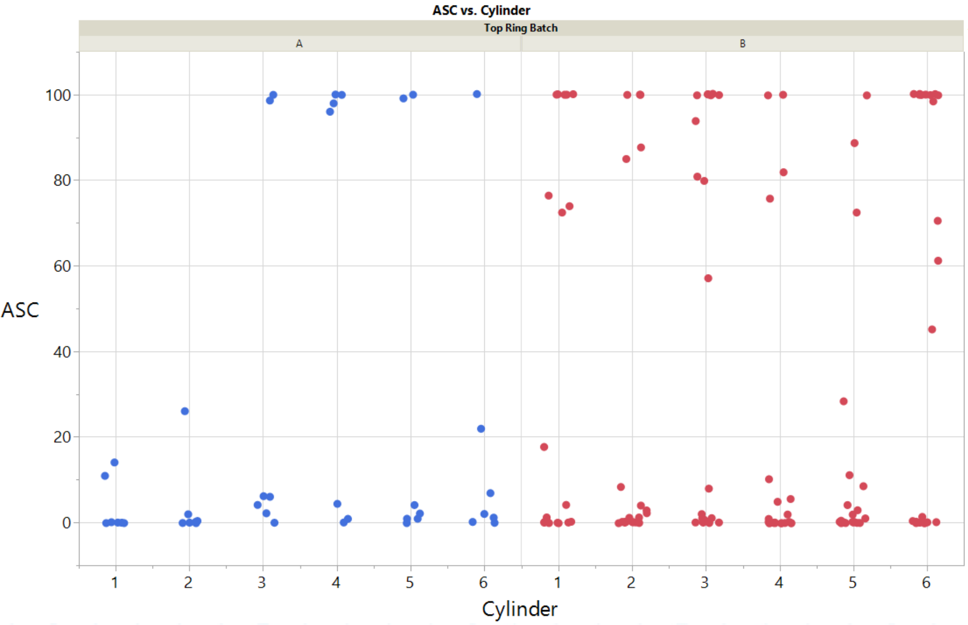
- New top rings have lower RA, RK, RPK, and RZ. The have a smaller back of ring width and face width. Though these parameters changed with the new batch, they have not been different with the batch.
- Distribution of cylinder scuffing appears to be different; more uniform across cylinders and more partial scuffing.
- Mild tests tend to have lower crankcase pressure and higher load.
- Measurements appear to be drifting over time.

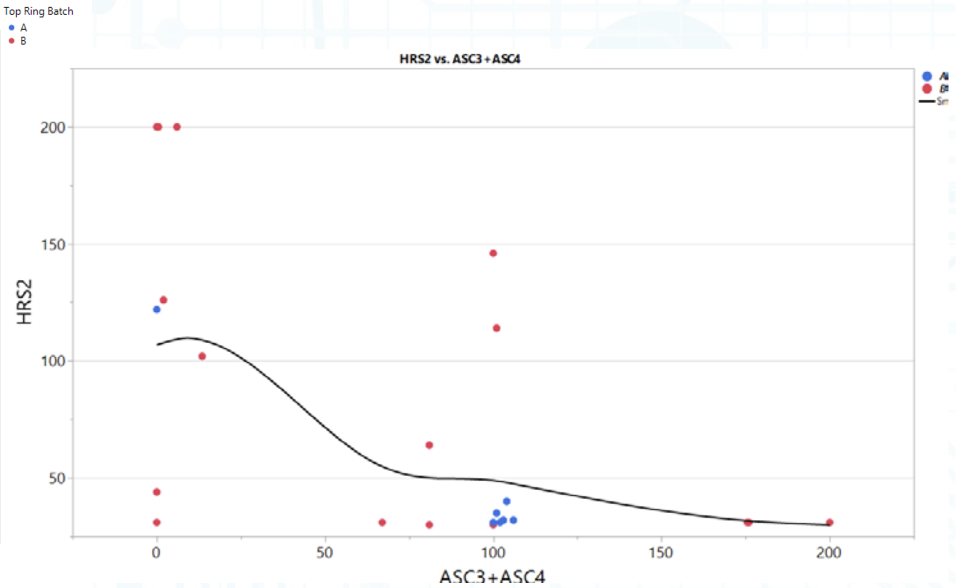
Distribution of Cylinder Scuffing

Batch Code A
- 100% scuff or near zero scuff
- Focused around cylinders #3 and #4

Batch Code B
- Lots of 60%-90% scuffs
- More uniform across cylinders

Cylinder	Avg. Scuff TRB A (%)	Avg. Scuff TRB B (%)	Delta B-A (%)
1	3.6	37.3	33.7
2	4.1	41.6	37.5
3	30.9	46.2	15.3
4	57.1	19.1	-38
5	29.6	16.0	-13.6
6	18.9	53.9	35





Top Ring Measurement Summary

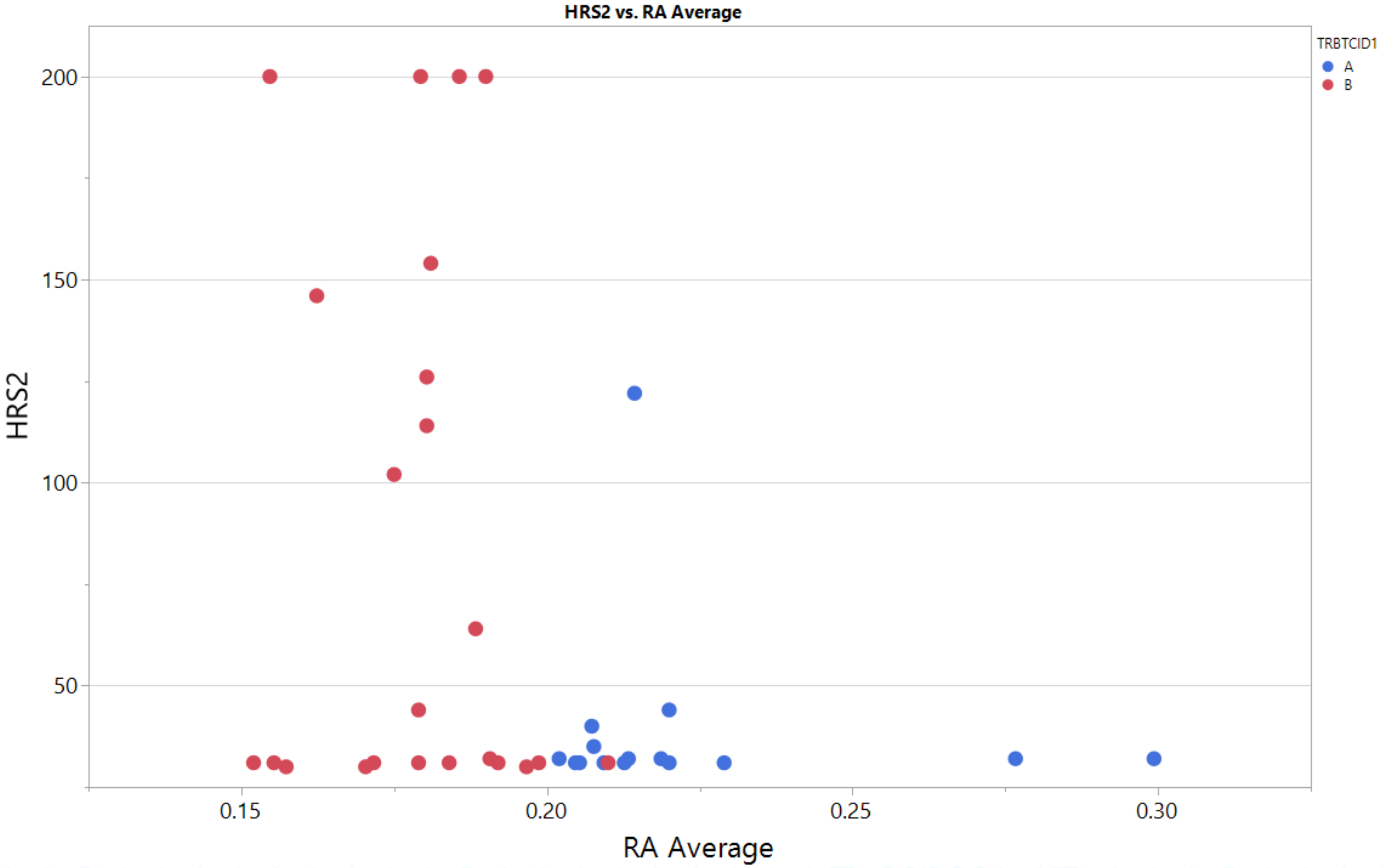
The table to the right compares the differences in top ring measurements from batch code "A" to batch code "B."

Parameter	TR Batch Code A	TR Batch Code B	Delta B-A
RA	0.223	0.181	-0.042
RK	0.607	0.36	-0.247
RM1	8.896	8.587	-0.309
RM2	83.787	83.346	-0.441
RPK	0.239	0.118	-0.121
RVK	1.105	1.04	-0.066
RZ	1.692	1.181	-0.511
TRBW	2.059	2.004	-0.055
TRFW	3.246	3.072	-0.174
TRPH1	0.402	0.403	0.001
TRPHA1	1.437	2.565	1.128
TRPHB1	32.371	31.814	-0.558
TRPHL	0.504	0.658	0.153
TRRT	4.646	4.644	-0.002
TRTENS	27.941	28.003	0.062
VOTR	0.088	0.088	0

RA to RZ – Surface Finish Parameters
TRBW – Back of ring width (mm)
TRFW – Face width (mm)
TRPH1 – Peak height cylinder (micrometers)
TRPHA1 – Peak height to 0.2 MM (micrometers)
TRPHB1 – Peak height to 2.75 MM (micrometers)
TRPHL – Peak height location (mm)
TRRT – Thickness (mm)
TRTENS – Tension (N)
VOTR - Vo

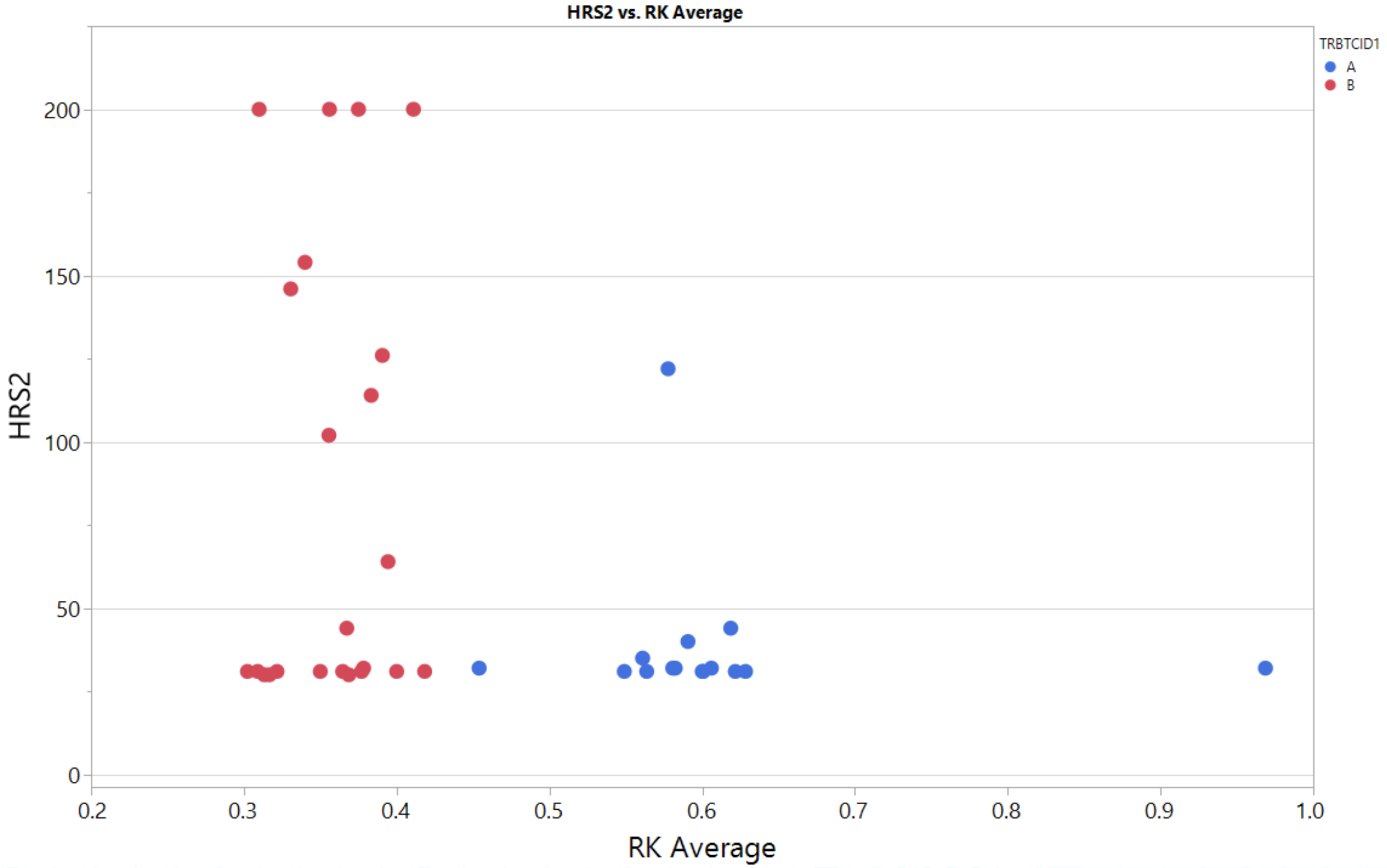
Top Ring RA

Below is a plot of Hours to Scuff vs. Top Ring RA. The RA average is averaged across the 6 cylinders and 3 measurement locations.



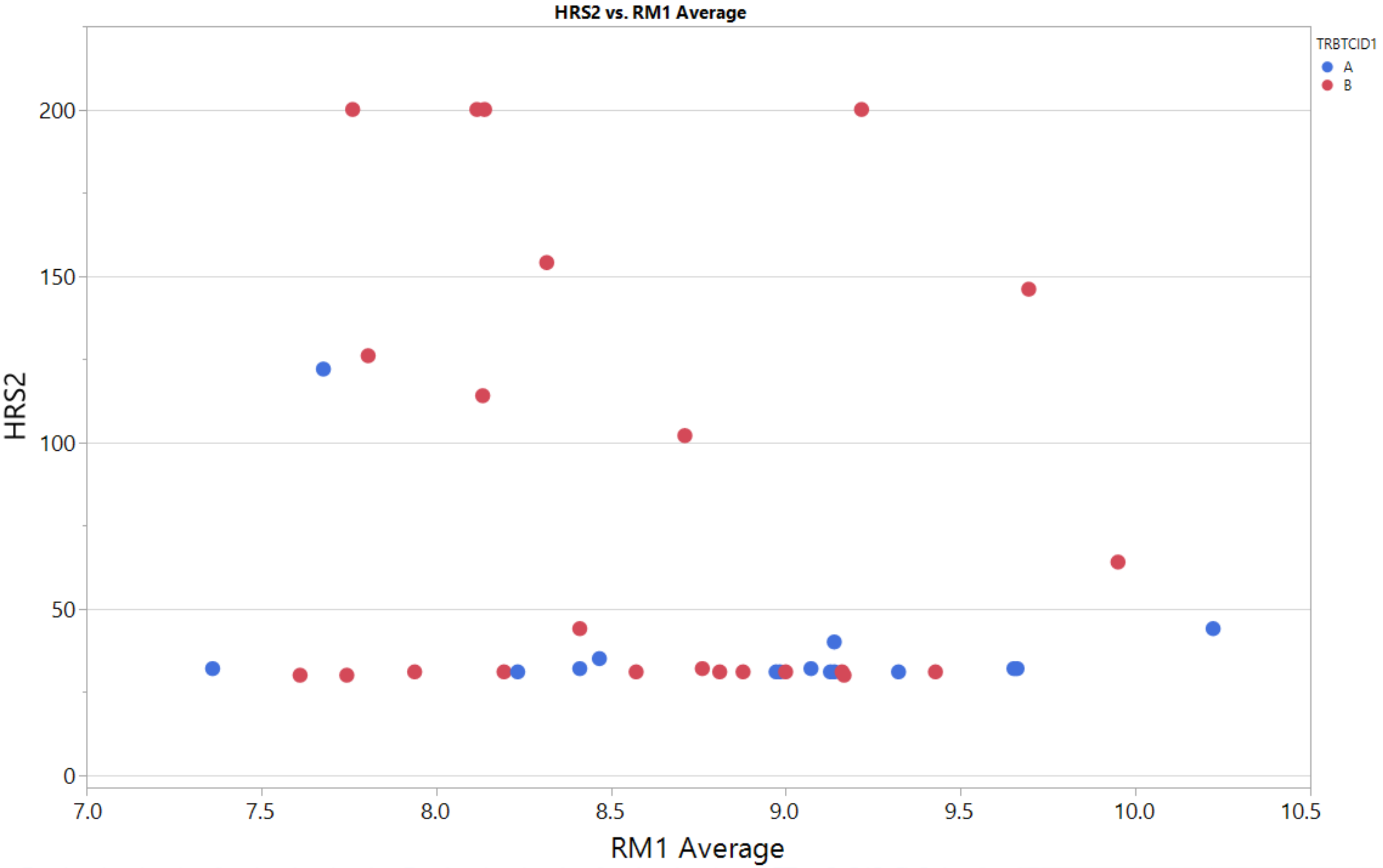
Top Ring RK

Below is a plot of Hours to Scuff vs. Top Ring RK. The RK average is averaged across the 6 cylinders and 3 measurement locations.



Top Ring RM1

Below is a plot of Hours to Scuff vs. Top Ring RM1. The RM1 average is averaged across the 6 cylinders and 3 measurement locations.

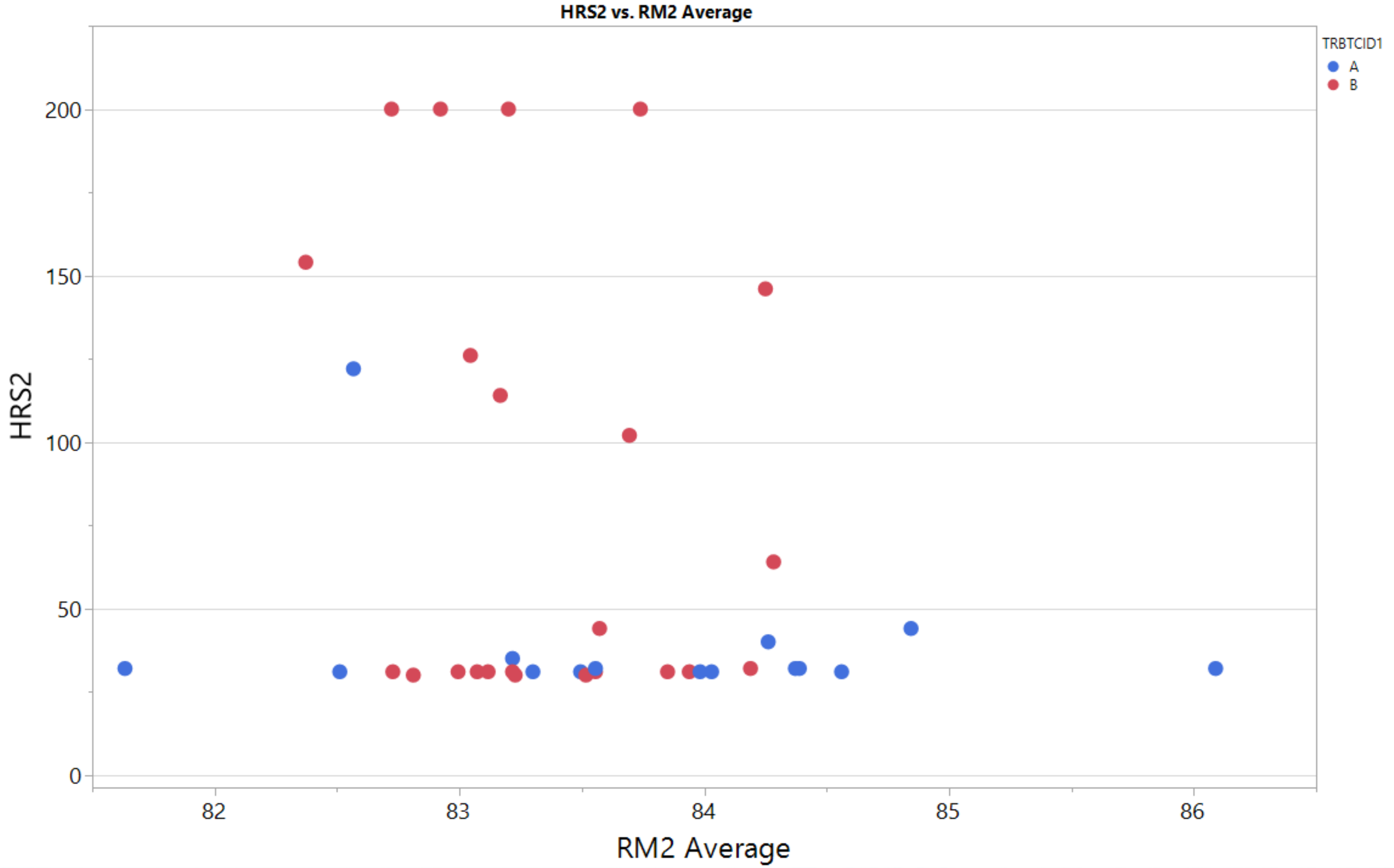


FUELS & LUBRICANTS RESEARCH

swri.org

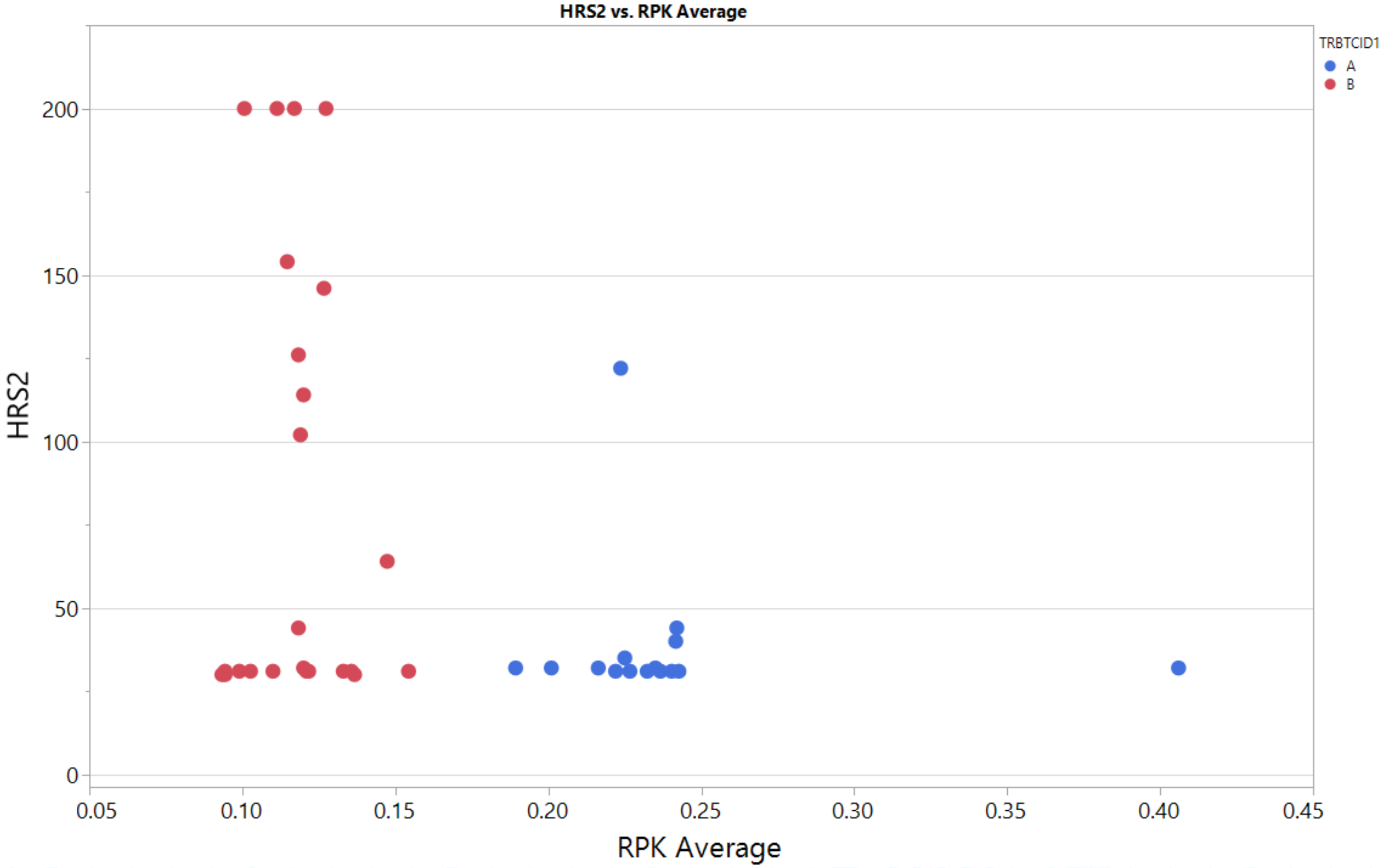
Top Ring RM2

Below is a plot of Hours to Scuff vs. Top Ring RM2. The RM2 average is averaged across the 6 cylinders and 3 measurement locations.



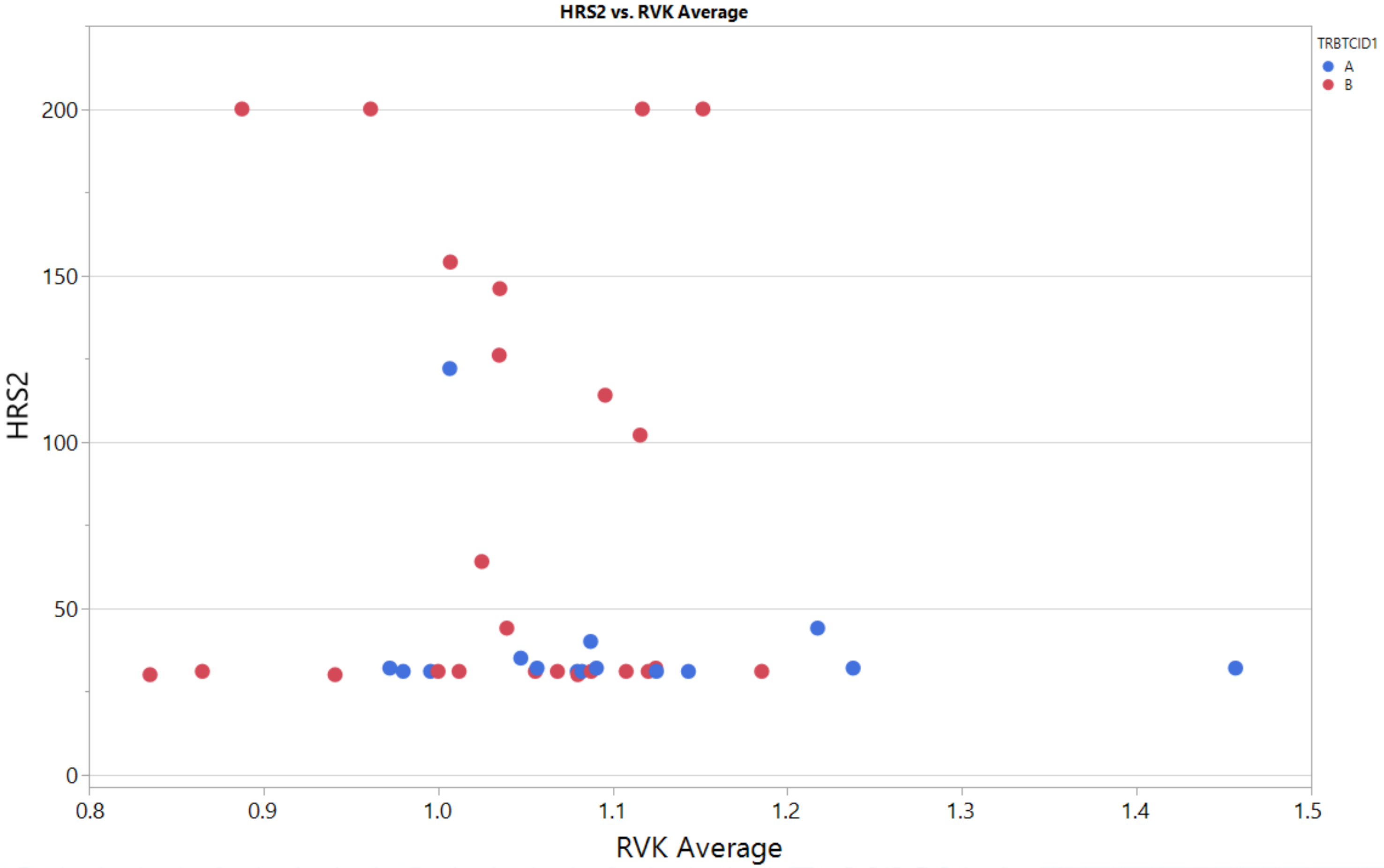
Top Ring RPK

Below is a plot of Hours to Scuff vs. Top Ring RPK. The RPK average is averaged across the 6 cylinders and 3 measurement locations.



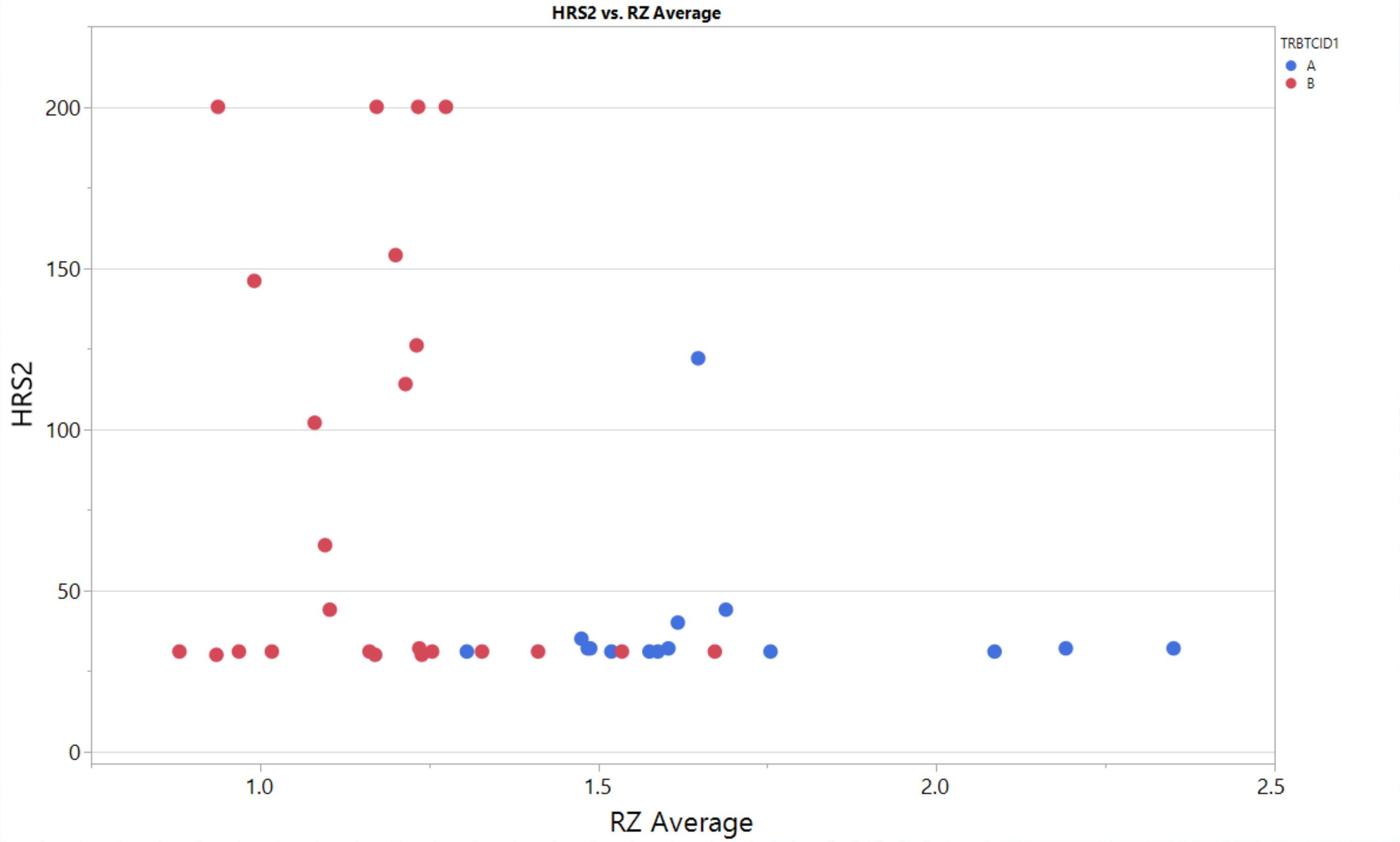
Top Ring RVK

Below is a plot of Hours to Scuff vs. Top Ring RVK. The RVK average is averaged across the 6 cylinders and 3 measurement locations.



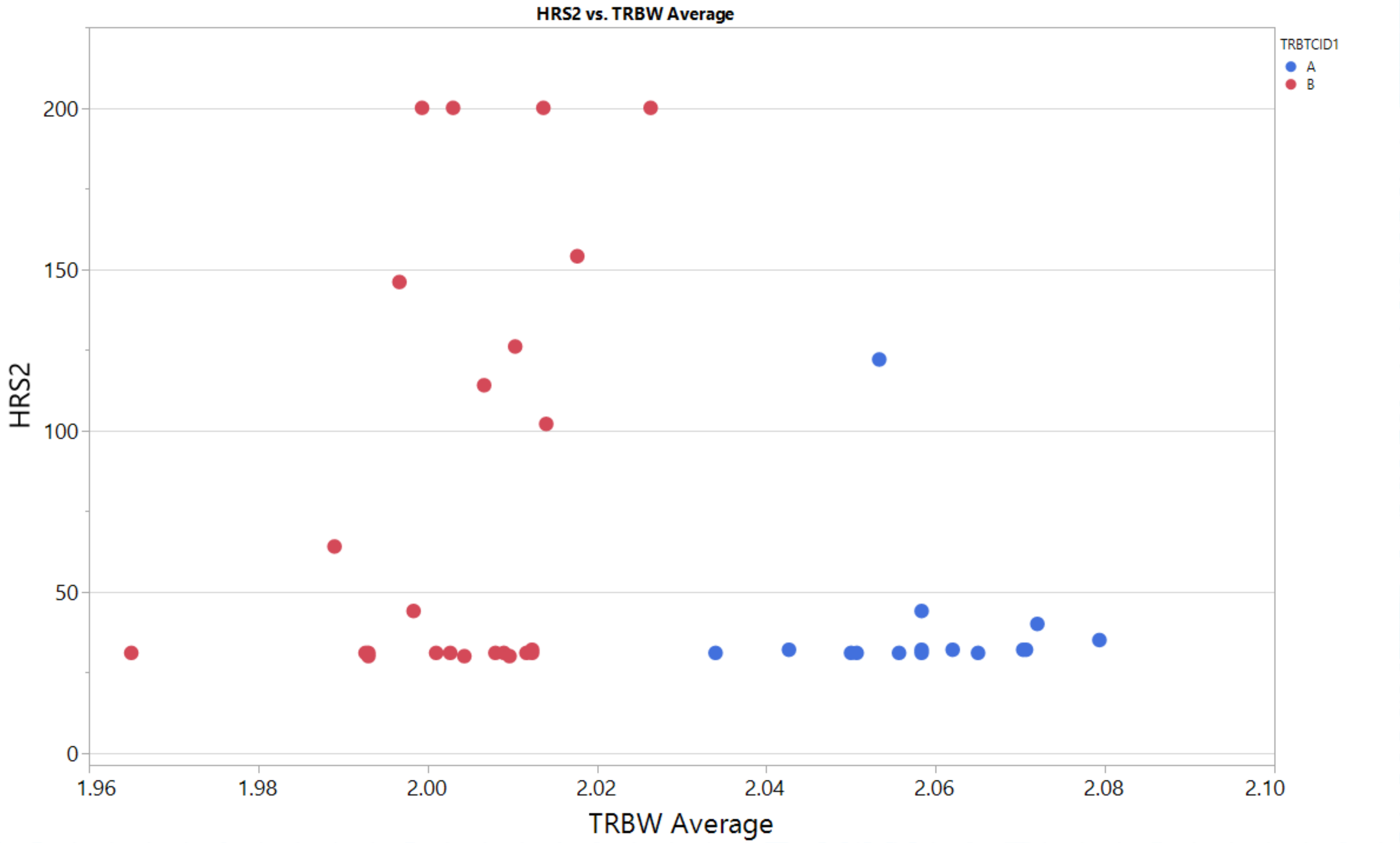
Top Ring RZ

Below is a plot of Hours to Scuff vs. Top Ring RZ. The RZ average is averaged across the 6 cylinders and 3 measurement locations.



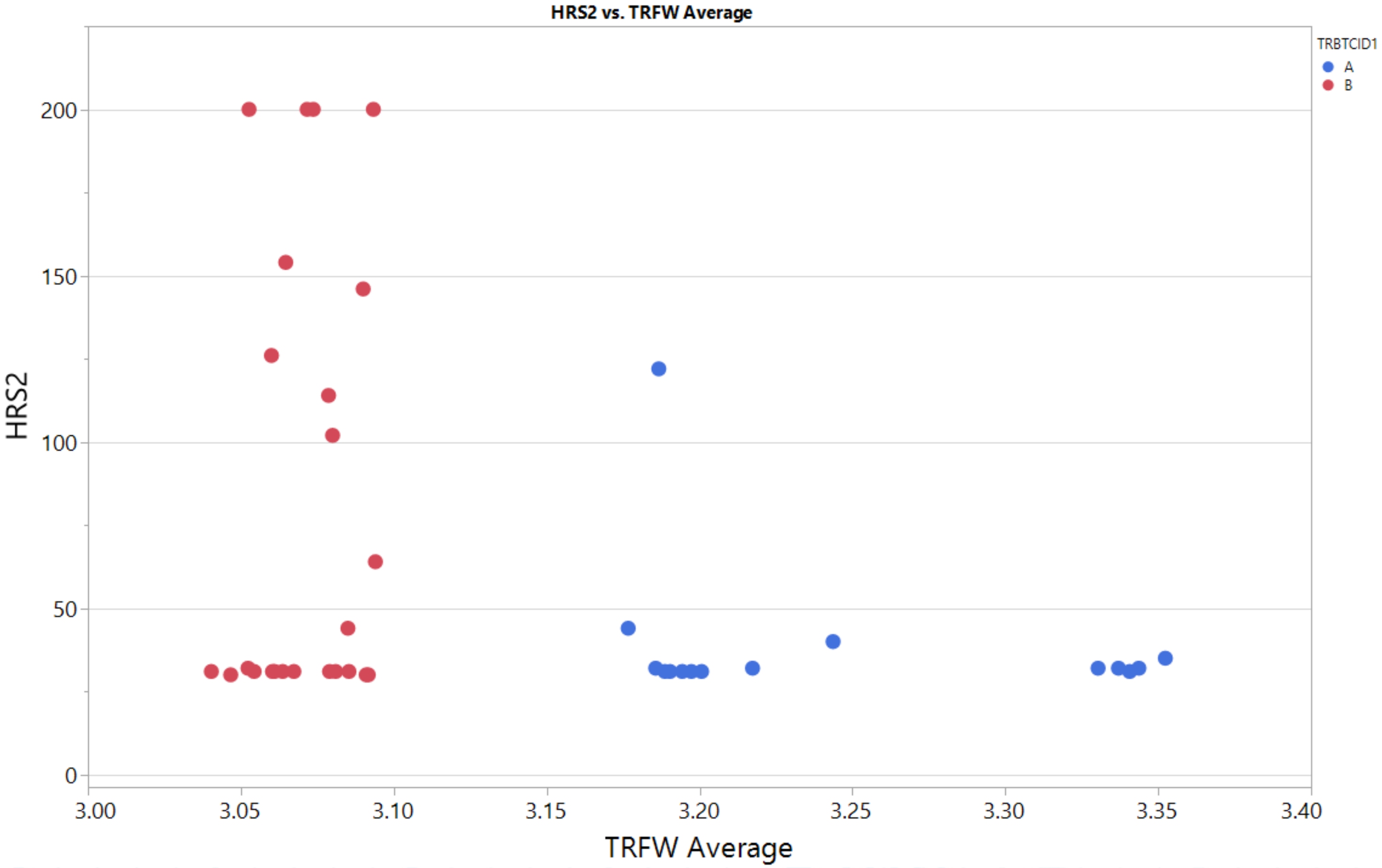
Top Ring Back of Ring Width

Below is a plot of Hours to Scuff vs. Top Ring Back of Ring Width. The width average is averaged across the 6 cylinders and 3 measurement locations.



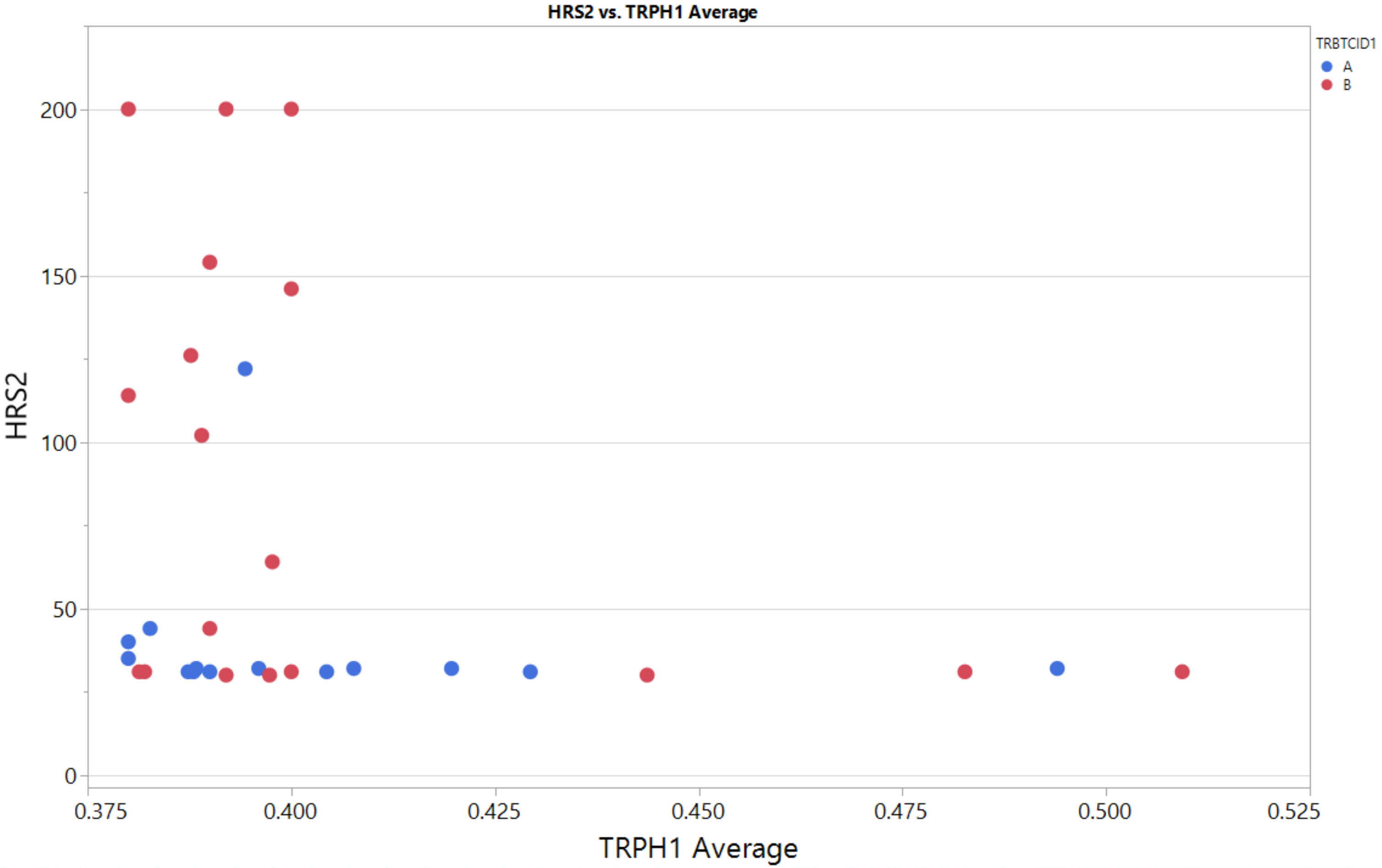
Top Ring Face Width

Below is a plot of Hours to Scuff vs. Top Ring Face Width. The width average is averaged across the 6 cylinders and 3 measurement locations.



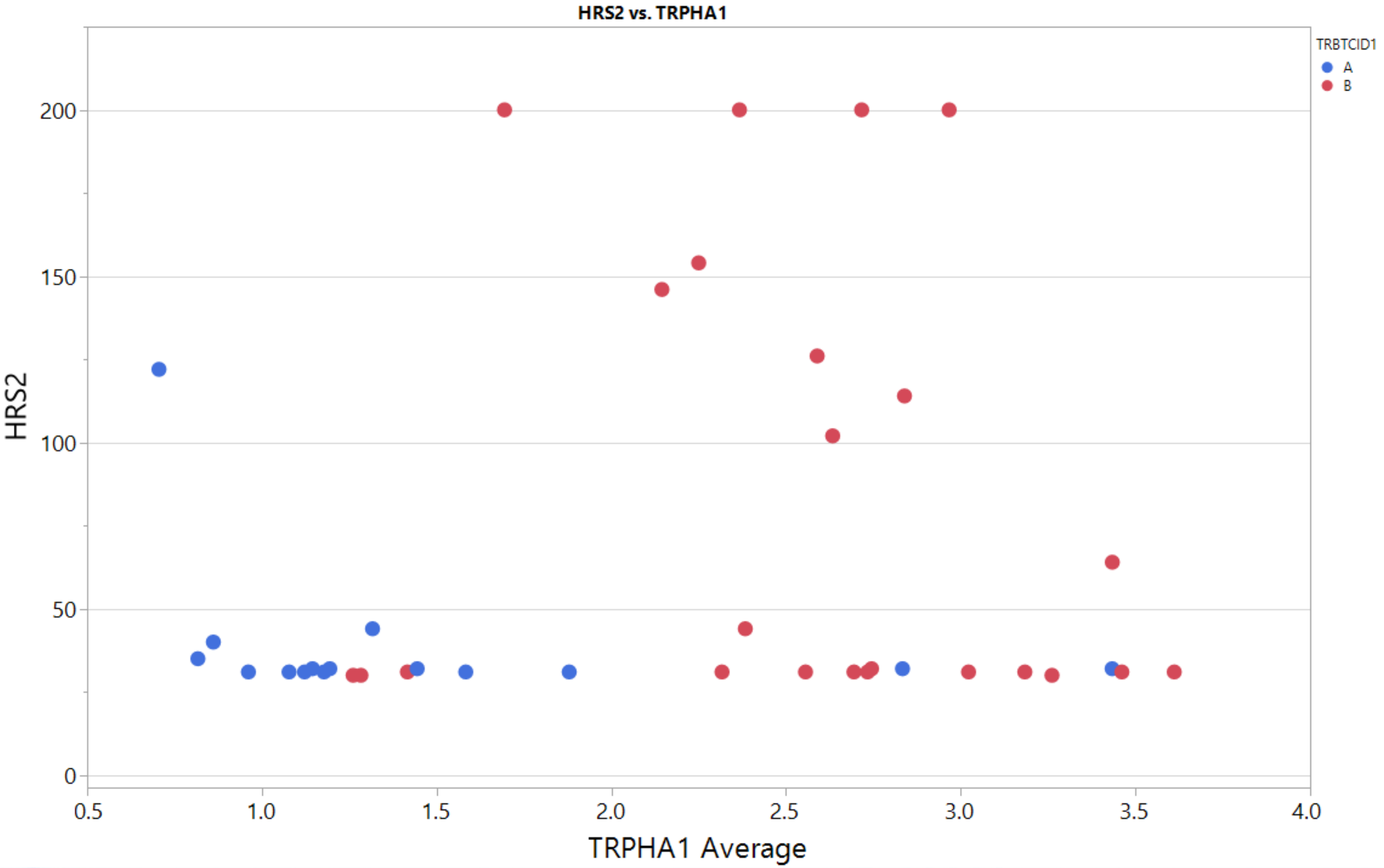
Top Ring Peak Height Cylinder (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Peak Height Cylinder. The height average is averaged across the 6 cylinders and 3 measurement locations.



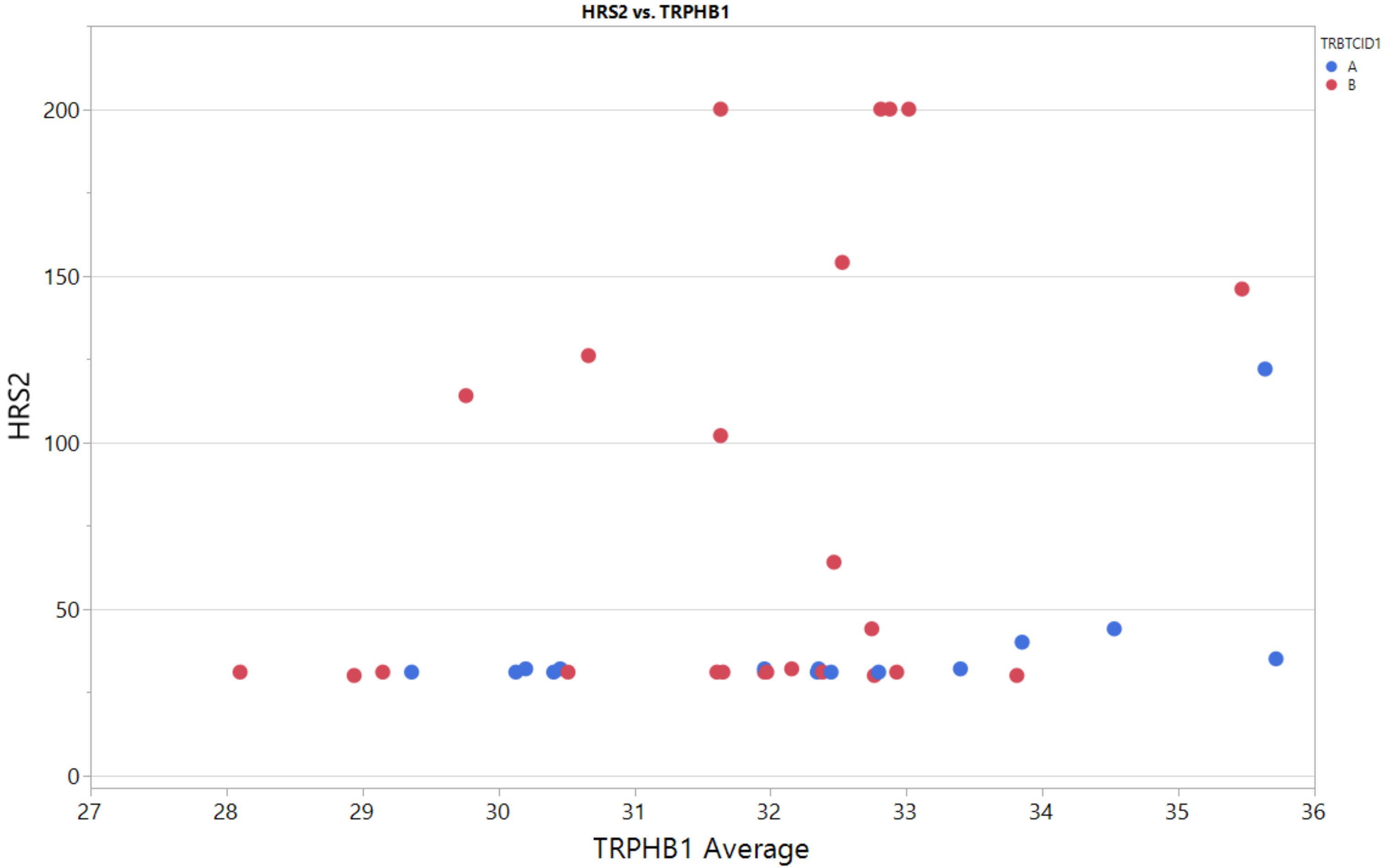
Top Ring Peak Height to 0.2MM (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Peak Height to 0.2 MM. The height average is averaged across the 6 cylinders and 3 measurement locations.



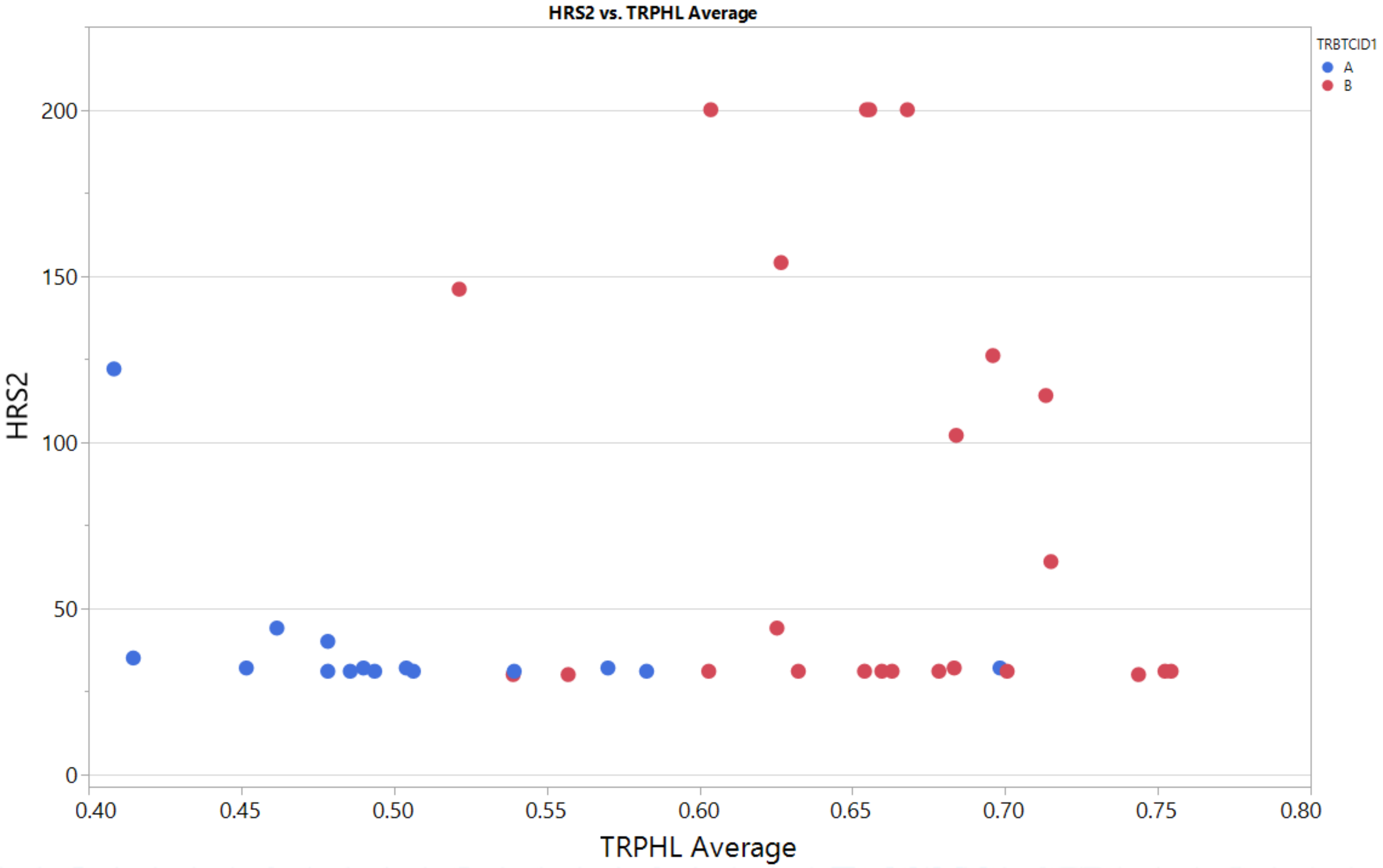
Top Ring Peak Height to 2.75MM (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Peak Height to 2.75 MM. The height average is averaged across the 6 cylinders and 3 measurement locations.



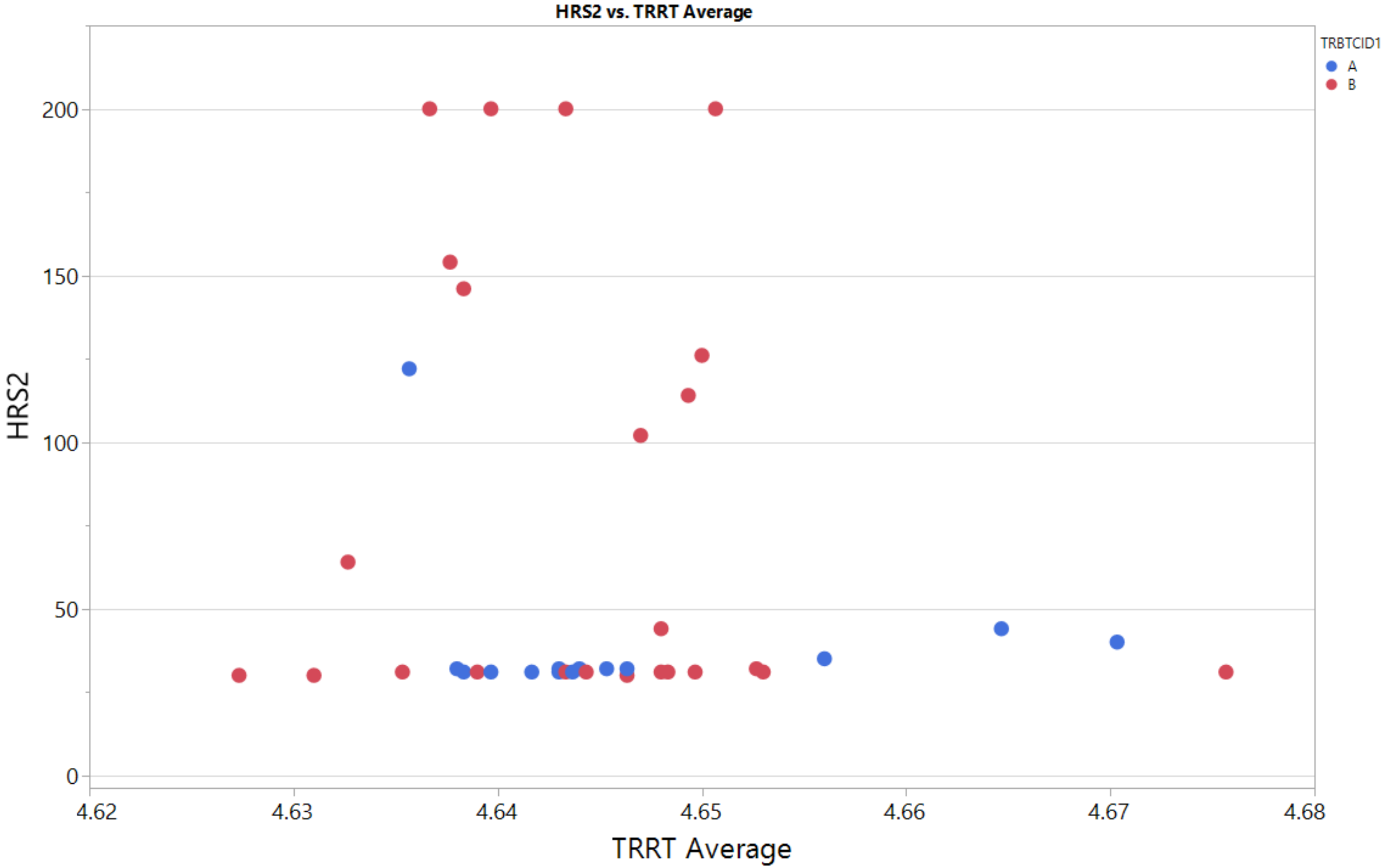
Top Ring Peak Height Location (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Peak Height Location. The height average is averaged across the 6 cylinders and 3 measurement locations.



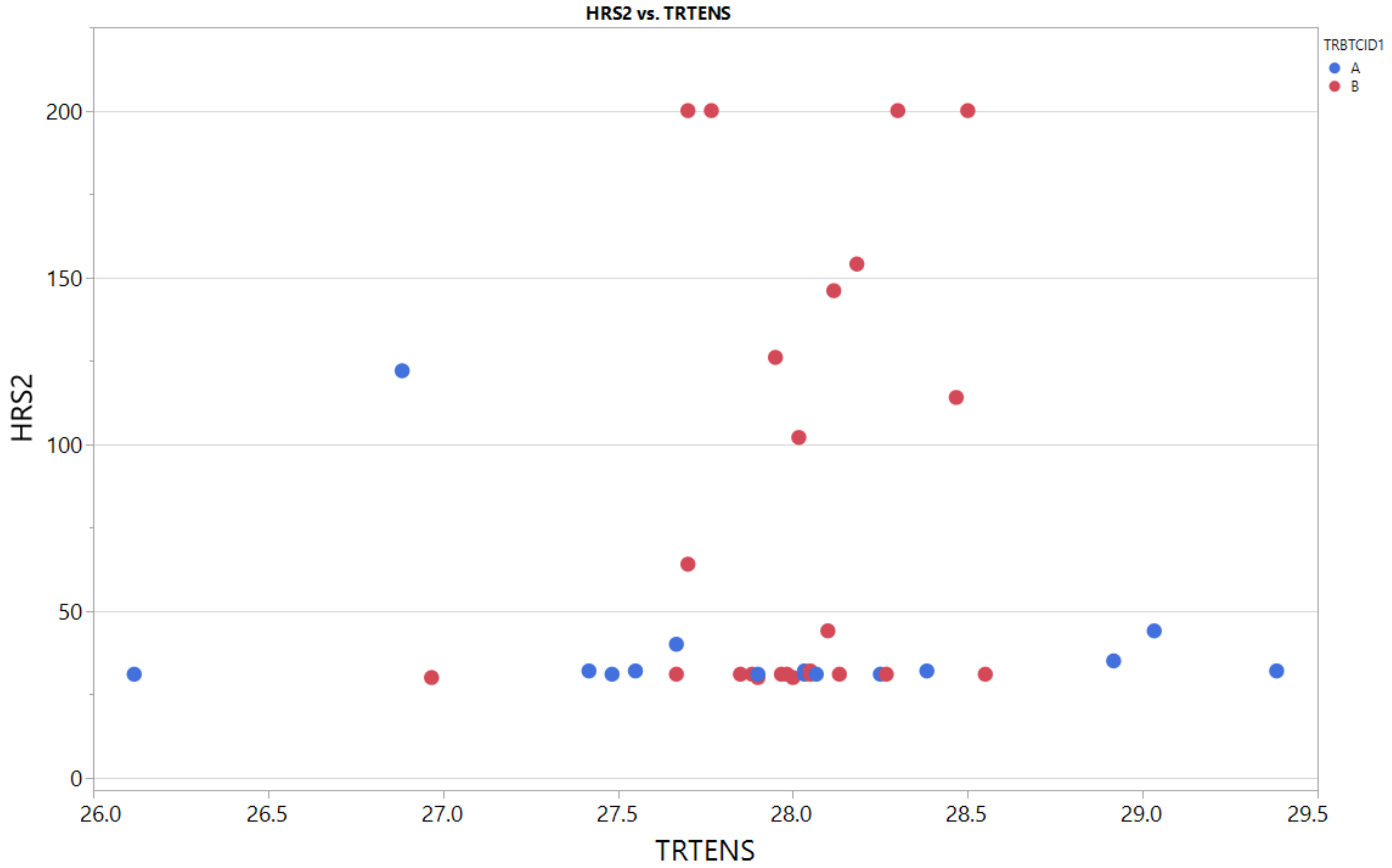
Top Ring Thickness (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Thickness. The thickness average is averaged across the 6 cylinders and 3 measurement locations.



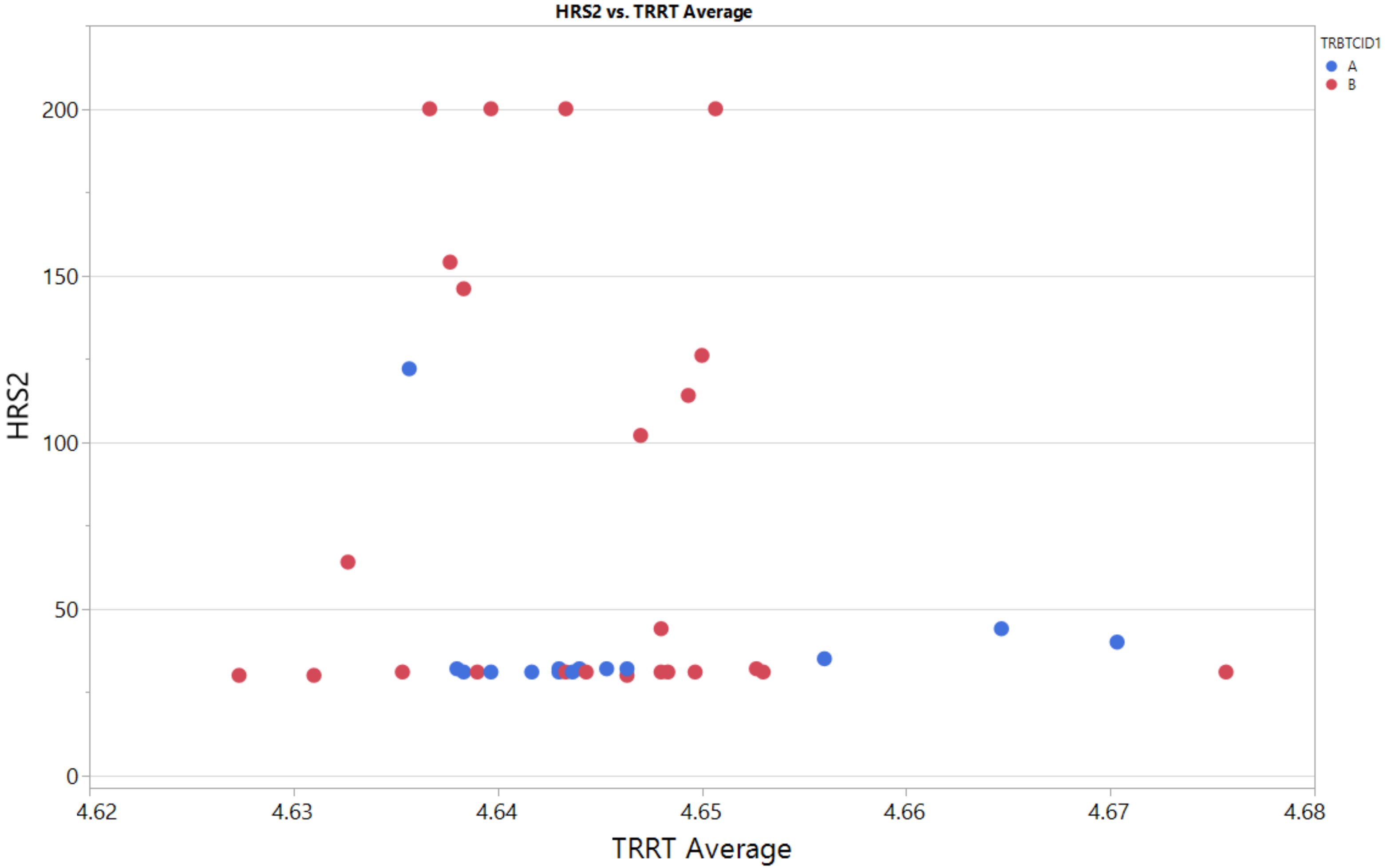
Top Ring Tension (N)

Below is a plot of Hours to Scuff vs. Top Ring Tension. The tension average is averaged across the 6 cylinders.



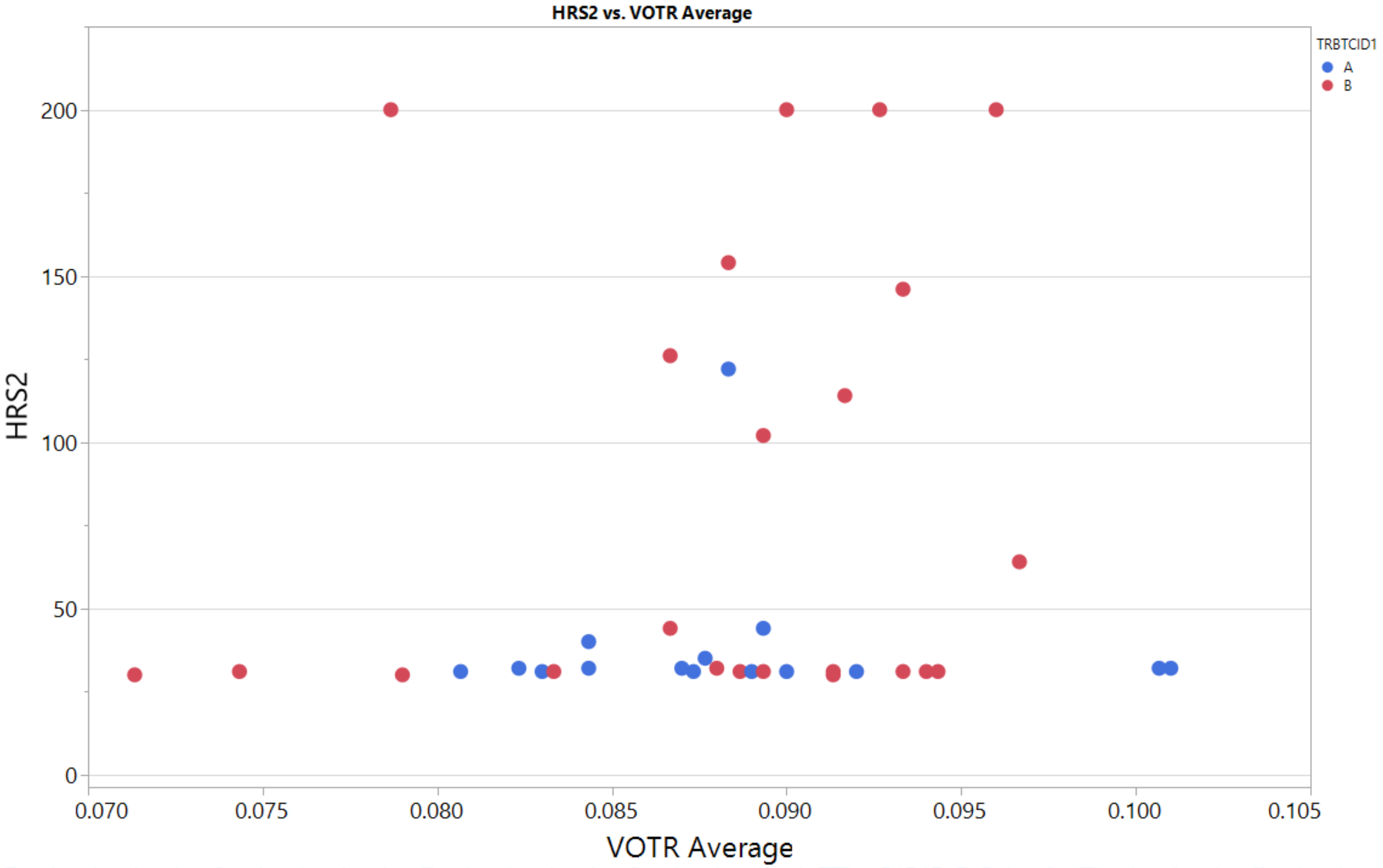
Top Ring Thickness (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Thickness. The thickness average is averaged across the 6 cylinders and 3 measurement locations.



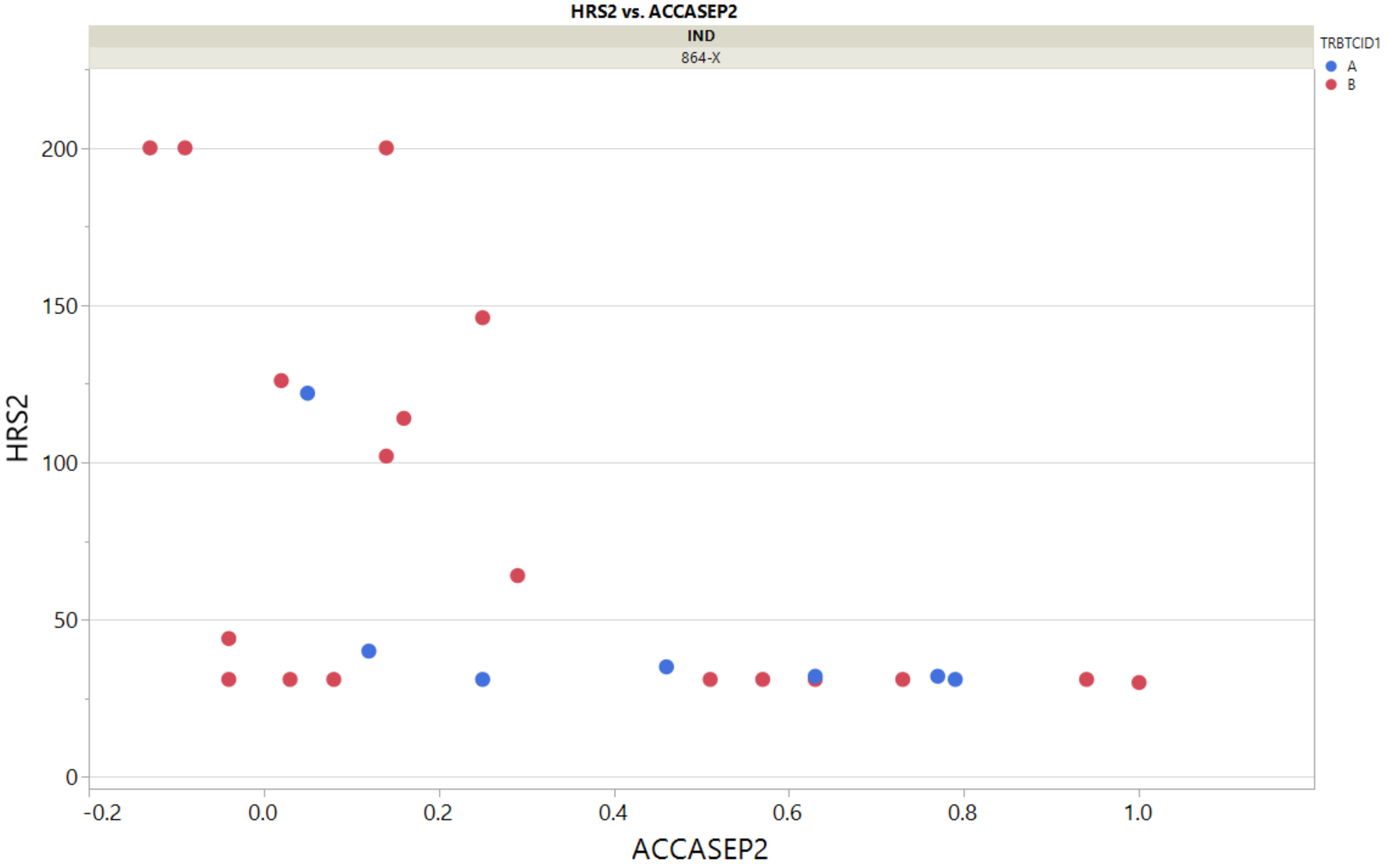
Top Ring Vo (micrometers)

Below is a plot of Hours to Scuff vs. Top Ring Vo. The Vo average is averaged across the 6 cylinders and 3 measurement locations.



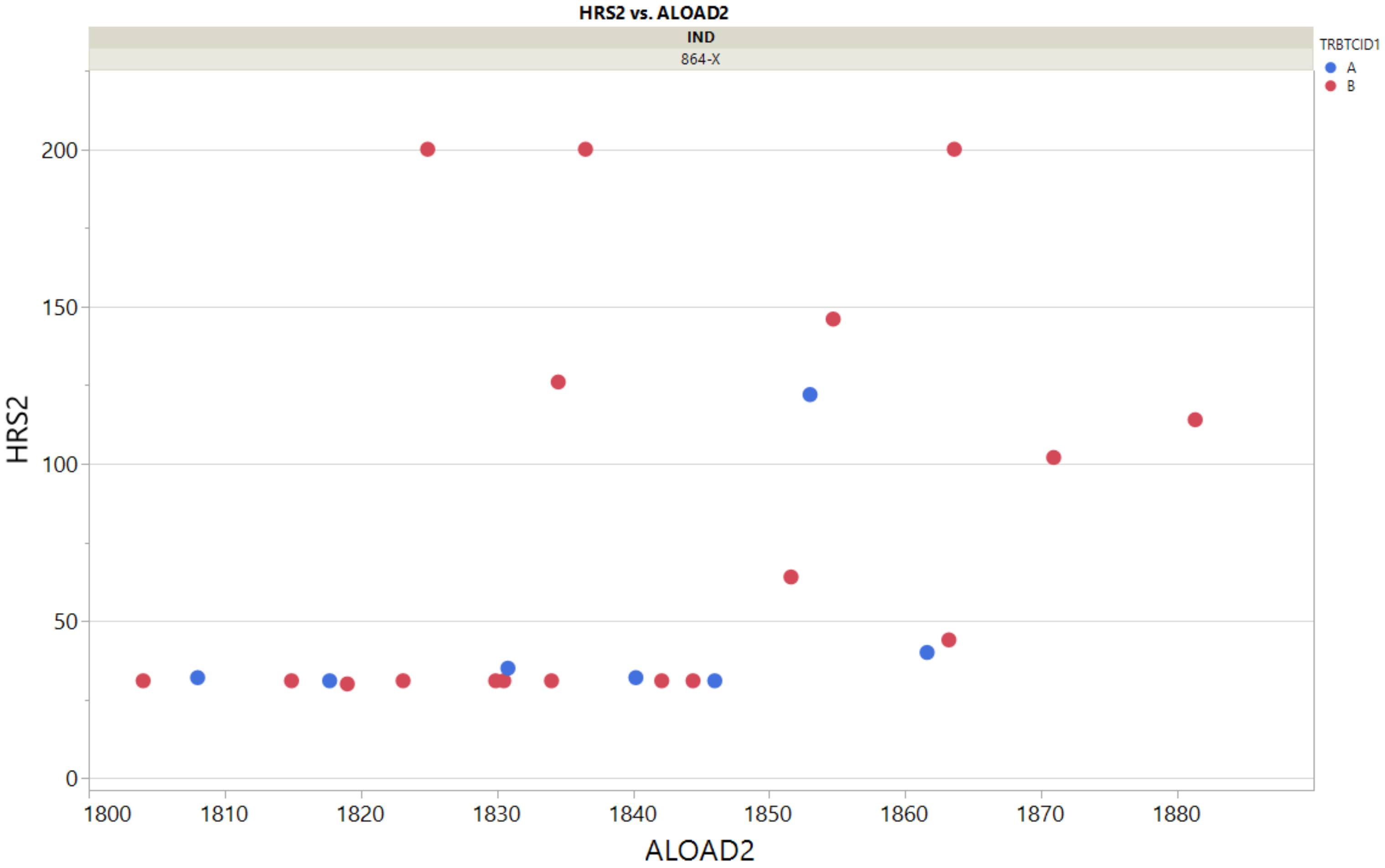
Avg. Crankcase Pressure Stage 2

Mild results tend to have lower stage 2 crankcase pressure.



Average Load Stage 2 (Nm)

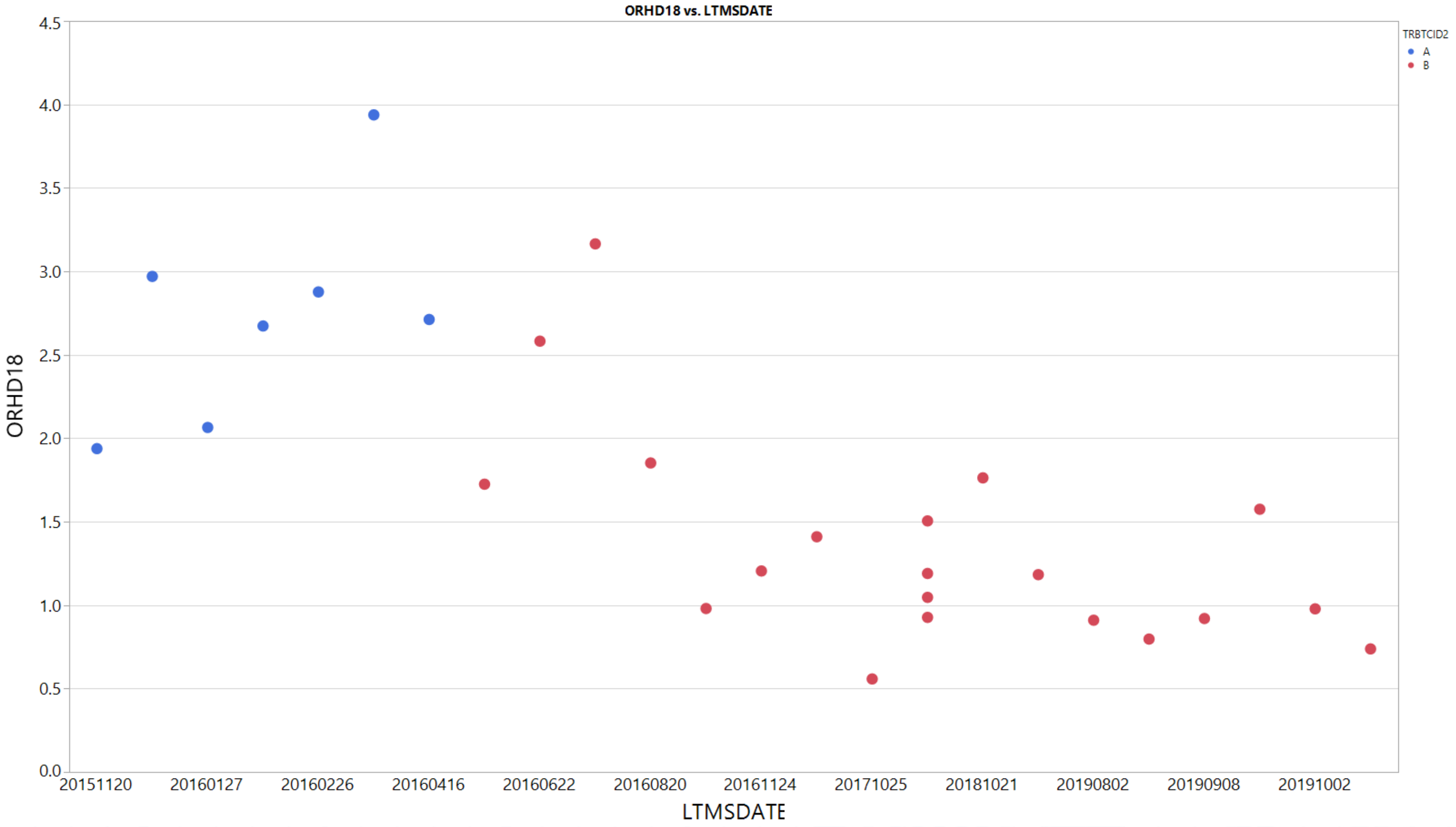
Tests with average load > 1850 Nm were mild.



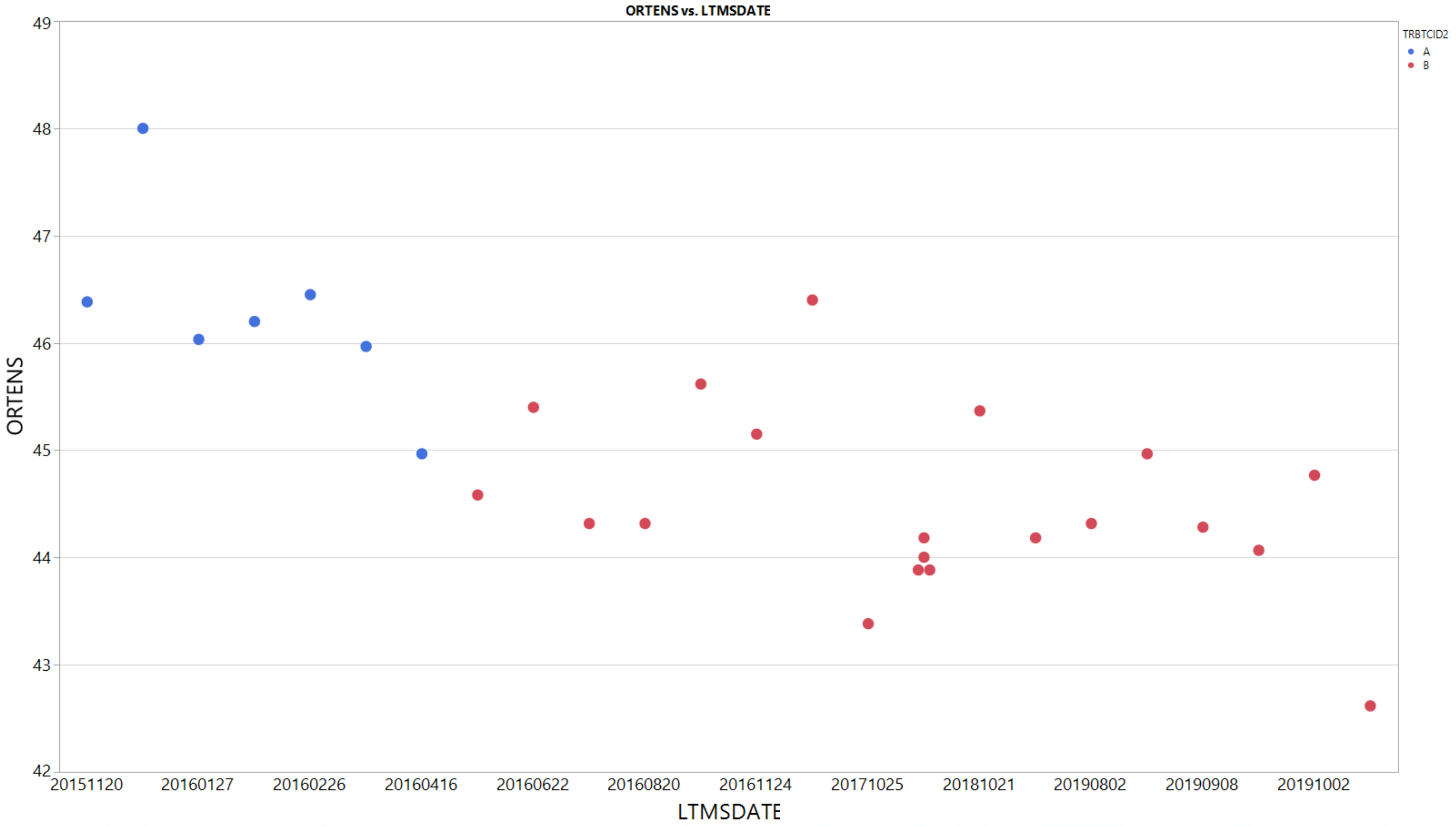
Measurement Device Calibrations?

Many Parameters appear to be drifting down over time, suggesting some of the observed differences may be due to instrument calibration. This is demonstrated for a few parameters in the following slides.

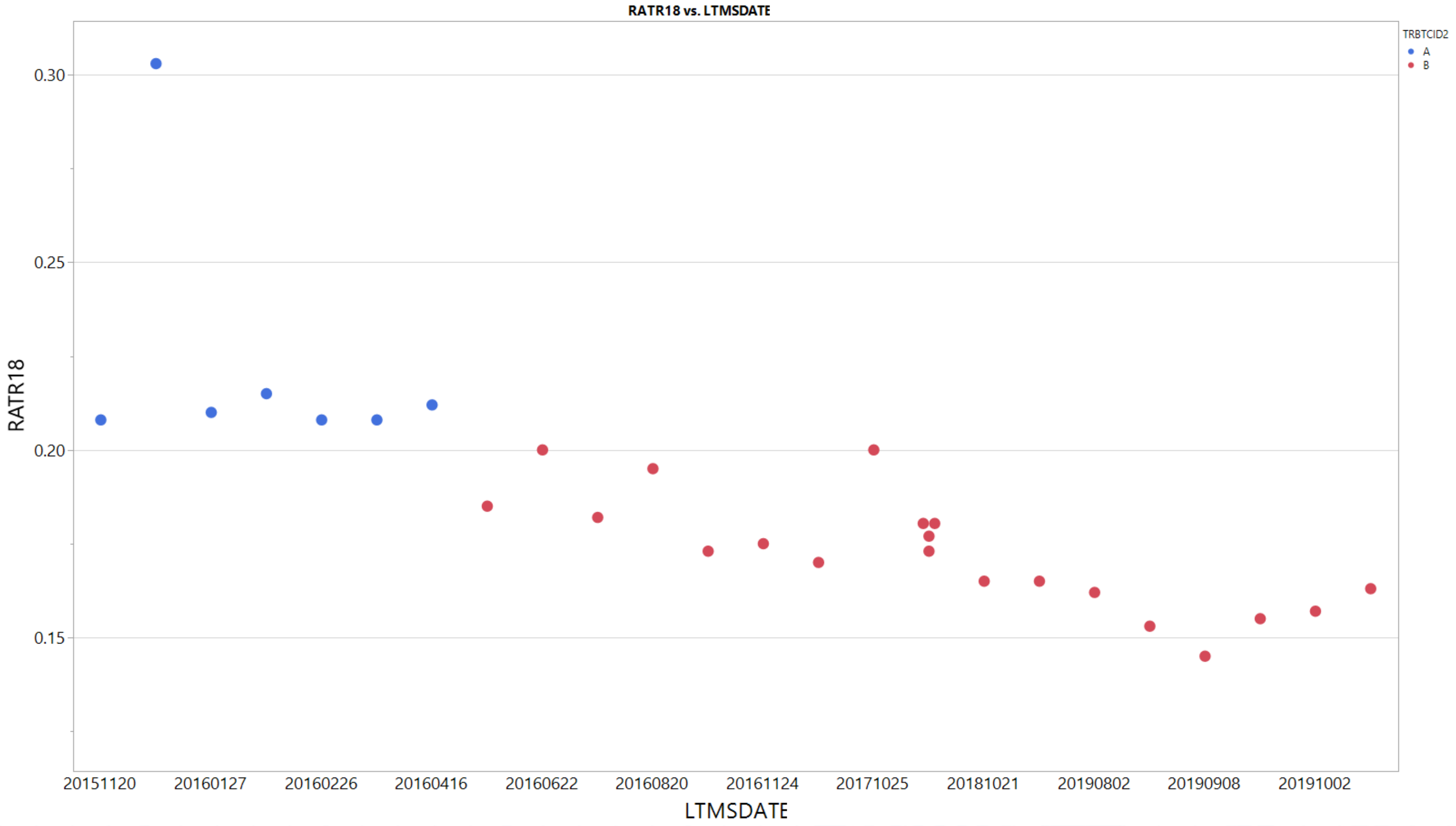
Oil Ring Rail Height



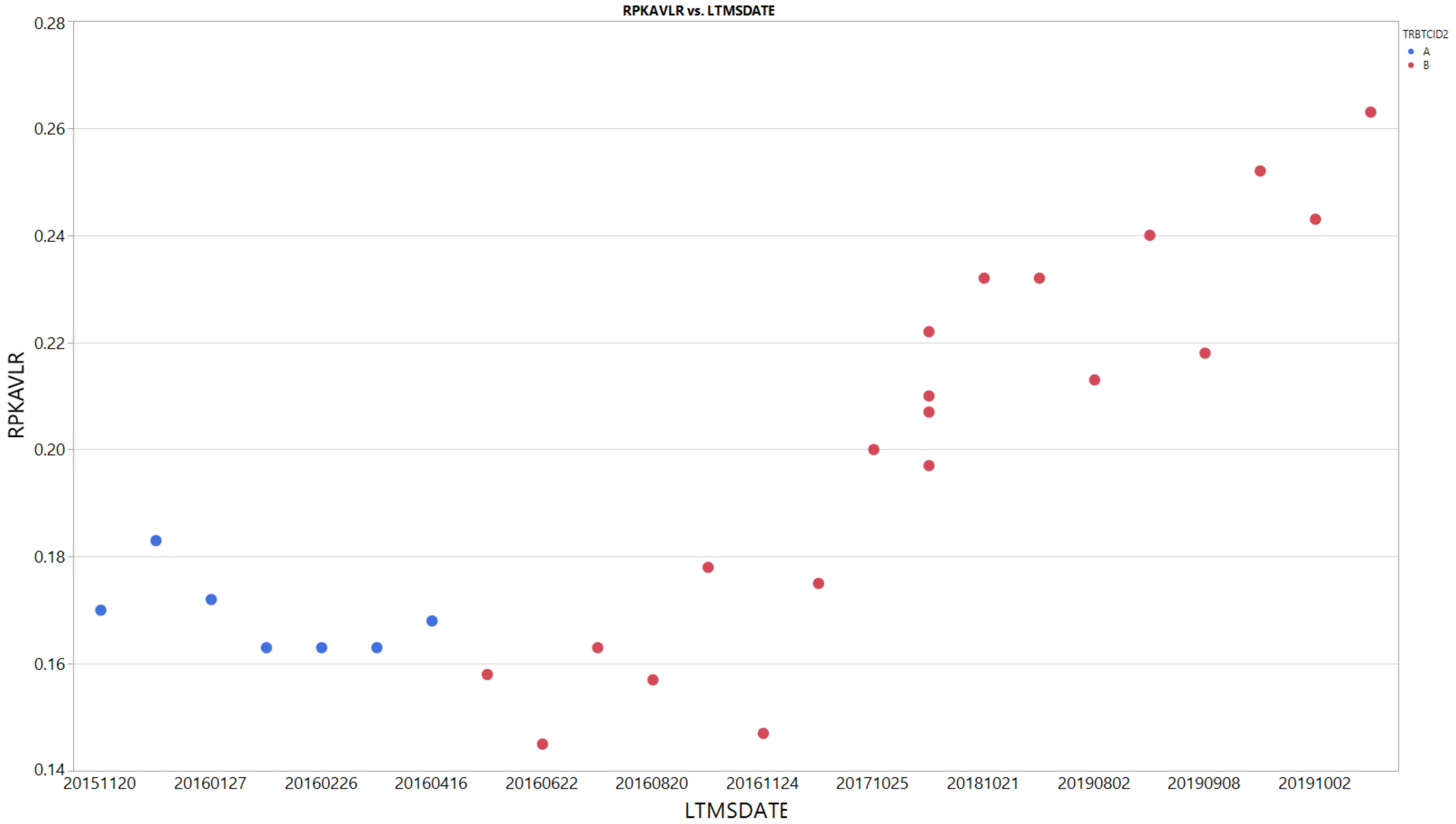
Oil Ring Tension



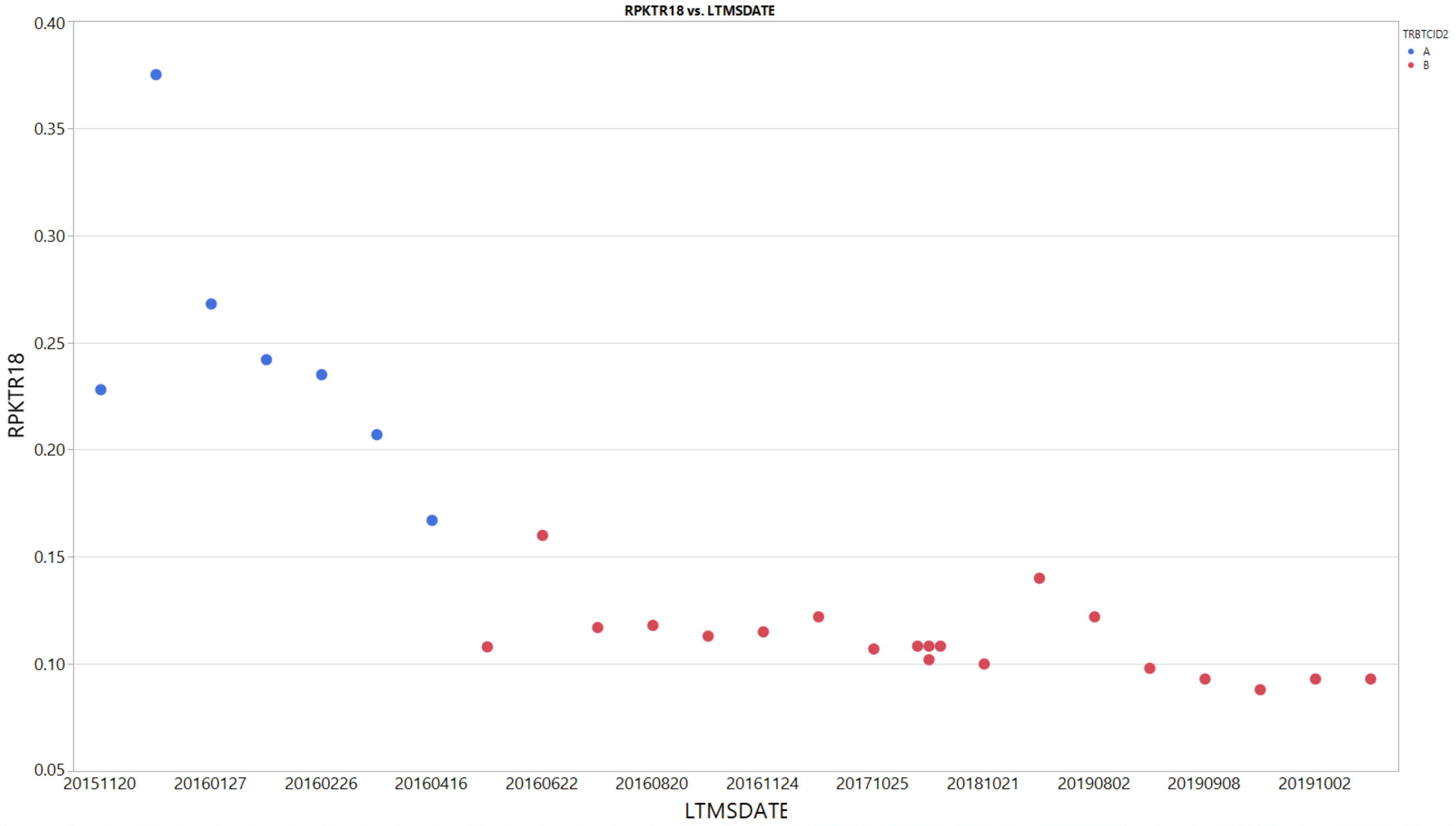
Top Ring RA


RATR18 vs. LTMSDATE
TRBTCID2
● A
● B
RATR18
0.30
0.25
0.20
0.15
20151120
20160127
20160226
20160416
20160622
20160820
20161124
20171025
20181021
20190802
20190908
20191002
LTMSDATE

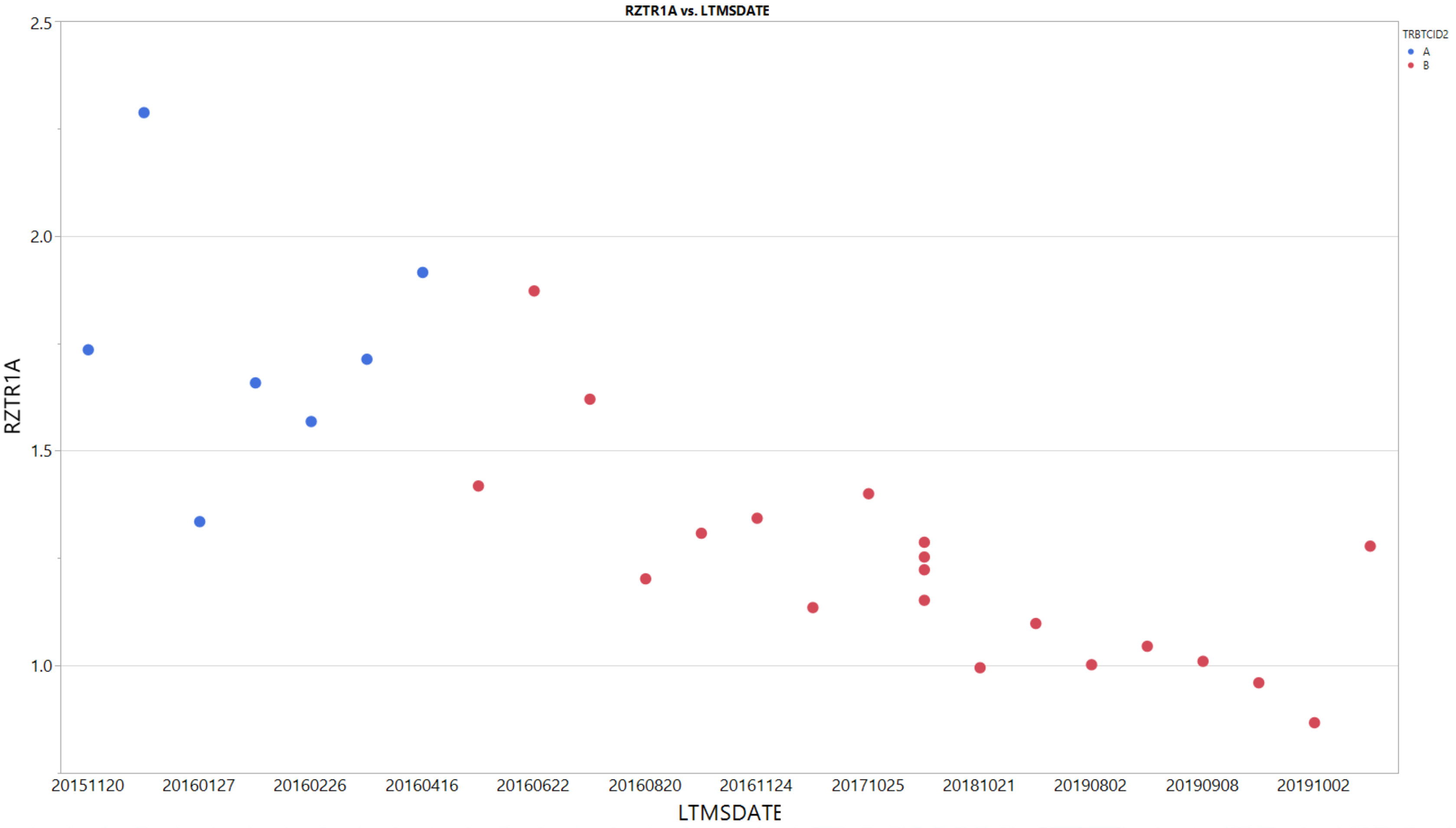
Liner RPK


RPKAVLR vs. LTMSDATE
RPKAVLR
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
LTMSDATE
20151120
20160127
20160226
20160416
20160622
20160820
20161124
20171025
20181021
20190802
20190908
20191002
TRBTCID2
● A
● B

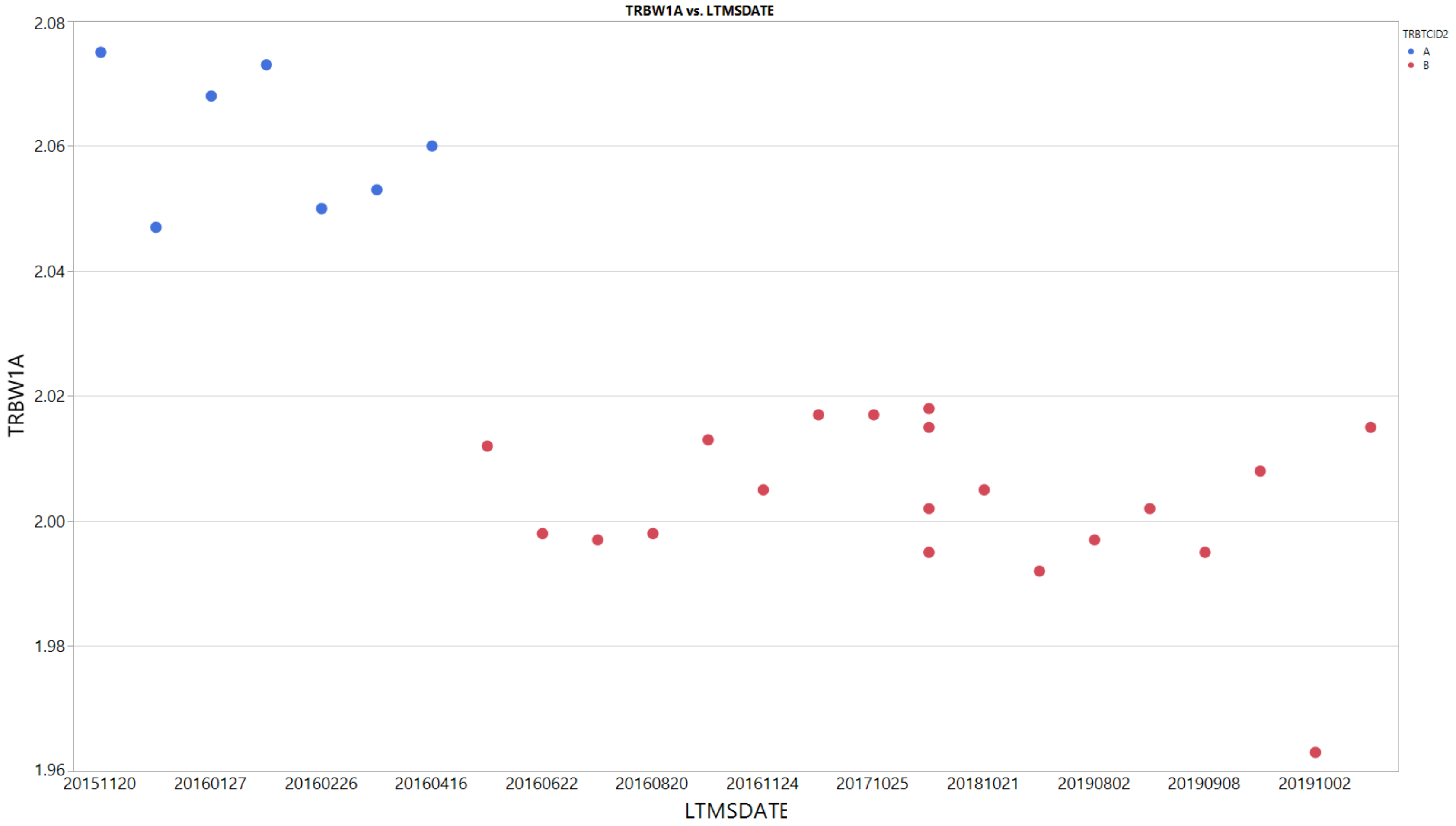
Top Ring RPK


RPKTR18 vs. LTMSDATE
RPKTR18
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
LTMSDATE
20151120
20160127
20160226
20160416
20160622
20160820
20161124
20171025
20181021
20190802
20190908
20191002
TRBTCID2
● A
● B

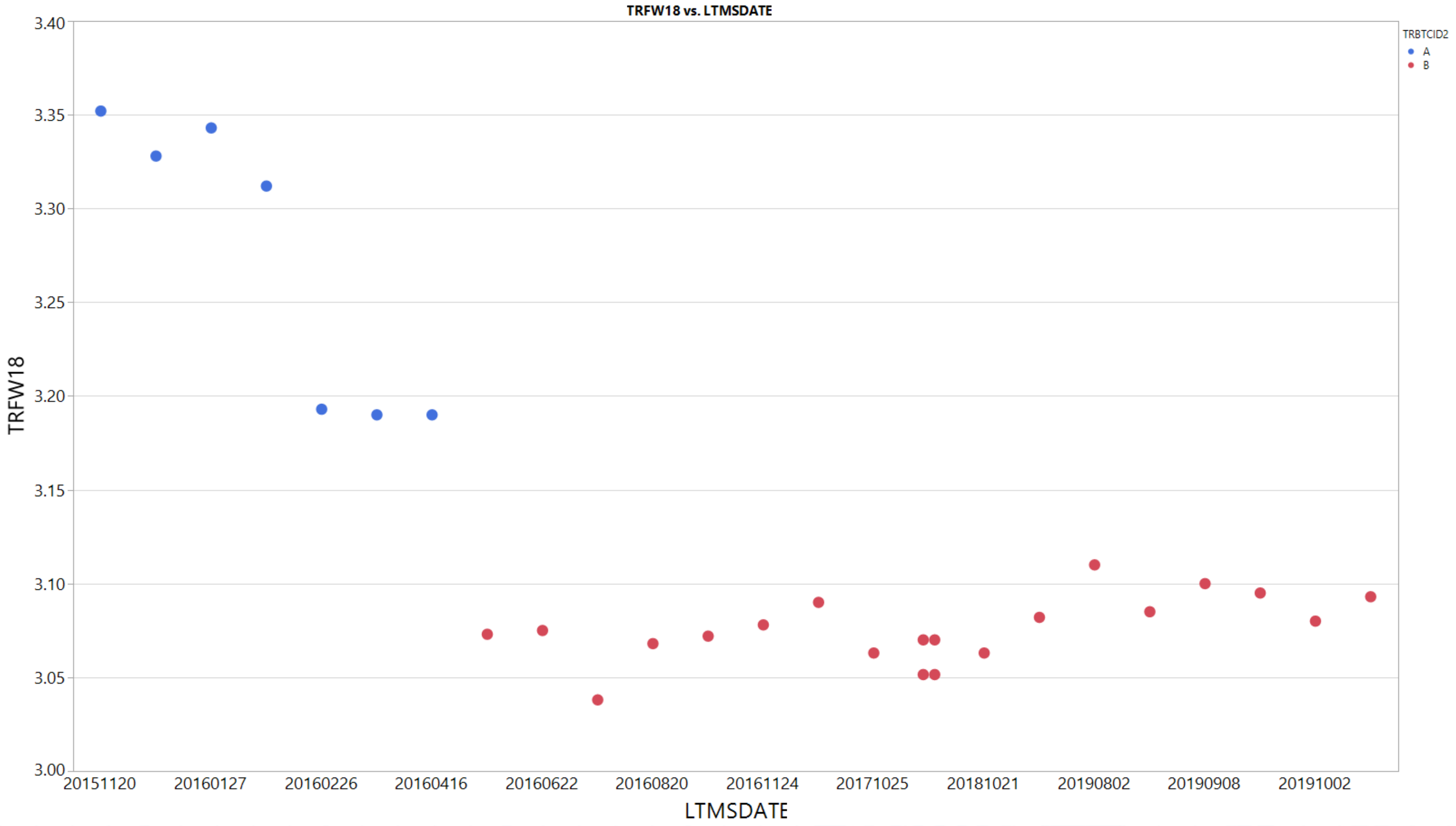
Top Ring RZ


RZTR1A vs. LTMSDATE
RZTR1A
2.5
2.0
1.5
1.0
LTMSDATE
20151120
20160127
20160226
20160416
20160622
20160820
20161124
20171025
20181021
20190802
20190908
20191002
TRBTCID2
● A
● B

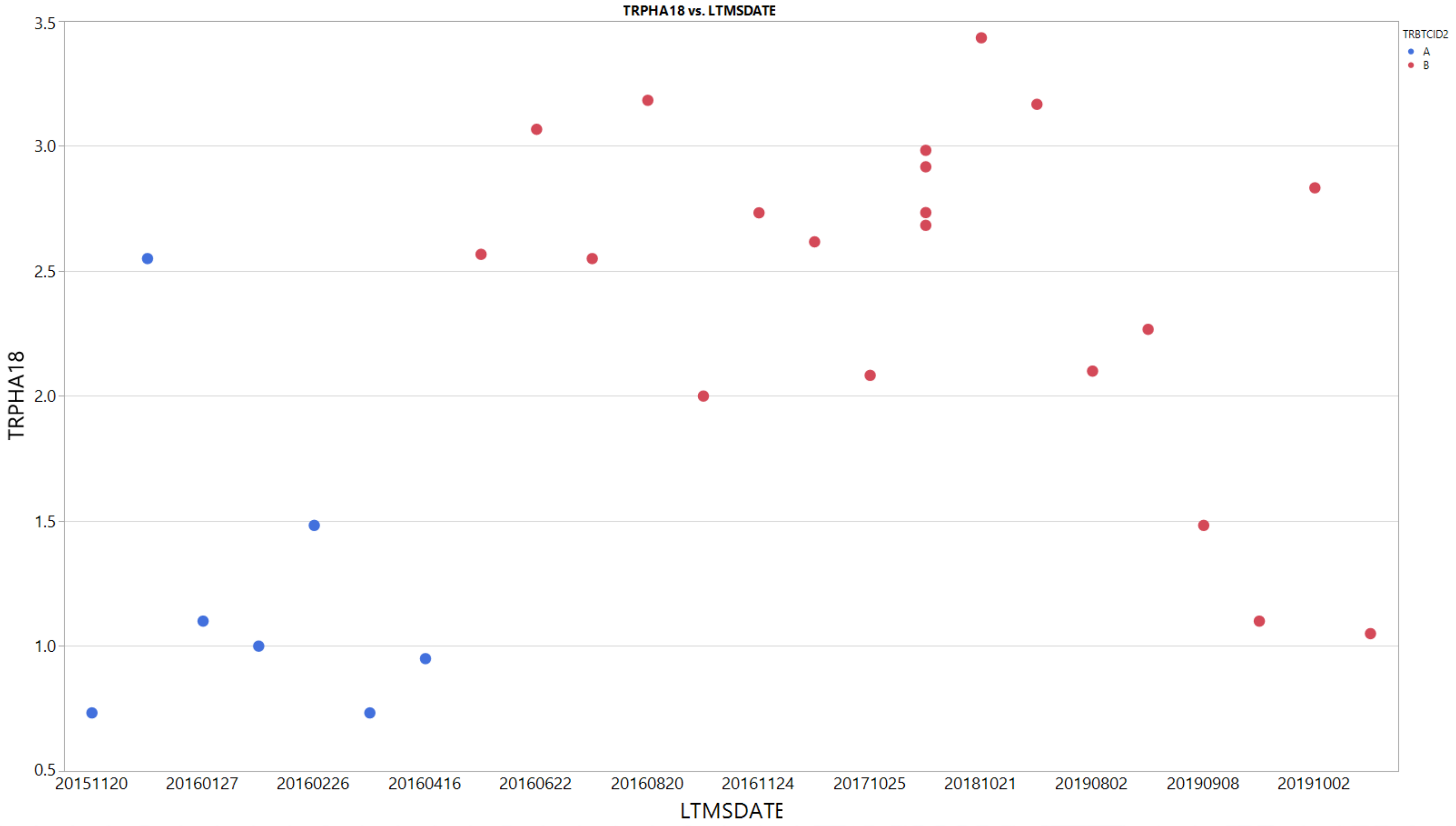
Top Ring Back of Ring Width



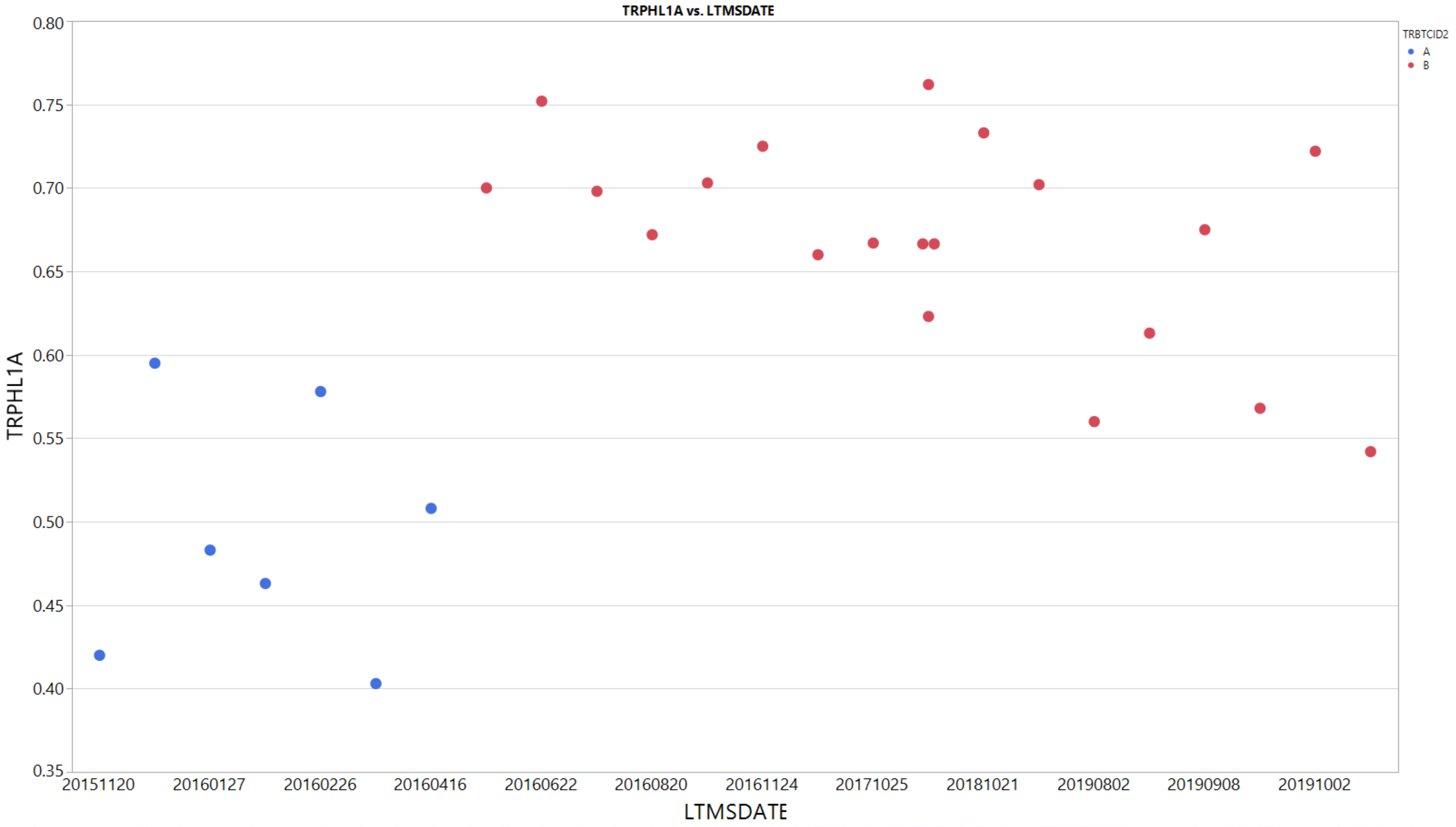
Top Ring Face Width



Top Ring Gap Peak Height to 0.2 MM



Top Ring Gap Peak Height Location



FUELS & LUBRICANTS RESEARCH

swri.org