

Ford LSPI Prove Out Analysis

12-17-15

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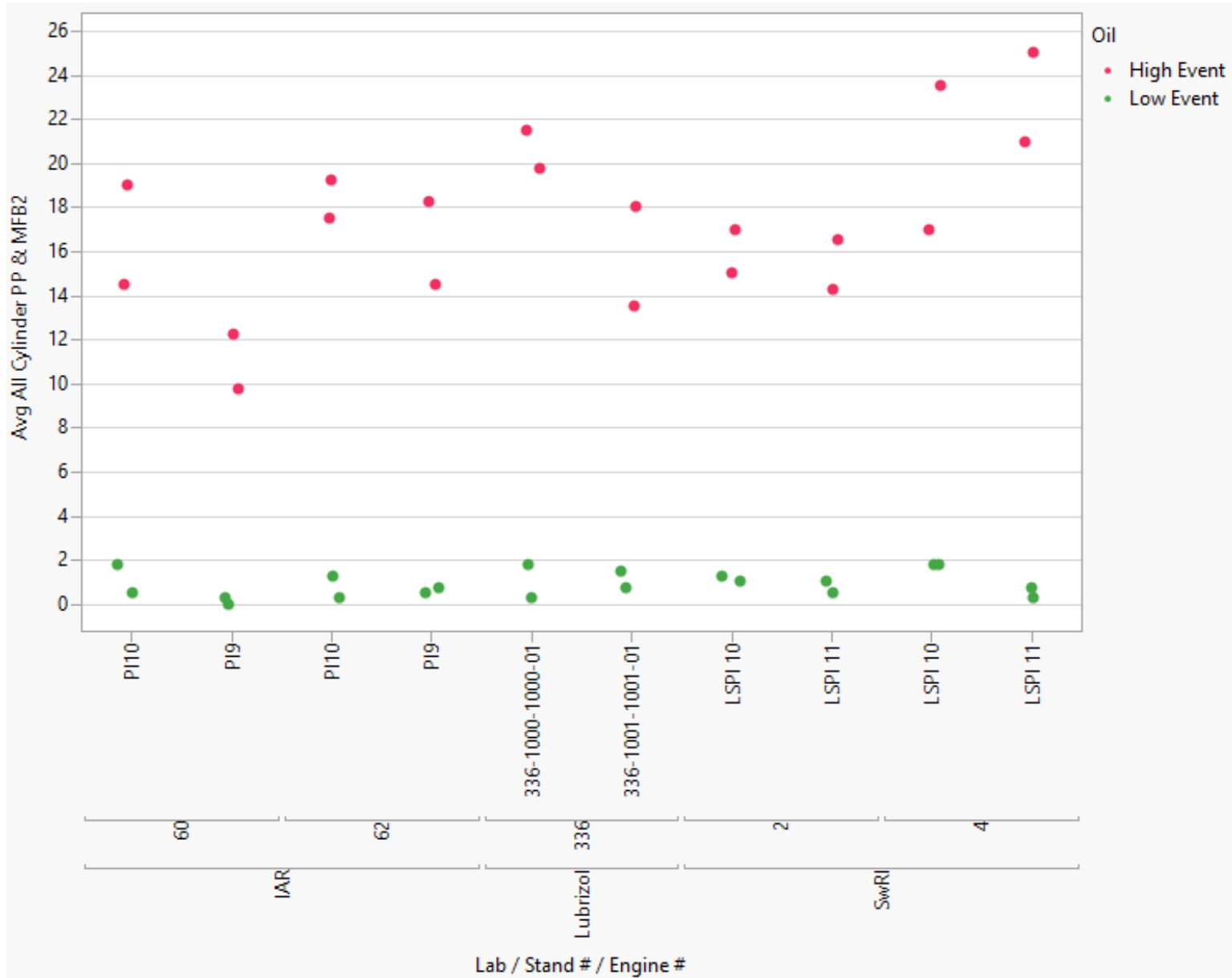
Overview

- 40 tests included
 - 16 IAR (2 stands; 8 tests per stand; 2 engine builds per stand)
 - 16 SwRI (2 stands; 8 tests per stand; 2 engine builds per stand)
 - 8 LZ (1 stand; 2 engine builds)
- 2 oils tested (low event oil and high event oil)
 - Each oil tested in duplicate within each stand-engine build combination

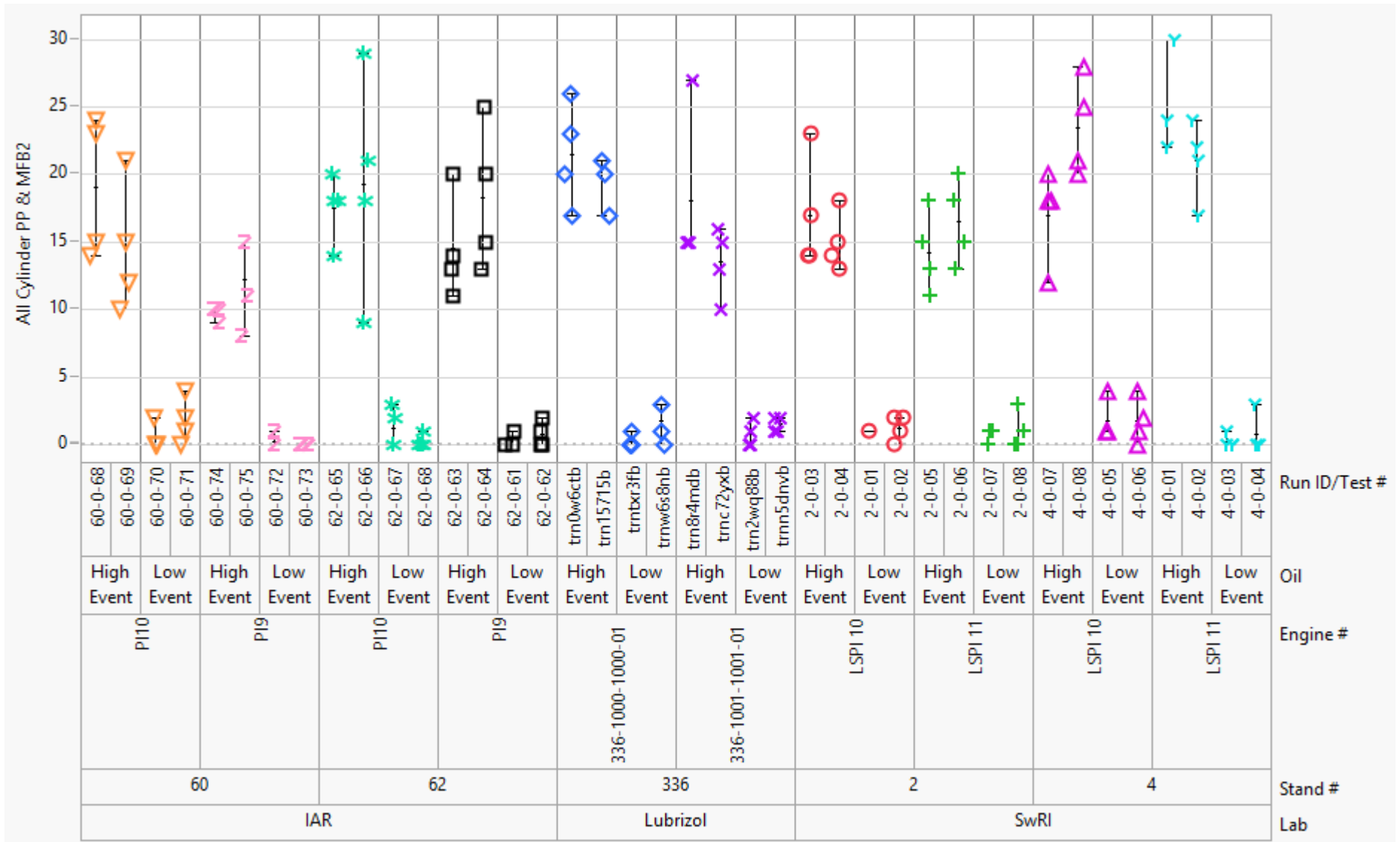
Data Table

Lab	Stand #	Engine #	Run ID/Test #	Oil	Previous Oil	Engine Block Run Hours (at test start)	Cylinder Head Run Hours (at test start)	Avg All Cylinder PP & MFB2	sqrt(LSPI + 0.5)	Test Start Time	Test Start Date	EOT Date
IAR	60	PI10	60-0-68	High Event	None	8	8	19	4.415880433	16:30	10/20/2015	10/22/2015
IAR	60	PI10	60-0-69	High Event	High Event	24	24	14.5	3.872983346	9:32	10/22/2015	10/23/2015
IAR	60	PI10	60-0-70	Low Event	High Event	42	42	0.5	1	15:46	10/23/2015	10/24/2015
IAR	60	PI10	60-0-71	Low Event	Low Event	58	58	1.75	1.5	13:57	10/24/2015	10/26/2015
IAR	60	PI9	60-0-72	Low Event	Low Event	72	72	0.25	0.866025404	14:43	10/27/2015	10/28/2015
IAR	60	PI9	60-0-73	Low Event	Low Event	88	88	0	0.707106781	17:28	10/27/2015	10/29/2015
IAR	60	PI9	60-0-74	High Event	Low Event	104	104	9.75	3.201562119	18:07	10/29/2015	10/30/2015
IAR	60	PI9	60-0-75	High Event	High Event	120	120	12.25	3.570714214	21:04	10/30/2015	10/31/2015
IAR	62	PI10	62-0-65	High Event	High Event	76	76	17.5	4.242640687	14:30	10/27/2015	10/28/2015
IAR	62	PI10	62-0-66	High Event	High Event	92	92	19.25	4.444097209	20:09	10/21/2015	10/29/2015
IAR	62	PI10	62-0-67	Low Event	High Event	108	108	1.25	1.322875656	20:20	10/29/2015	10/30/2015
IAR	62	PI10	62-0-68	Low Event	Low Event	124	124	0.25	0.866025404	13:57	10/31/2015	11/2/2015
IAR	62	PI9	62-0-61	Low Event	None	8	8	0.5	1	14:14	10/16/2015	10/17/2015
IAR	62	PI9	62-0-62	Low Event	Low Event	24	24	0.75	1.118033989	8:58	10/18/2015	10/19/2015
IAR	62	PI9	62-0-63	High Event	Low Event	40	40	14.5	3.872983346	16:04	10/19/2015	10/20/2015
IAR	62	PI9	62-0-64	High Event	High Event	56	56	18.25	4.330127019	18:05	10/20/2015	10/21/2015
Lubrizol	336	336-1000-1000-01	trn0w6ctb	High Event	None	26	26	21.5	4.69041576	16:07	10/29/2015	10/30/2015
Lubrizol	336	336-1000-1000-01	trn15715b	High Event	High Event	55	55	19.75	4.5	17:40	11/3/2015	11/3/2015
Lubrizol	336	336-1000-1000-01	trntr3fb	Low Event	Low Event	103	103	0.25	0.866025404	21:34	11/4/2015	11/5/2015
Lubrizol	336	336-1000-1000-01	trnw6s8nb	Low Event	High Event	80.5	80.5	1.75	1.5	21:31	11/3/2015	11/4/2015
Lubrizol	336	336-1001-1001-01	trn2wq88b	Low Event	Low Event	59	59	0.75	1.118033989	9:30	11/24/2015	11/25/2015
Lubrizol	336	336-1001-1001-01	trn8r4mdb	High Event	Low Event	80	80	18	4.301162634	15:23	12/1/2015	12/2/2015
Lubrizol	336	336-1001-1001-01	trnc72yxb	High Event	High Event	103	103	13.5	3.741657387	16:05	12/3/2015	12/4/2015
Lubrizol	336	336-1001-1001-01	trnn5dnvb	Low Event	Low Event	28	28	1.5	1.414213562	10:40	11/19/2015	11/23/2015
SwRI	2	LSPI 10	2-0-01	Low Event	None	0	0	1	1.224744871	19:12	10/13/2015	10/15/2015
SwRI	2	LSPI 10	2-0-02	Low Event	Low Event	17.46	17.46	1.25	1.322875656	17:43	10/15/2015	10/16/2015
SwRI	2	LSPI 10	2-0-03	High Event	Low Event	31.46	31.46	17	4.183300133	17:41	10/16/2015	10/18/2015
SwRI	2	LSPI 10	2-0-04	High Event	High Event	45.46	45.46	15	3.937003937	11:30	10/18/2015	10/19/2015
SwRI	2	LSPI 11	2-0-05	High Event	High Event	57.96	57.96	14.25	3.840572874	17:20	10/20/2015	10/21/2015
SwRI	2	LSPI 11	2-0-06	High Event	High Event	77.52	77.52	16.5	4.123105626	1:12	10/22/2015	10/22/2015
SwRI	2	LSPI 11	2-0-07	Low Event	High Event	91.52	91.52	0.5	1	22:50	10/22/2015	10/23/2015
SwRI	2	LSPI 11	2-0-08	Low Event	Low Event	104.76	104.76	1	1.224744871	21:28	10/23/2015	10/24/2015
SwRI	4	LSPI 10	4-0-05	Low Event	Low Event	60.51	60.51	1.75	1.5	18:03	10/20/2015	10/21/2015
SwRI	4	LSPI 10	4-0-06	Low Event	Low Event	74.51	74.51	1.75	1.5	18:57	10/21/2015	10/22/2015
SwRI	4	LSPI 10	4-0-07	High Event	Low Event	88.51	88.51	17	4.183300133	16:08	10/22/2015	10/23/2015
SwRI	4	LSPI 10	4-0-08	High Event	High Event	102.51	102.51	23.5	4.898979486	17:52	10/23/2015	10/24/2015
SwRI	4	LSPI 11	4-0-01	High Event	None	0	0	25	5.049752469	2:35	10/14/2015	10/15/2015
SwRI	4	LSPI 11	4-0-02	High Event	High Event	16.23	16.23	21	4.636809248	22:00	10/15/2015	10/16/2015
SwRI	4	LSPI 11	4-0-03	Low Event	High Event	30.15	30.15	0.25	0.866025404	22:00	10/16/2015	10/17/2015
SwRI	4	LSPI 11	4-0-04	Low Event	Low Event	44.15	44.15	0.75	1.118033989	22:31	10/17/2015	10/18/2015

Plot of Prove out Results



Plot of Prove out Results



The number of LSP1 events is shown for each of the 4 valid iterations per test

Regression Analysis – HEO & LEO

Overall Effects Table

Source	DF	Prob > F
Lab	2	0.0541
Stand #[Lab]	2	0.0156*
Engine #[Lab]	3	0.0441*
Oil	1	<.0001*
Cylinder Head Run Hours (at test start)(0,124)	1	0.0237*

Carry Over Effect not included;
No strong evidence of its effect

IAR tends to be more mild compared to LZ and SwRI

Level	Least Sq Mean
Lubrizol A	2.7862200
SwRI A	2.7633259
IAR A	2.5355524

Levels not connected by same letter are significantly different.

Term	Prob> t
Lab[IAR]:Stand #[60]	0.0771
Lab[SwRI]:Stand #[2]	0.0182*

Level	Least Sq Mean
[IAR]60	2.4042839
[IAR]62	2.6668209
[Lubrizol]336	2.7862200
[SwRI]2	2.5841748
[SwRI]4	2.9424771

IAR Stand 60 tends to be more mild than Stand 62
SwRI Stand 2 is more mild than Stand 4

Term	Prob> t
Lab[IAR]:Engine #[PI10]	0.0122*
Lab[Lubrizol]:Engine #[336-1000-1000-01]	0.2440
Lab[SwRI]:Engine #[LSPI 10]	0.4463

Level	Least Sq Mean
[IAR]PI10	2.7268602
[IAR]PI9	2.3442446
[Lubrizol]336-1000-1000-01	2.9067269
[Lubrizol]336-1001-1001-01	2.6657130
[SwRI]LSPI 10	2.8186554
[SwRI]LSPI 11	2.7079965

IAR PI10 is more severe than PI9
No strong indication that engines significantly differ within other labs

Regression Analysis – LEO Only

Overall Effects Table

Source	DF	Prob > F
Lab	2	0.3808
Stand #[Lab]	2	0.9070
Engine #[Lab]	3	0.1976
Cylinder Head Run Hours (at test start)(0,124)	1	0.6660

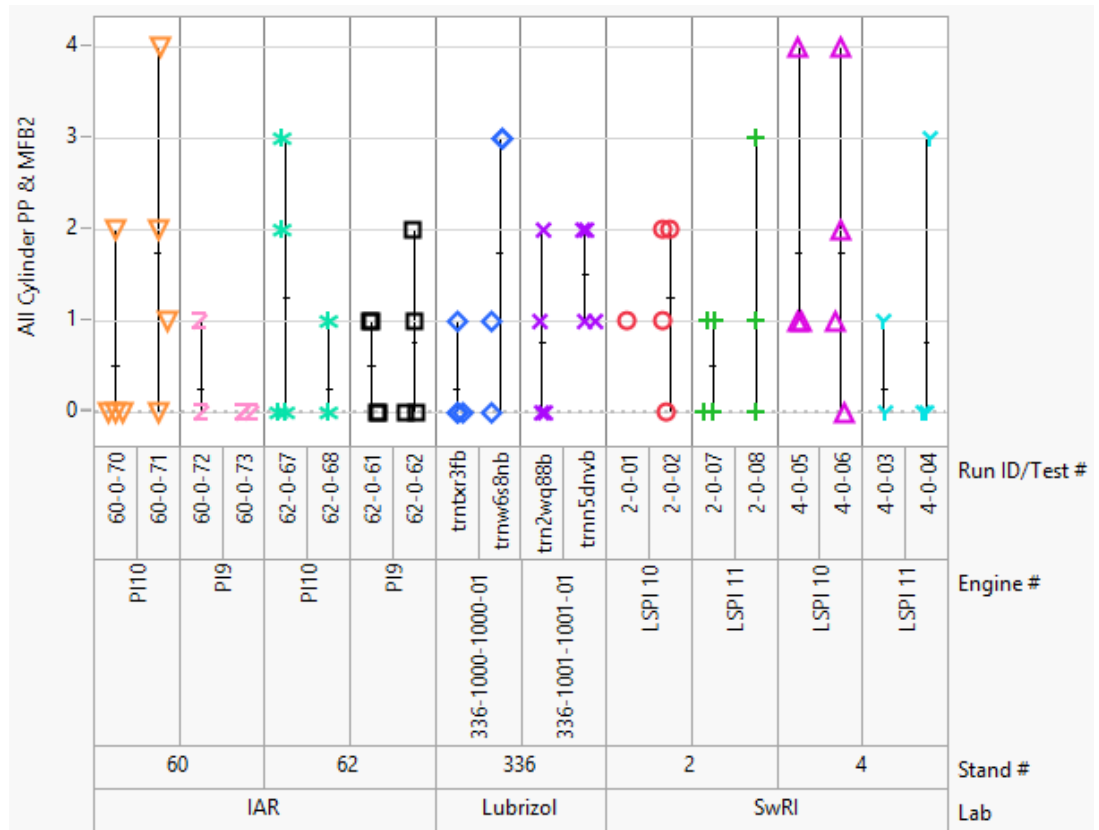
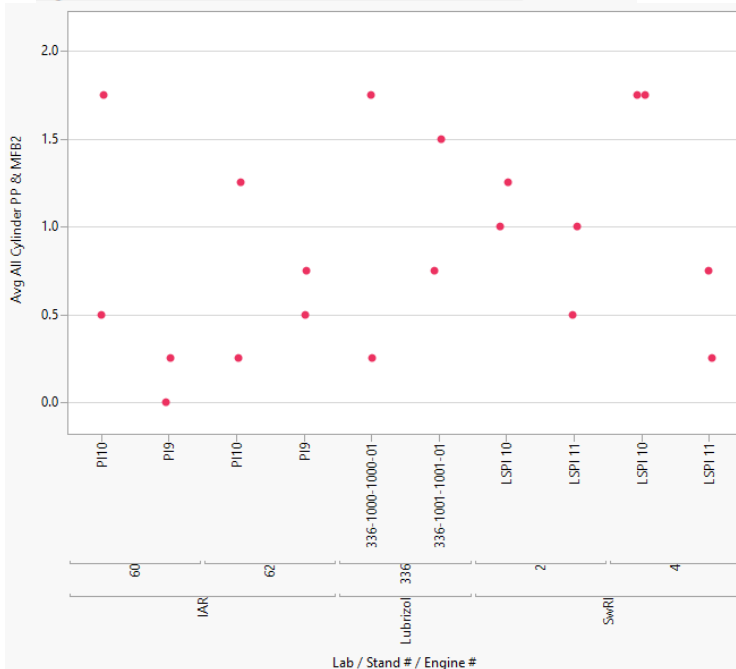
On average, there is no strong evidence to conclude lab, stand, engine, and cylinder head hours affect the number of LSPI events

However, there is some evidence suggesting

Parameter Estimates Table

Term	Prob> t
Intercept	<.0001*
Lab[IAR]	0.1443
Lab[Lubrizol]	0.4677
Lab[IAR]:Engine #[PI10]	0.1373
Lab[Lubrizol]:Engine #[336-1000-1000-01]	0.8676
Lab[SwRI]:Engine #[LSPI 10]	0.0968
Cylinder Head Run Hours (at test start)(0,124)	0.6407

- IAR is more mild than LZ and SwRI
- IAR PI10 is more severe than PI9
- SwRI LSPI 10 is more severe than LSPI 11



Regression Analysis – HEO Only

Overall Effects Table

Source	DF	Prob > F
Lab	2	0.1014
Stand #[Lab]	2	0.0078*
Engine #[Lab]	3	0.2608
Cylinder Head Run Hours (at test start)(0,124)	1	0.1513

There is more evidence that cylinder head run hours affects LSPI events in HEO results

Level	Least Sq Mean
IAR	4.0103379
Lubrizol	4.3281910
SwRI	4.3301976

IAR tends to be more mild compared to LZ and SwRI

Term	Prob> t
Lab[IAR]:Stand #[60]	0.0455*
Lab[SwRI]:Stand #[2]	0.0079*

IAR Stand 60 is more mild than Stand 62

SwRI Stand 2 is more mild than Stand 4

Level	Least Sq Mean
[IAR]60	3.7783318
[IAR]62	4.2423441
[Lubrizol]336	4.3281910
[SwRI]2	3.9967903
[SwRI]4	4.6636049

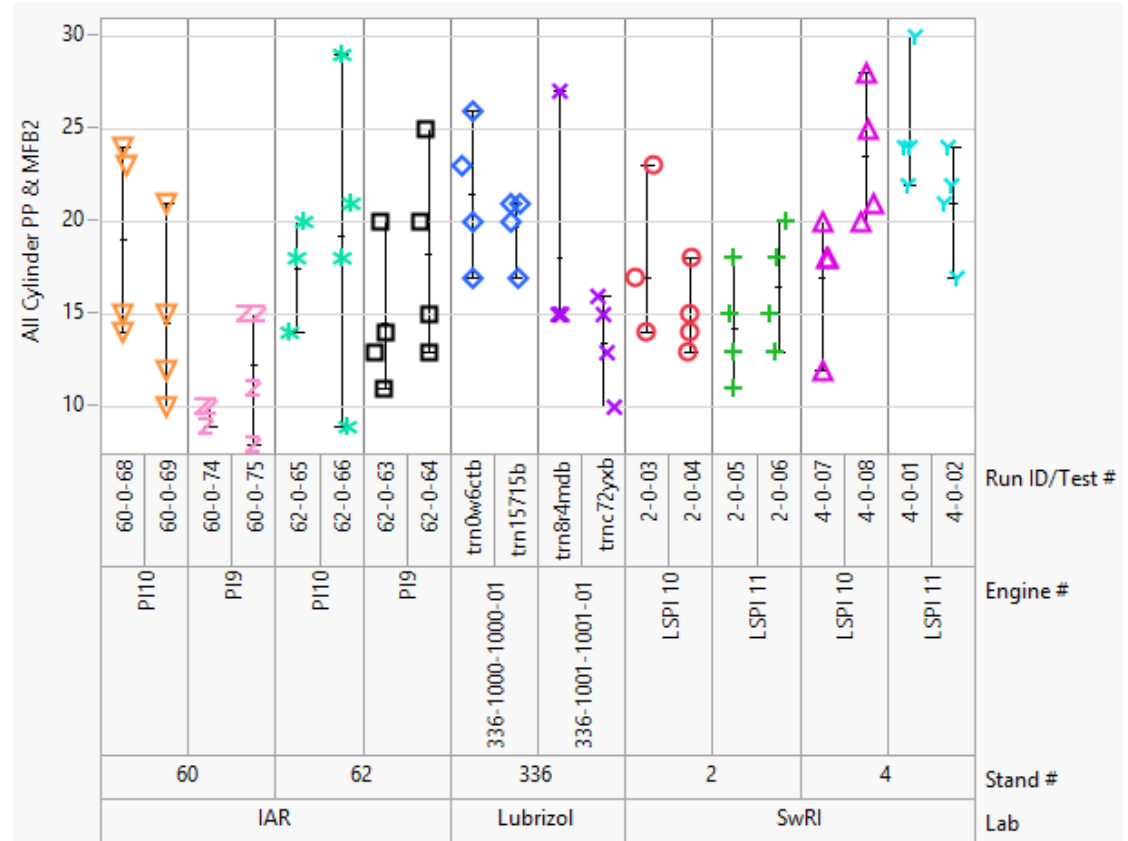
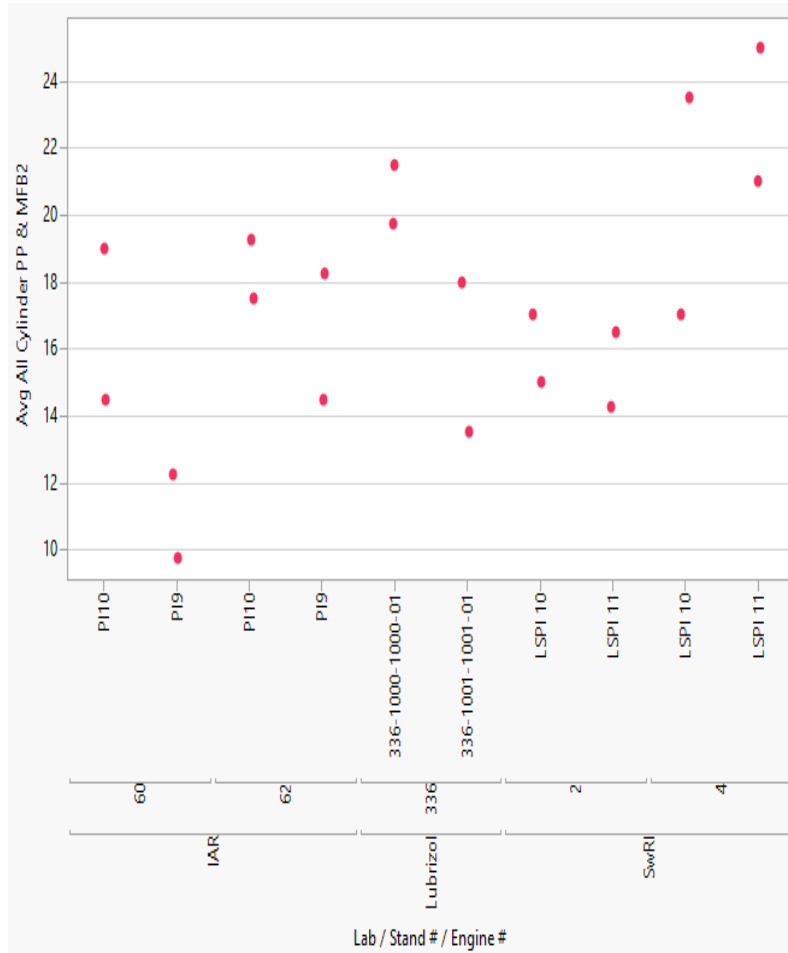
Level	Least Sq Mean
[IAR]PI10	4.2091005
[IAR]PI9	3.8115754
[Lubrizol]336-1000-1000-01	4.5279406
[Lubrizol]336-1001-1001-01	4.1284413
[SwRI]LSPI 10	4.3238943
[SwRI]LSPI 11	4.3365009

Term	Prob> t
Lab[IAR]:Engine #[PI10]	0.0931
Lab[Lubrizol]:Engine #[336-1000-1000-01]	0.2269
Lab[SwRI]:Engine #[LSPI 10]	0.9544

IAR PI10 is more severe than PI9

No strong indication that engines significantly differ within other labs

Regression Analysis – HEO Only



Regression Analysis – HEO Only

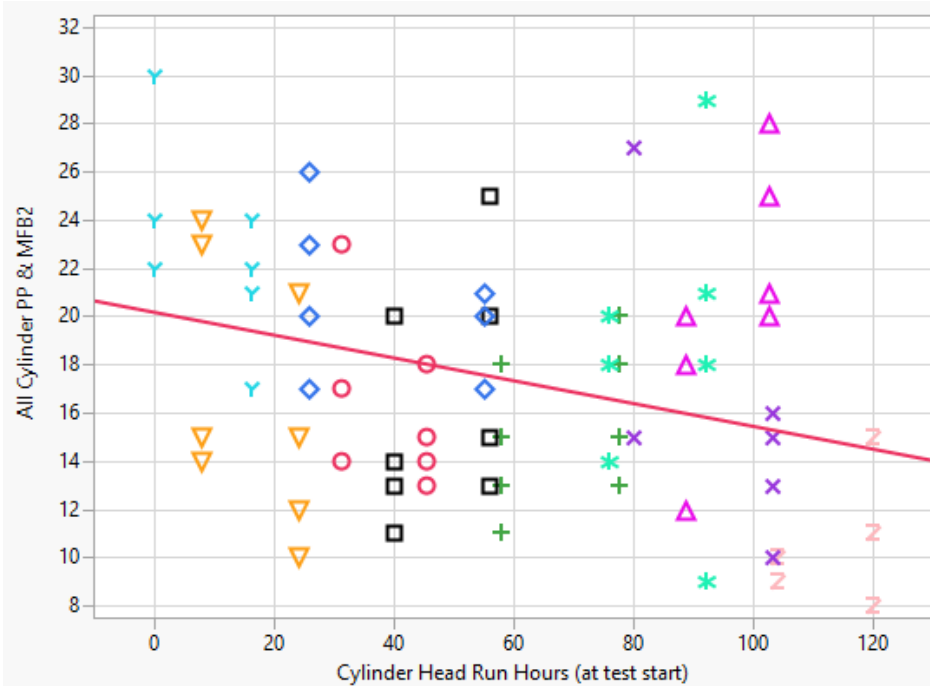
VIF values give us an indication of the collinearity among the factors in the model

The higher the VIF the more difficult it is to separate the factor's effect from other terms in the model

This suggests that there could be engine-stand differences as opposed to an cylinder head hours effect

Term	VIF
Intercept	.
Lab[IAR]	1.6936109
Lab[Lubrizol]	1.7089502
Lab[IAR]:EngineStand[PI1060]	7.096726
Lab[IAR]:EngineStand[PI1062]	2.3414902
Lab[IAR]:EngineStand[PI960]	6.6491744
Lab[Lubrizol]:EngineStand[336-1000-1000-01336]	2.5157314
Lab[SwRI]:EngineStand[LSPI 102]	1.9566309
Lab[SwRI]:EngineStand[LSPI 104]	5.8207969
Lab[SwRI]:EngineStand[LSPI 112]	2.0445048
Cylinder Head Run Hours (at test start)(0,124)	14.064147

EngineStand(lab) included in the model



- StandEngine
- 2LSPI 10
- + 2LSPI 11
- ◇ 336336-1000-1000-01
- × 336336-1001-1001-01
- △ 4LSPI 10
- Y 4LSPI 11
- ▽ 60PI10
- Z 60PI9
- * 62PI10
- 62PI9

4LSPI 11 is on the high end of # of events
60PI9 is on the low end of # of events

Regression Analysis – HEO Only

Level	Least Sq Mean
IAR	3.9938735
Lubrizol	4.3083089
SwRI	4.3566030

IAR tends to be the most mild lab

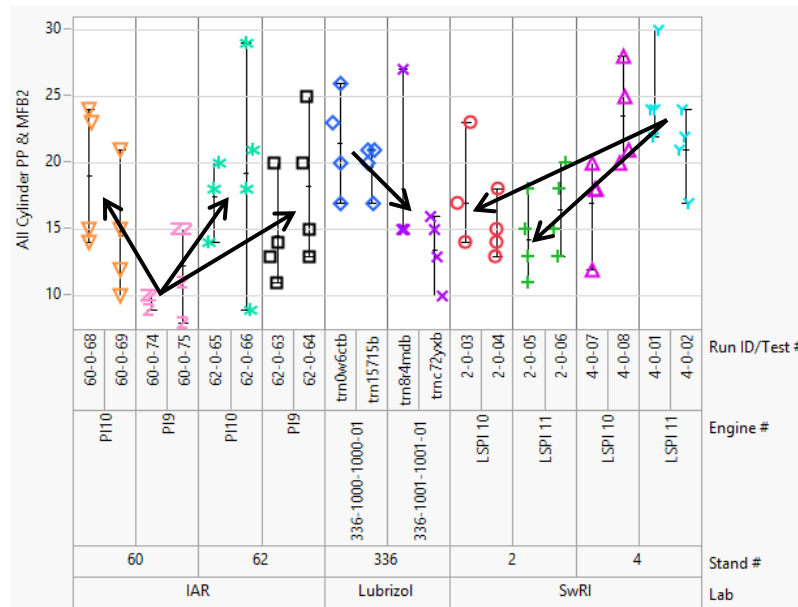
Overall Effects Table

Source	DF	Prob > F
Lab	2	0.0871
EngineStand[Lab]	7	0.0315*

Level	Least Sq Mean
[IAR]PI1060	4.1444319
[IAR]PI1062	4.3433689
[IAR]PI960	3.3861382
[IAR]PI962	4.1015552
[Lubrizol]336-1000-1000-01336	4.5952079
[Lubrizol]336-1001-1001-01336	4.0214100
[SwRI]LSPI 102	4.0601520
[SwRI]LSPI 104	4.5411398
[SwRI]LSPI 112	3.9818392
[SwRI]LSPI 114	4.8432809

A deeper inspection of these differences reveals:

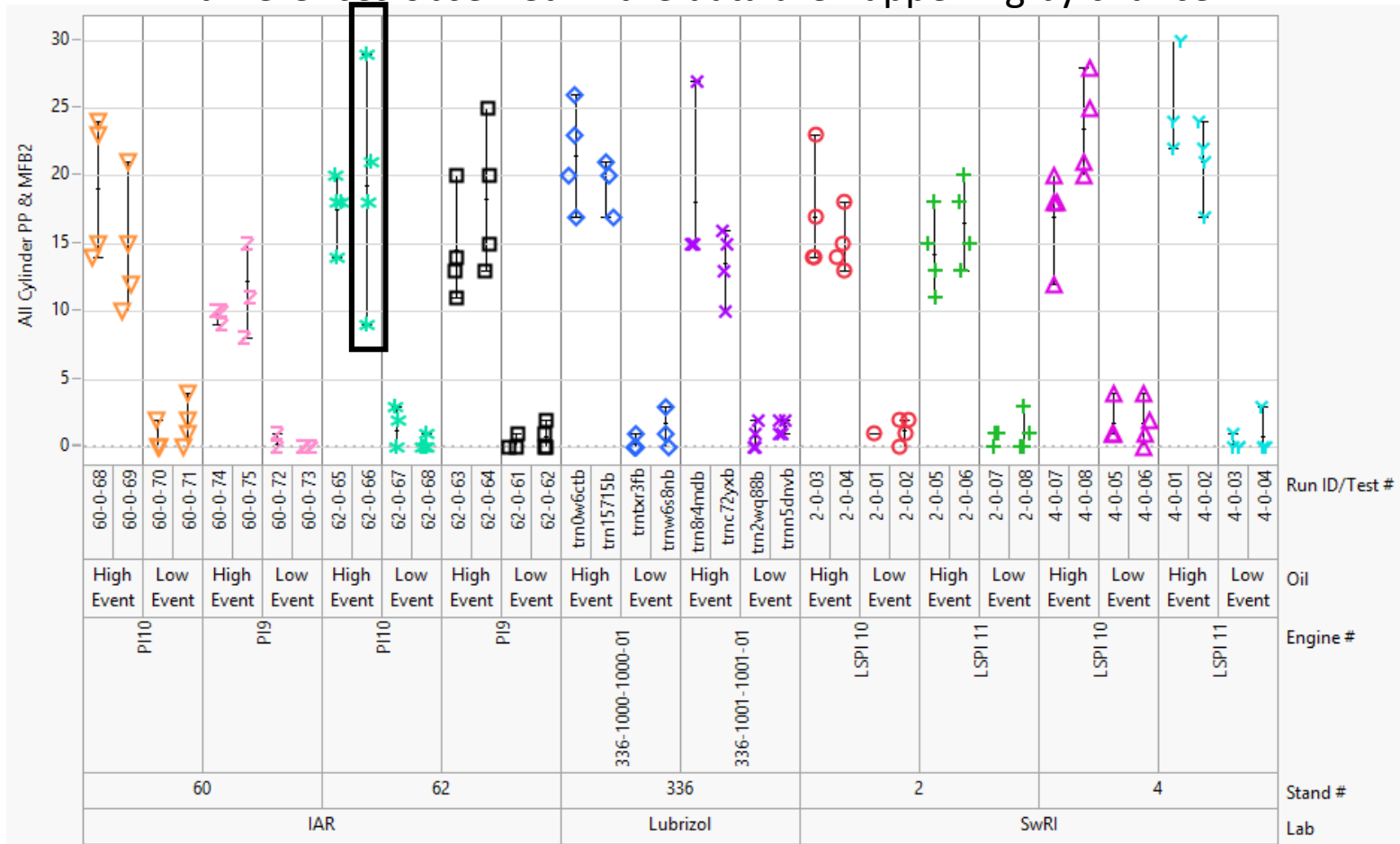
- At IAR, Stand 60 PI9 is more severe than the other stand-engine combinations
- At LZ, engine 1000 tends to be more severe than 1001
- At SwRI, LSPI 11 in stand 4 is more severe than both engines in stand 2



What are these prove-out data trying to tell us?

Option 1: There are only oil differences
 (analysis suggests this is not the case, but it's still possible)

Perhaps 62-0-66 suggests a wide range of variability and the other differences observed in the data are happening by chance



What are these prove-out data trying to tell us?

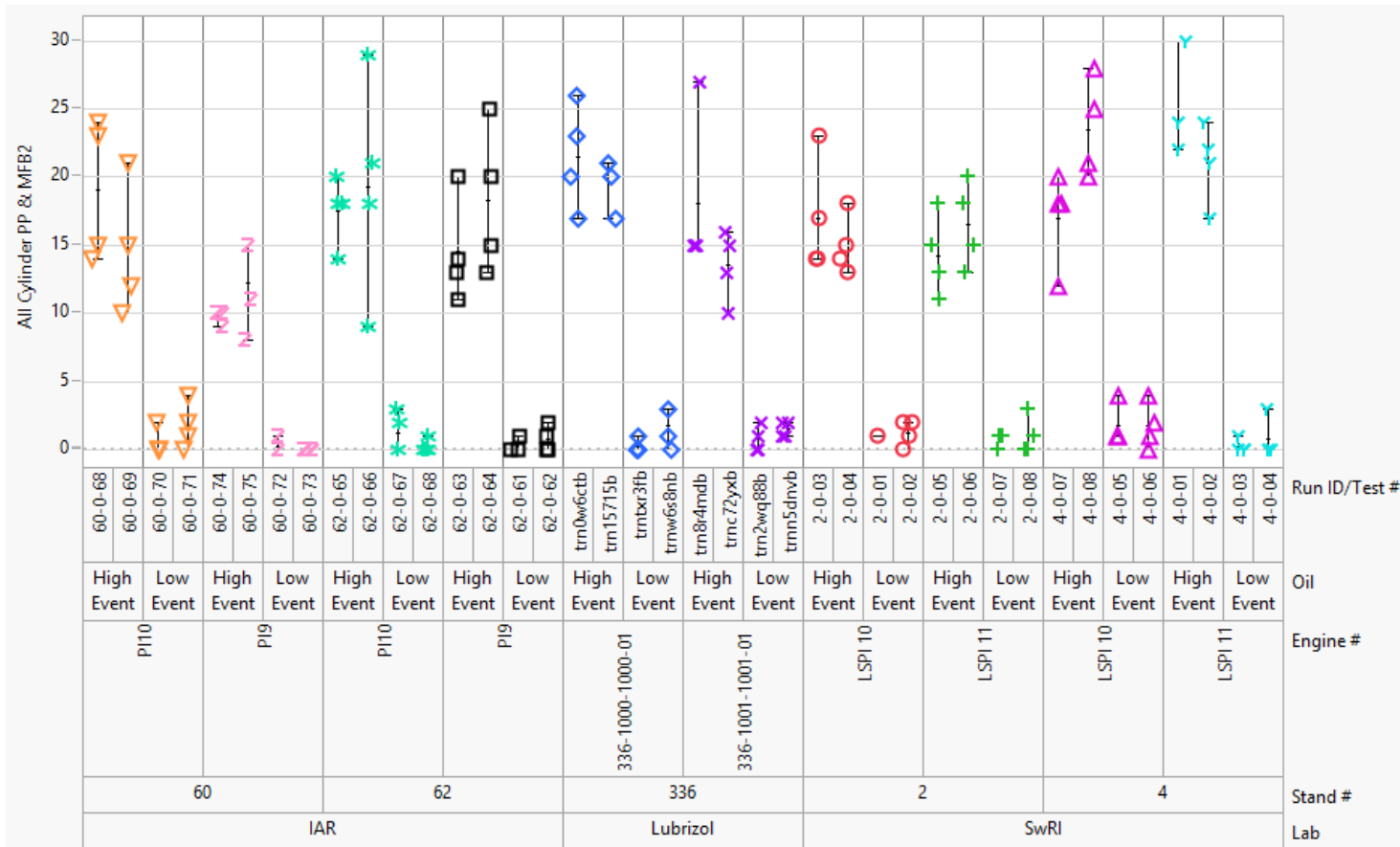
Option 2: There are oil differences and the effect of cylinder head run hours is real

IAR is the most mild lab on average

IAR Stand 60 is more mild than Stand 62

SwRI Stand 2 is more mild than Stand 4

IAR PI10 is more severe than PI9



What are these prove-out data trying to tell us?

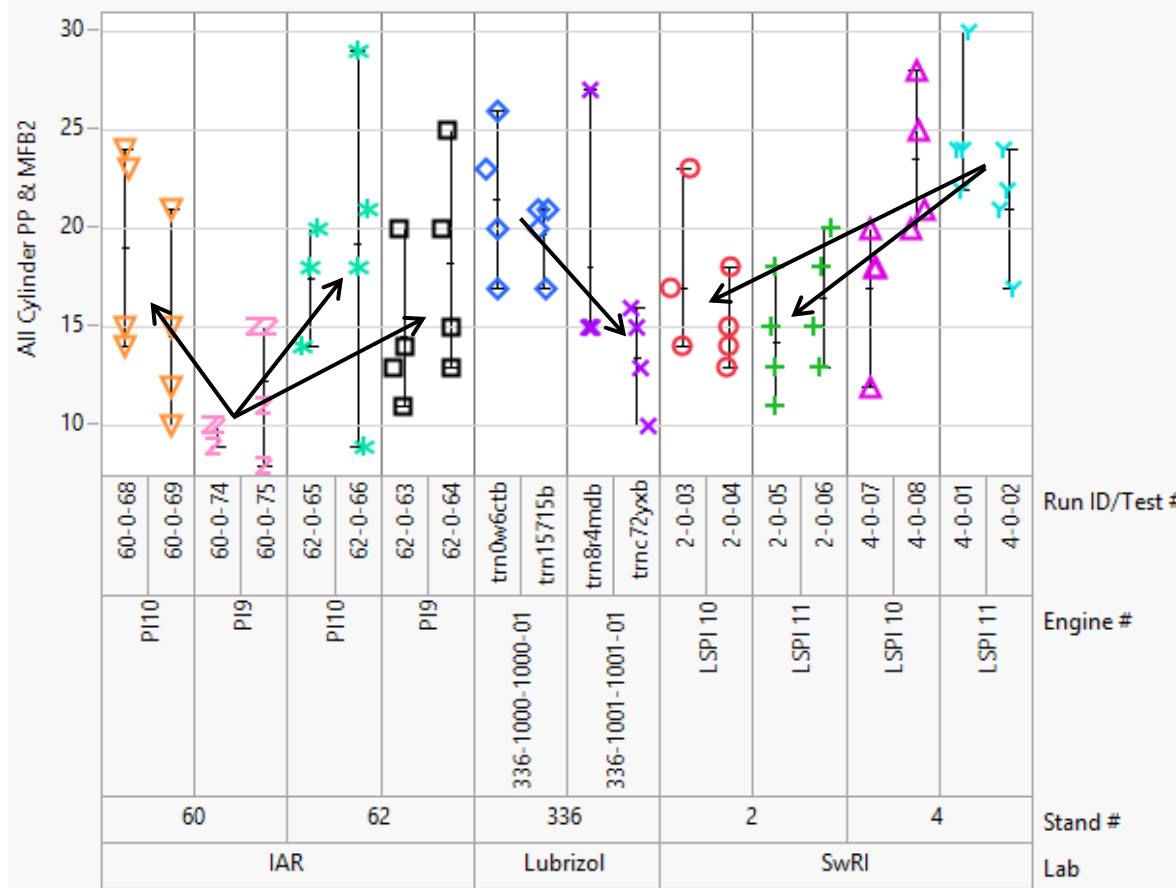
Option 3: There are oil and stand-engine differences

IAR tends to be the most mild lab

At IAR, Stand 60 PI9 is more severe than the other stand-engine combinations

At LZ, engine 1000 tends to be more severe than 1001

At SwRI, LSPI 11 in stand 4 is more severe than both engines in stand 2



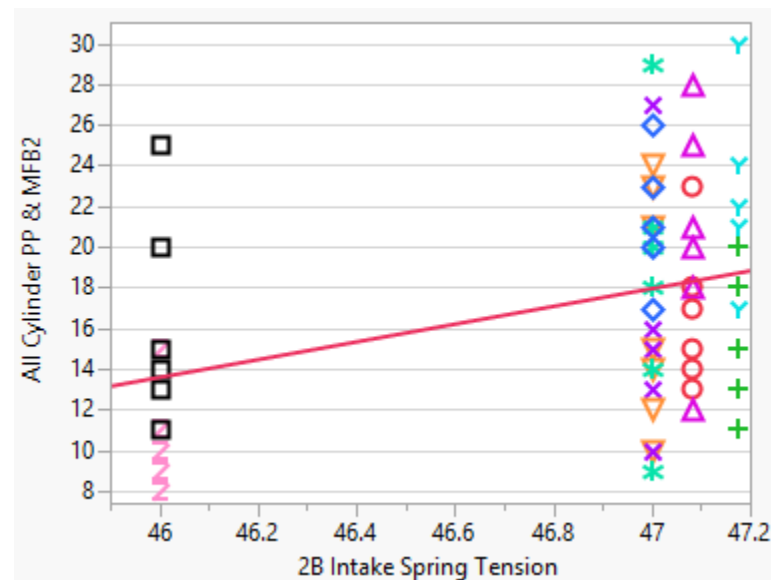
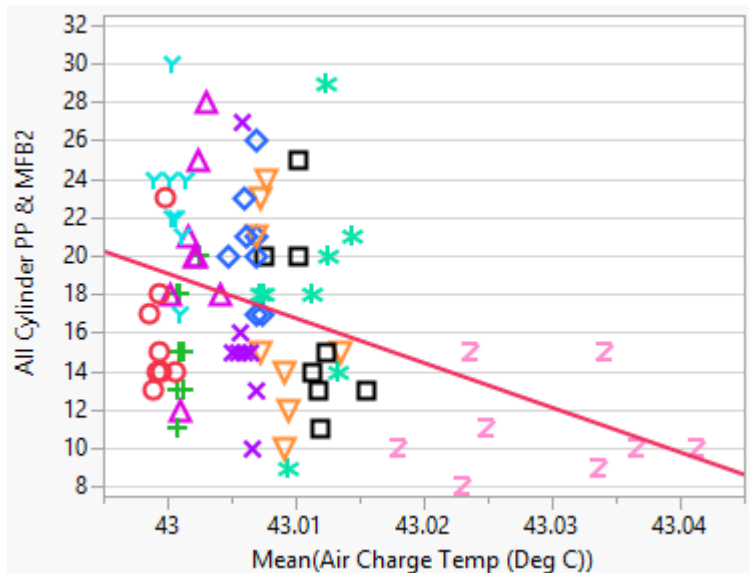
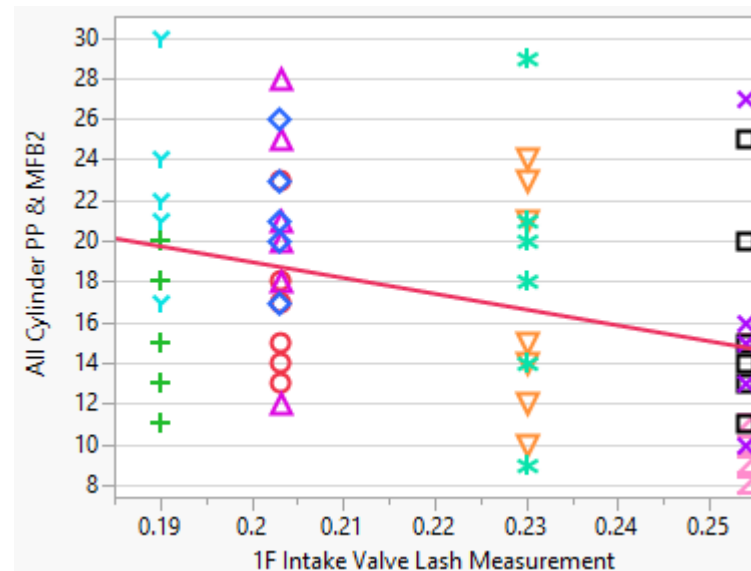
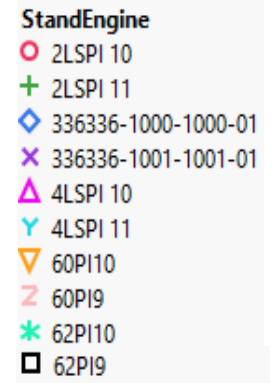
General Comments

- It is not very clear what explains variability in the number of LSPI events
 - It's possible that cylinder head hours affects the variability
 - Or it could be attributed to something related to setting up engine-stand combinations
 - Or it could be that the only difference in LSPI events is the oil
 - Or it could be build or operational data differences
 - Or it could be something we have not yet identified or recorded
- The complexity in these data should be kept in mind when setting up LTMS post precision matrix
 - We may find that the most conservative approach is an engine-stand based system

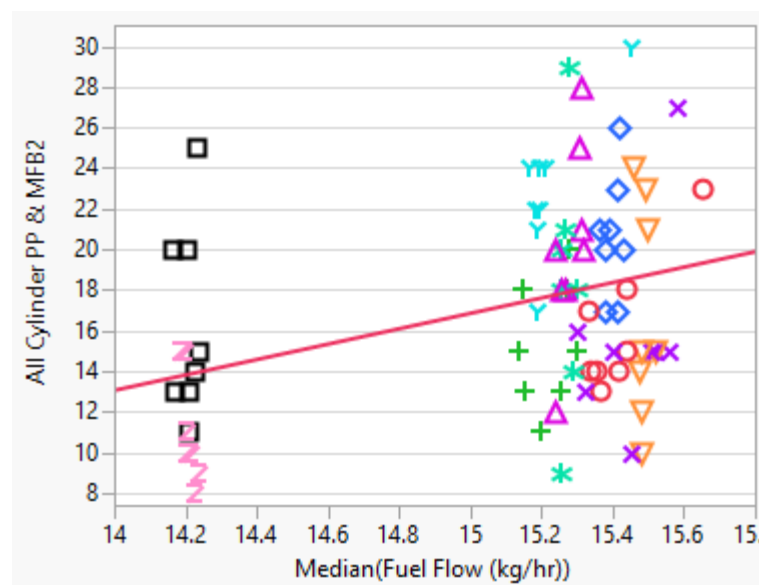
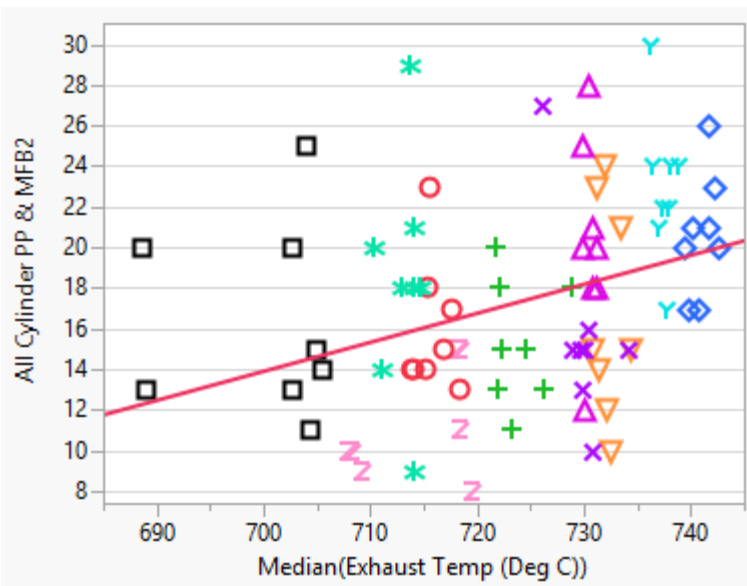
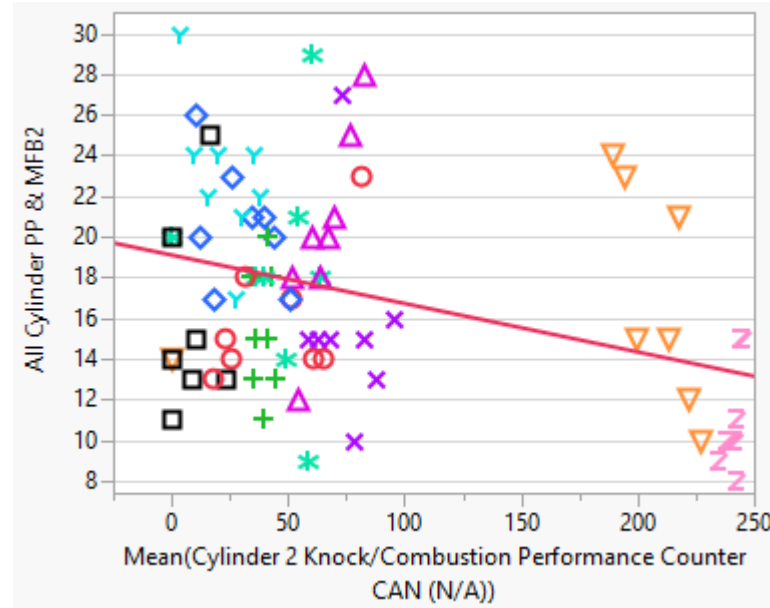
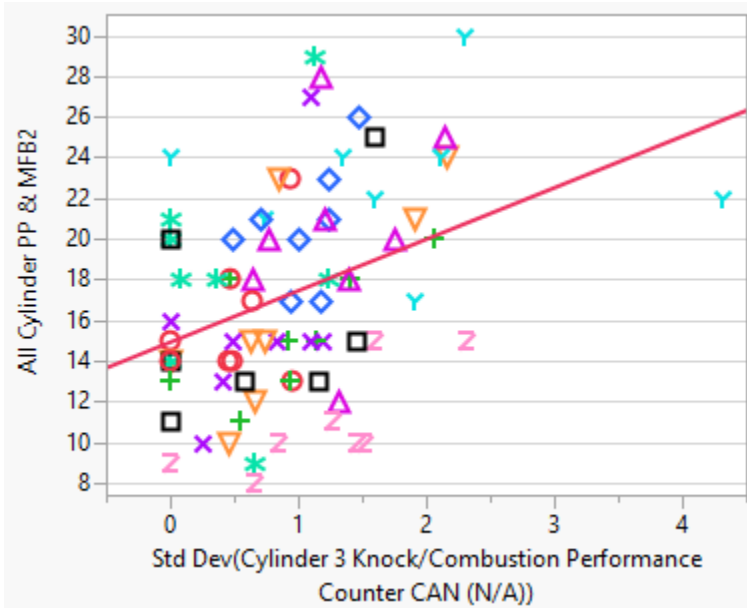
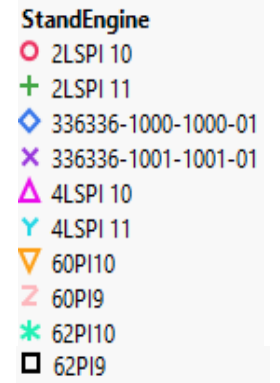
Quest to Understand Sources of variability

- Assume each of the 3 options is plausible
- Mine operational data and build data to identify correlations for further review
 - Mean, median, and standard deviation of each operational parameter
 - Summarized by iteration
 - Build data is unique to the engine
- Trend lines have been added to plots, but should be used with caution
- Comments
 - When option 1 is assumed, build and a few operational differences could be affecting the number of LSPI events
 - These differences generally line up with stand-engine differences
 - When options 2 and 3 are assumed, build and operational differences do not appear to explain the residual variability

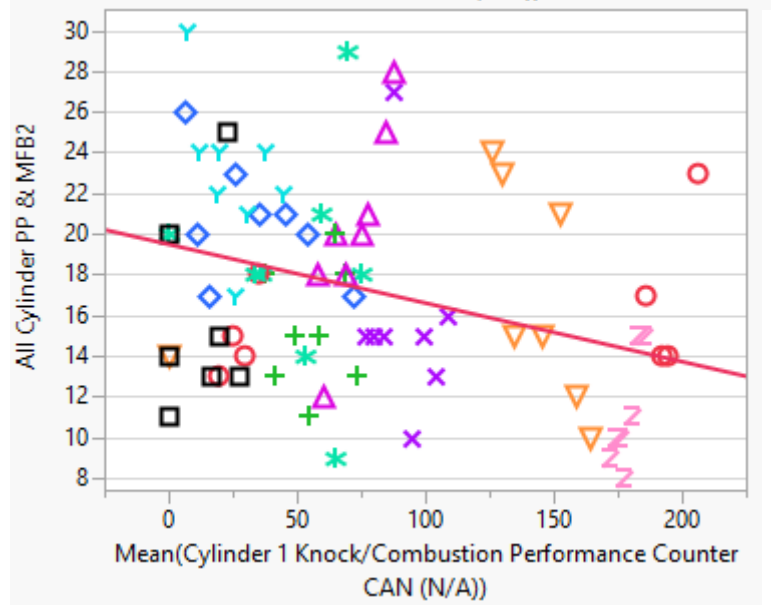
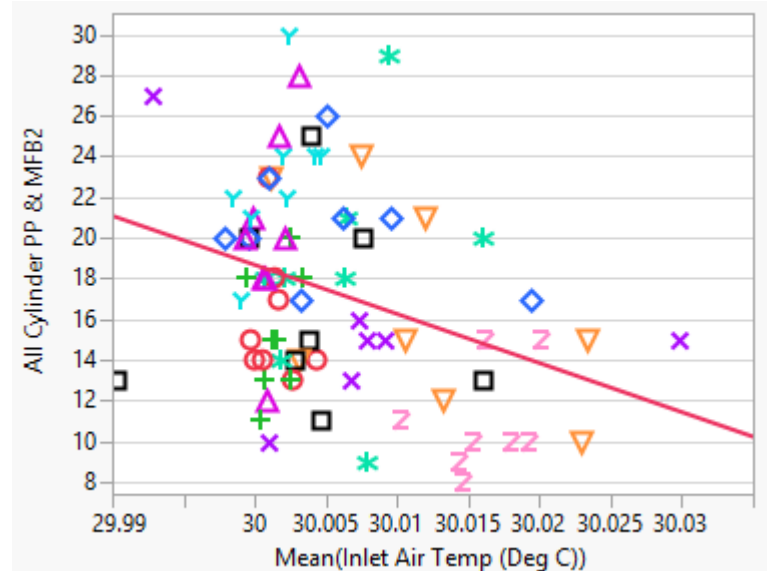
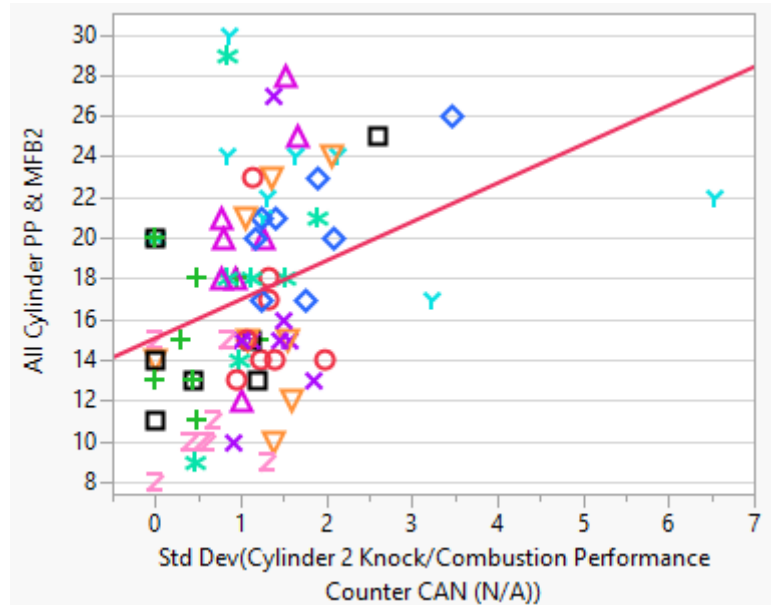
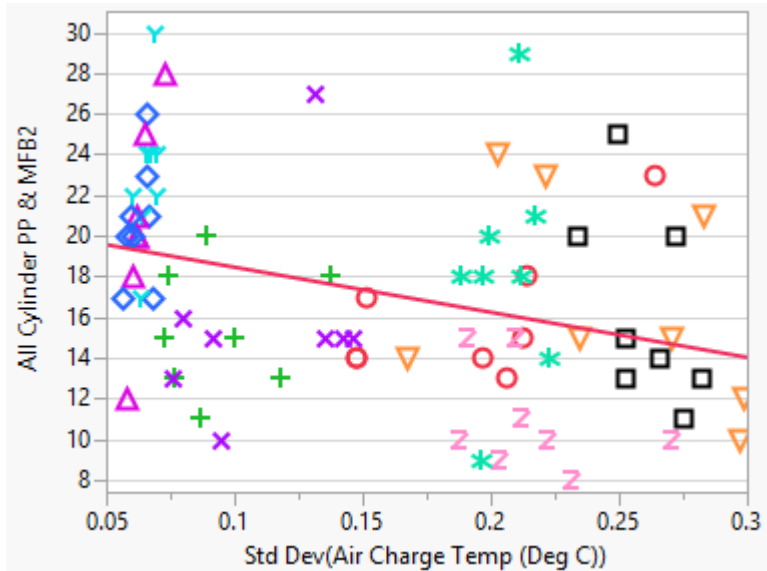
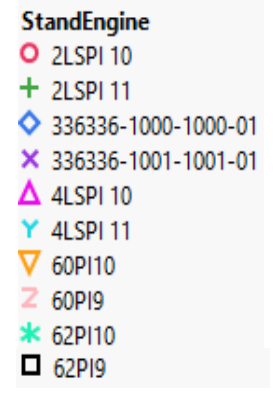
Quest to Understand Sources of variability - Option1



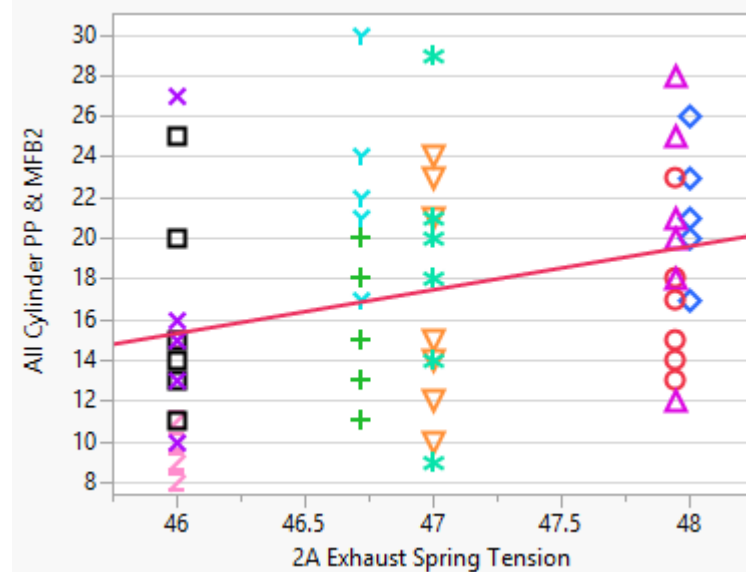
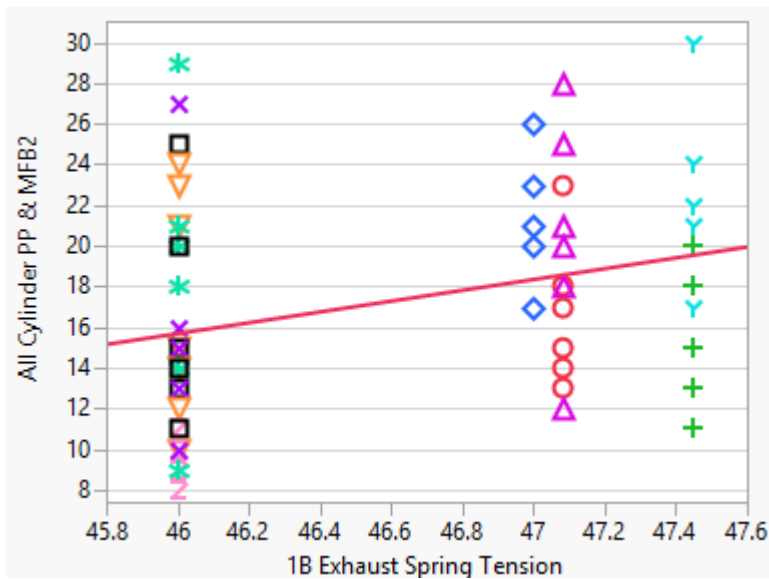
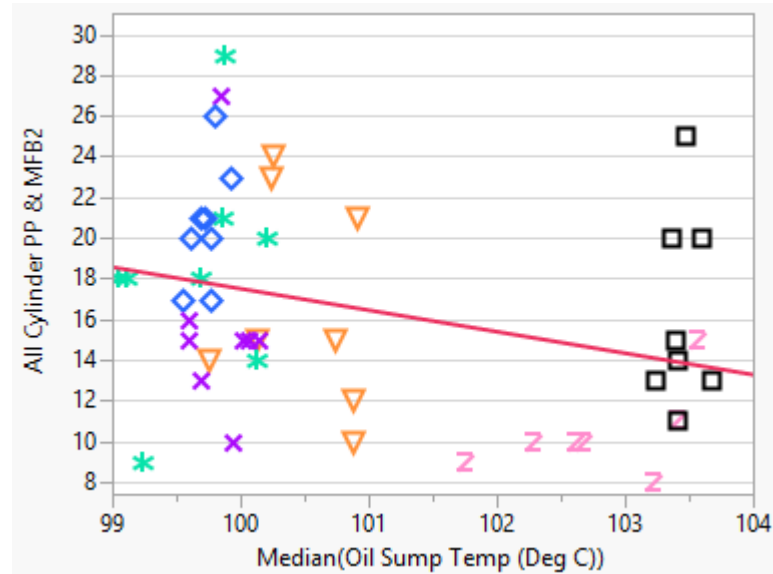
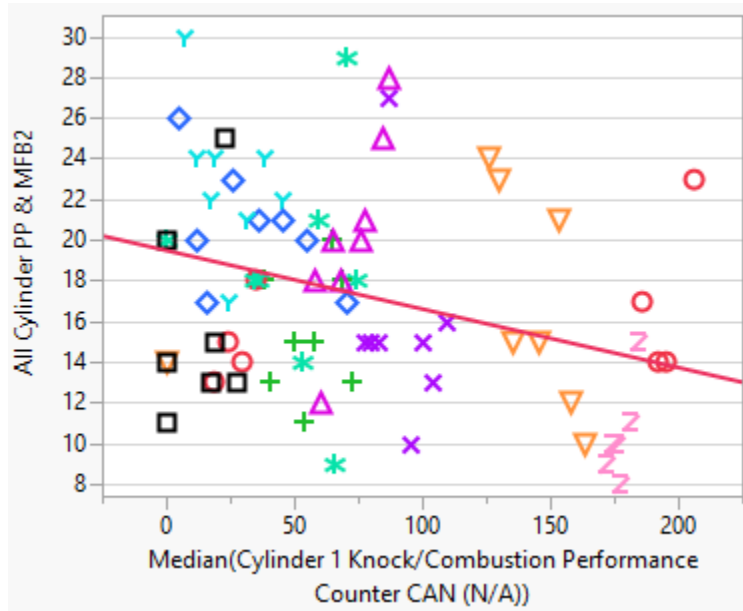
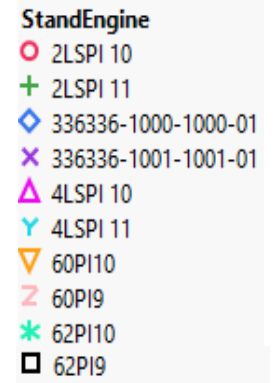
Quest to Understand Sources of variability - Option1



Quest to Understand Sources of variability - Option1

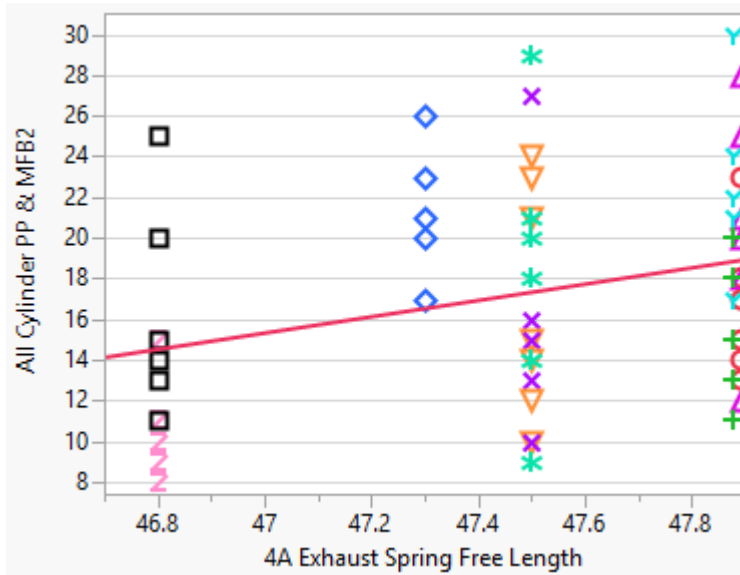
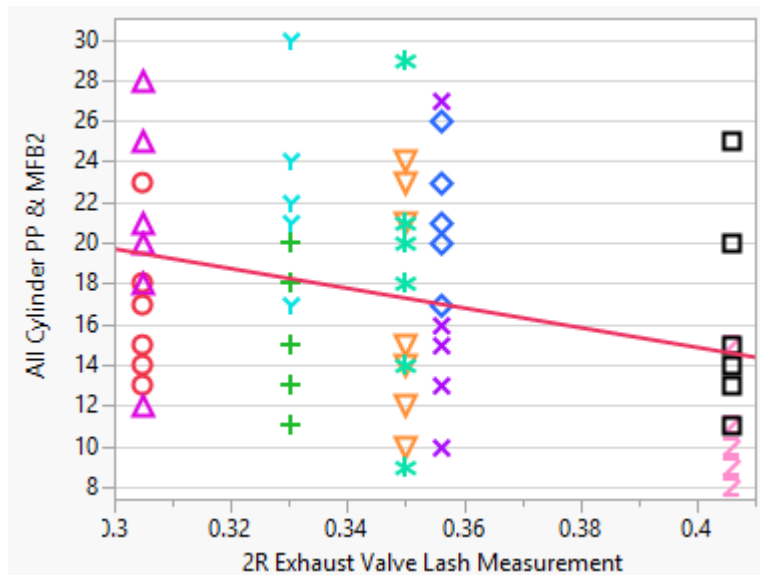
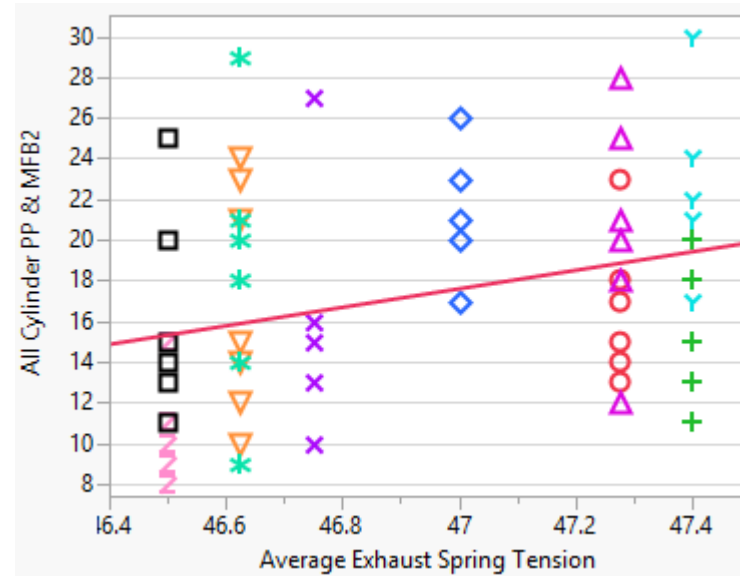
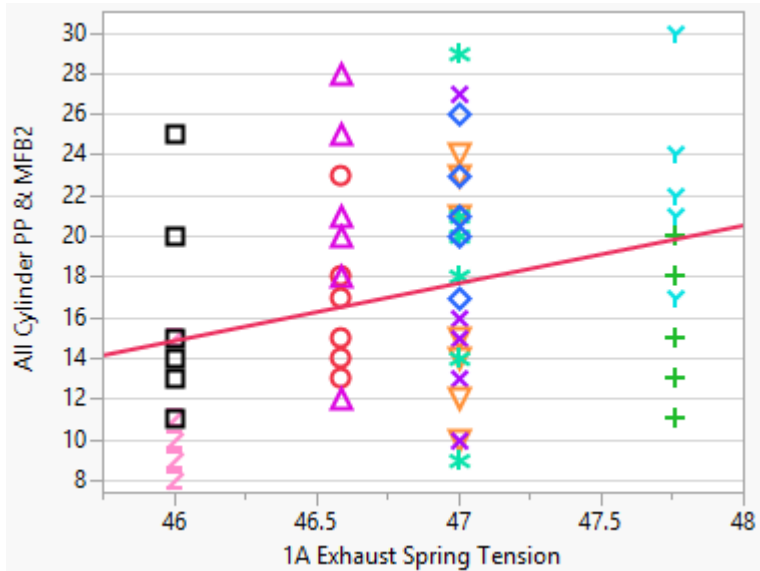


Quest to Understand Sources of variability - Option1

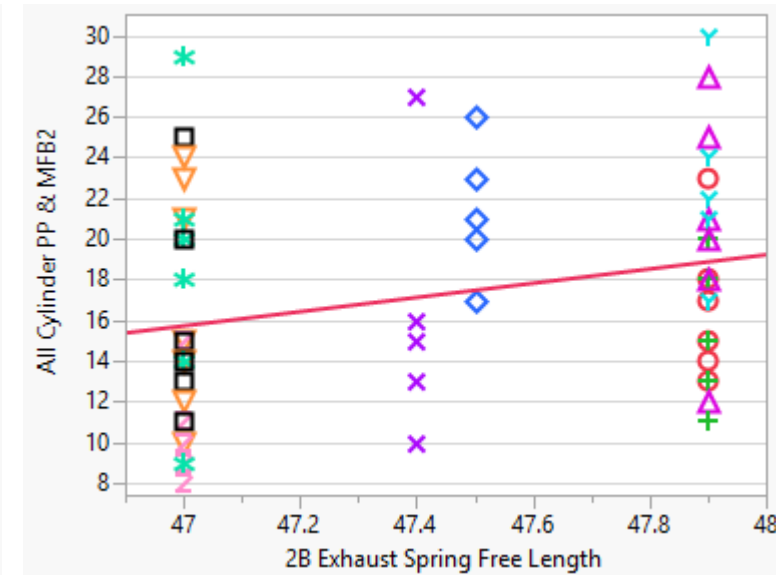
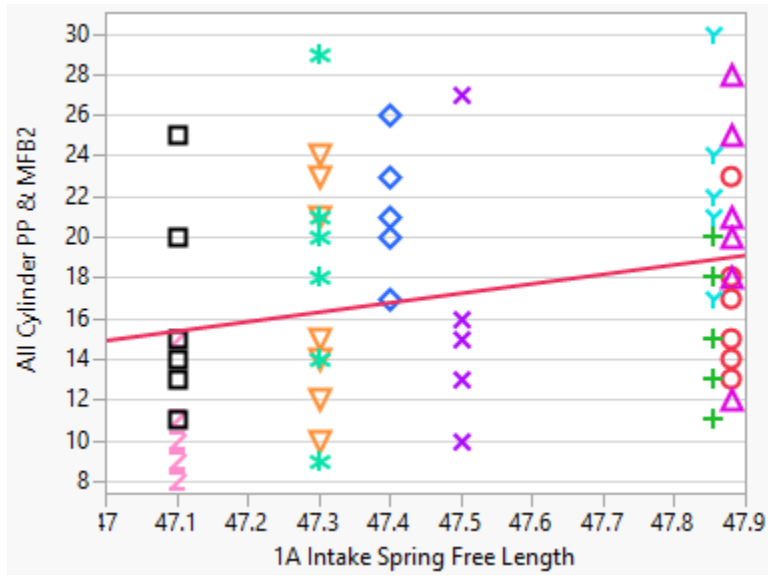
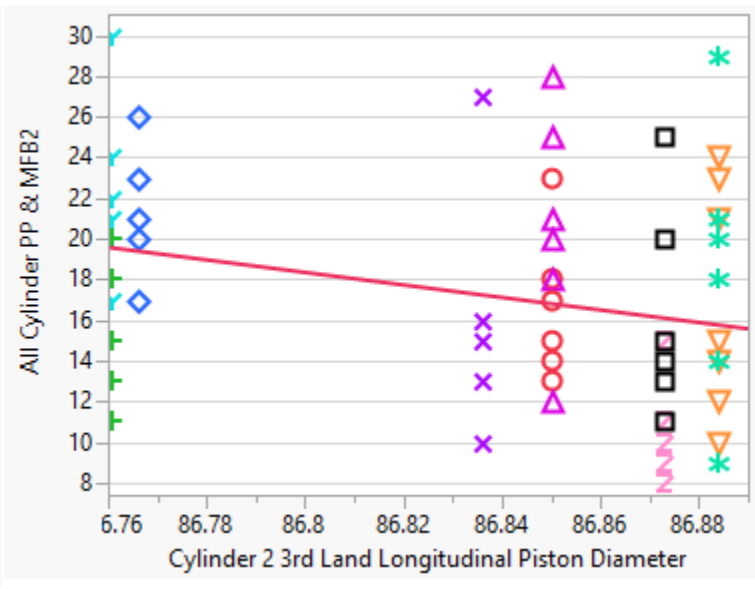
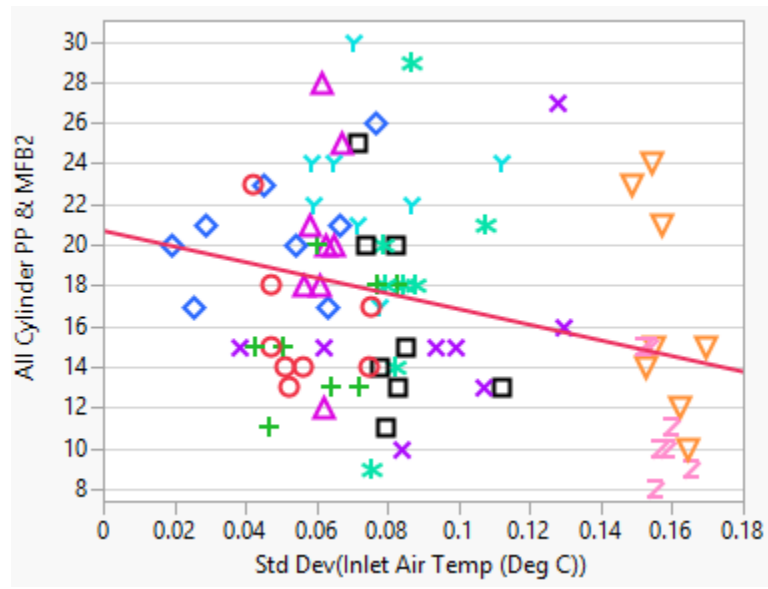
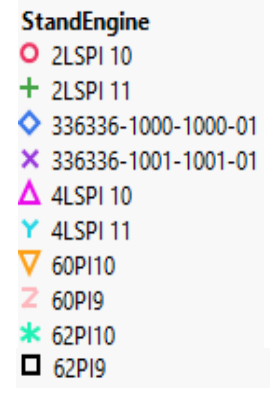


Quest to Understand Sources of variability - Option1

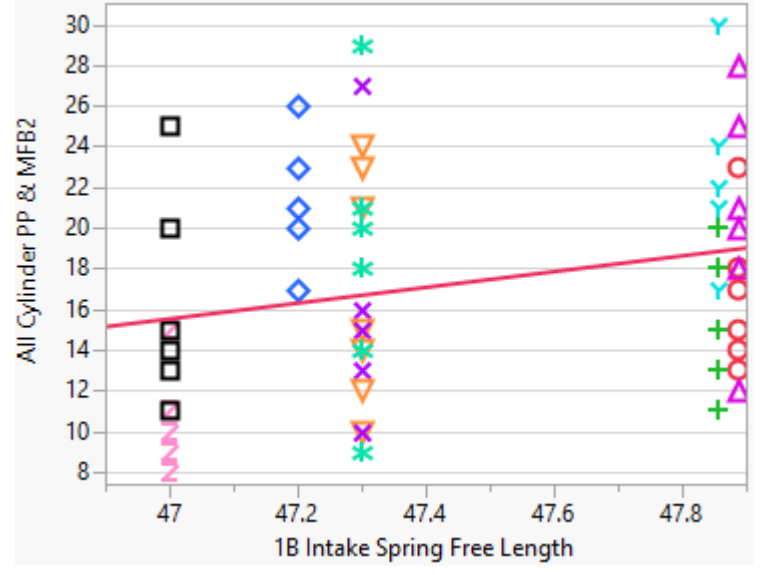
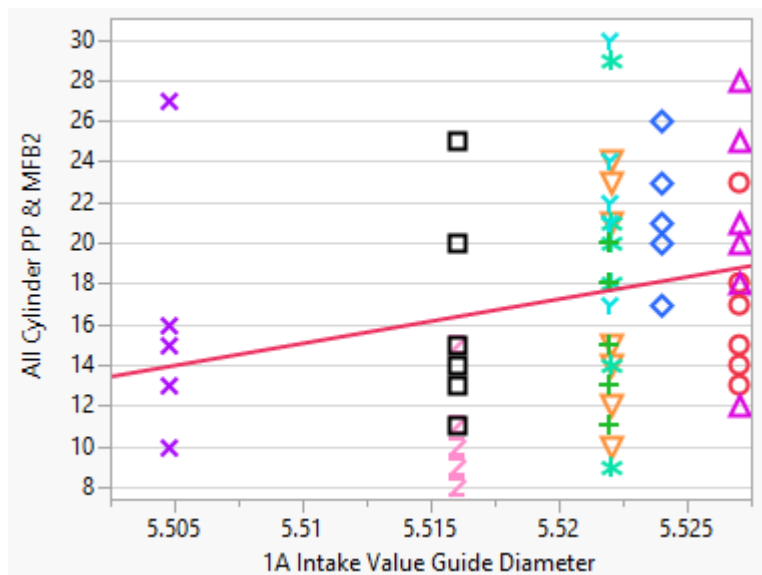
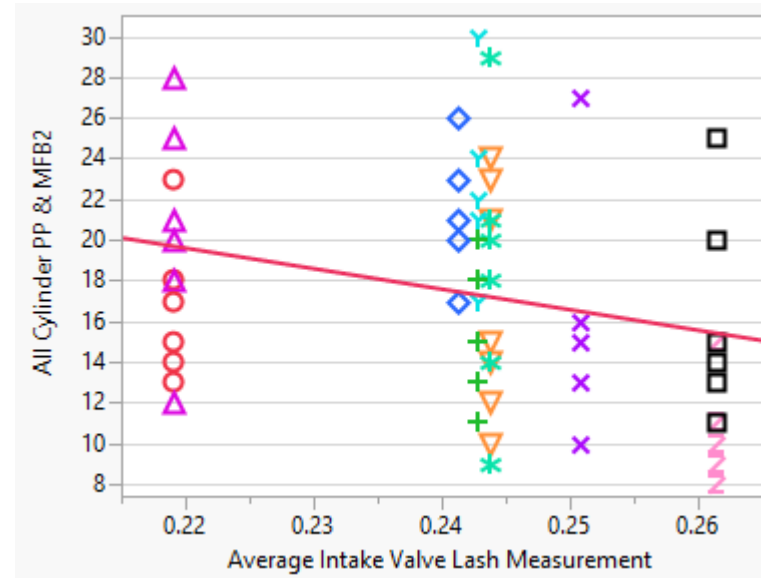
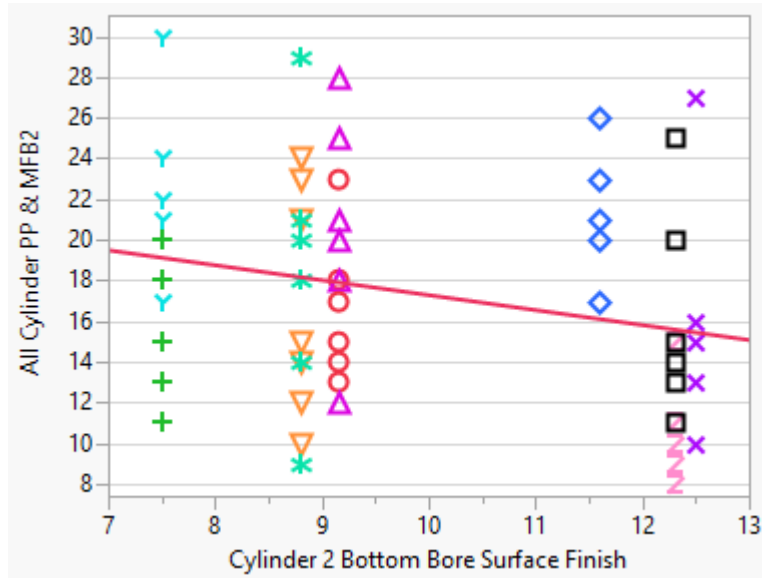
- StandEngine**
- 2LSPI 10
 - + 2LSPI 11
 - ◇ 336336-1000-1000-01
 - × 336336-1001-1001-01
 - △ 4LSPI 10
 - Y 4LSPI 11
 - ▽ 60PI10
 - ∟ 60PI9
 - * 62PI10
 - 62PI9



Quest to Understand Sources of variability - Option1

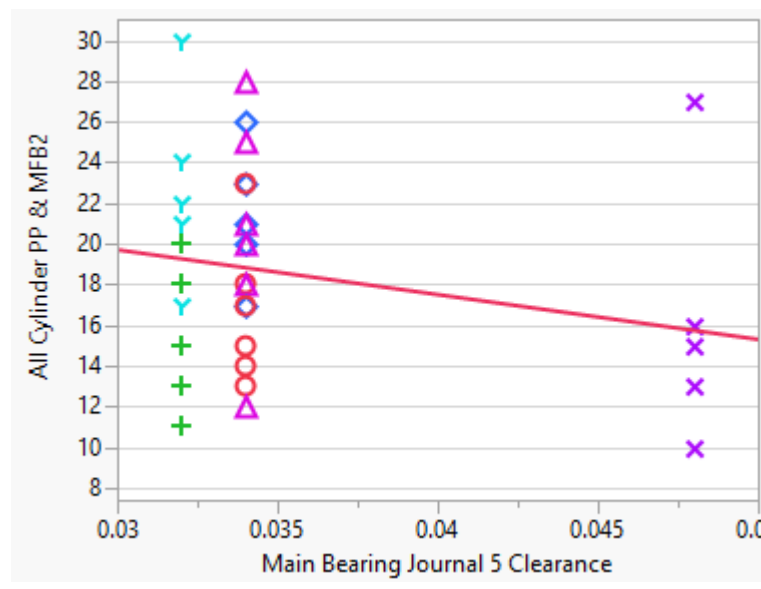
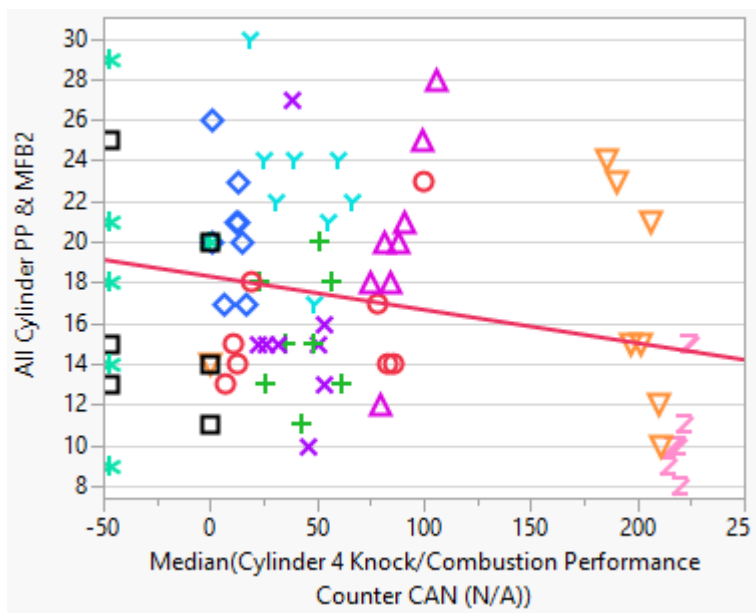
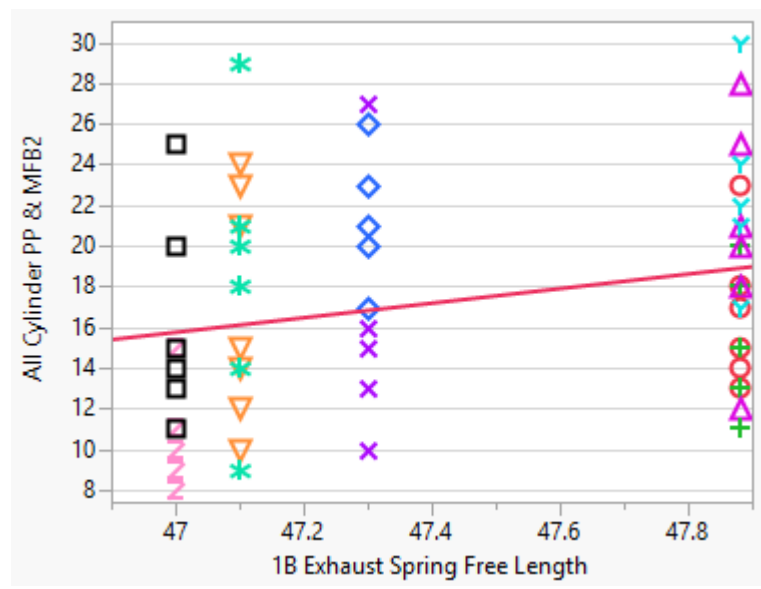
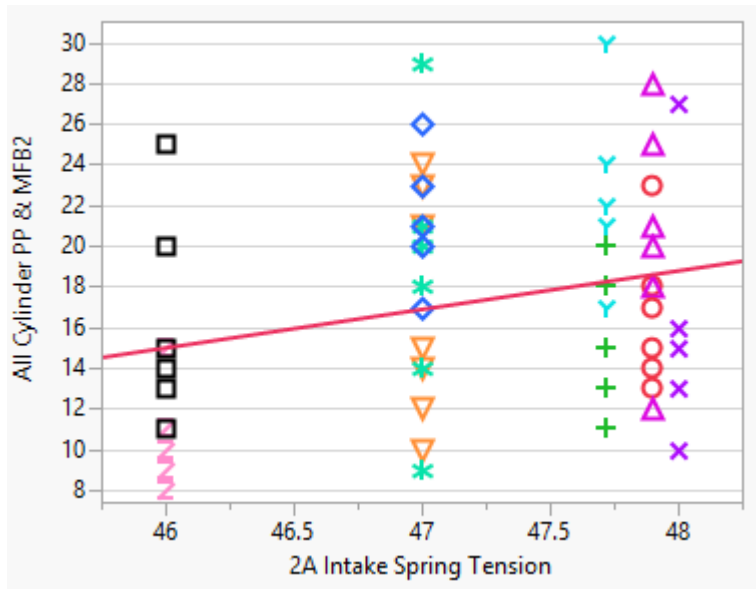


Quest to Understand Sources of variability - Option1

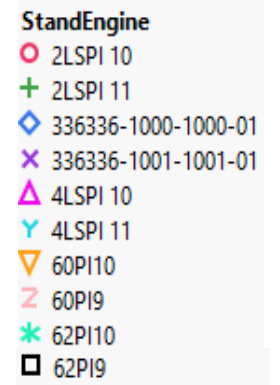
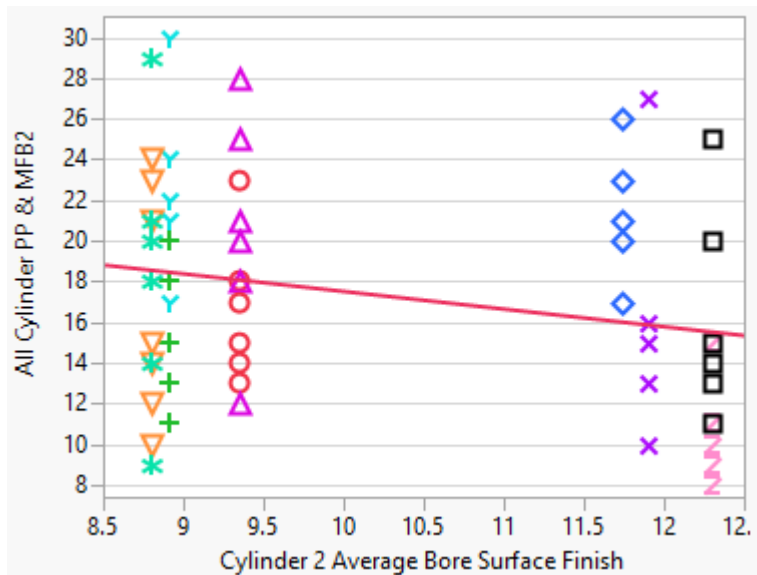
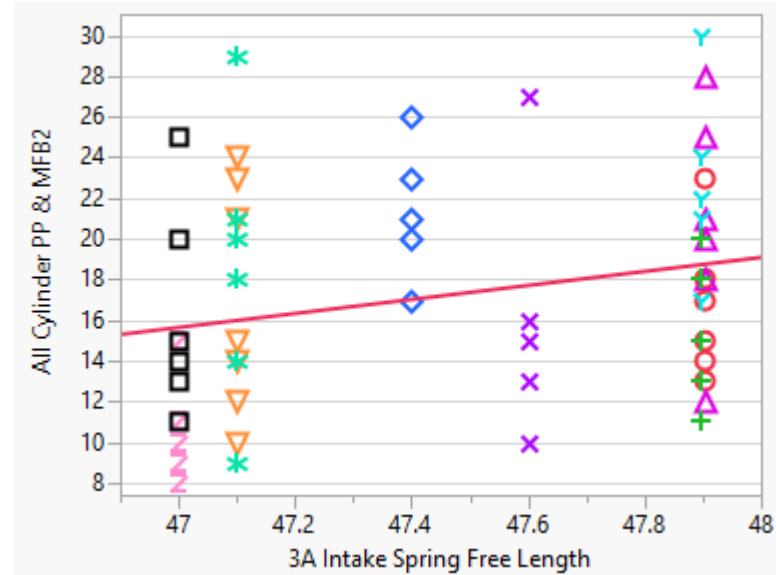
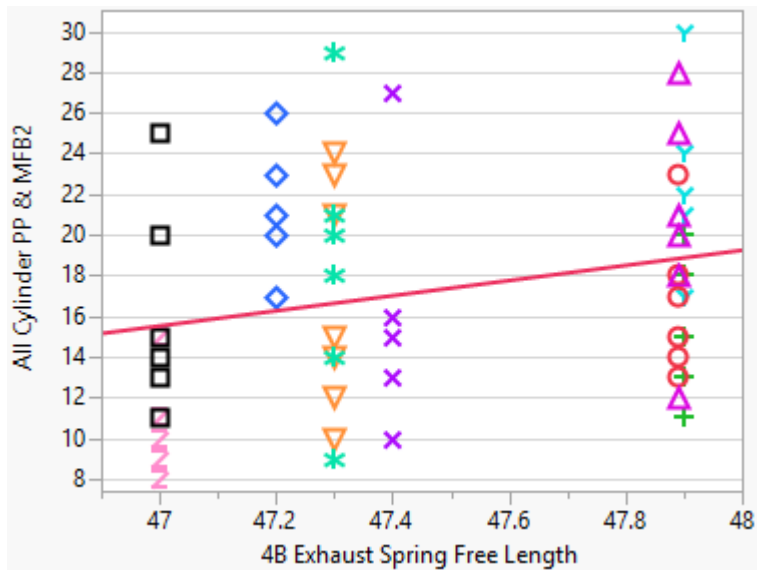


Quest to Understand Sources of variability - Option1

- StandEngine**
- 2LSPI 10
 - + 2LSPI 11
 - ◇ 336336-1000-1000-01
 - × 336336-1001-1001-01
 - △ 4LSPI 10
 - Y 4LSPI 11
 - ▽ 60PI10
 - z 60PI9
 - * 62PI10
 - 62PI9



Quest to Understand Sources of variability - Option1



Quest to Understand Sources of variability – Option2

Build and operational differences do not appear to explain the residual variability

Quest to Understand Sources of variability – Option2

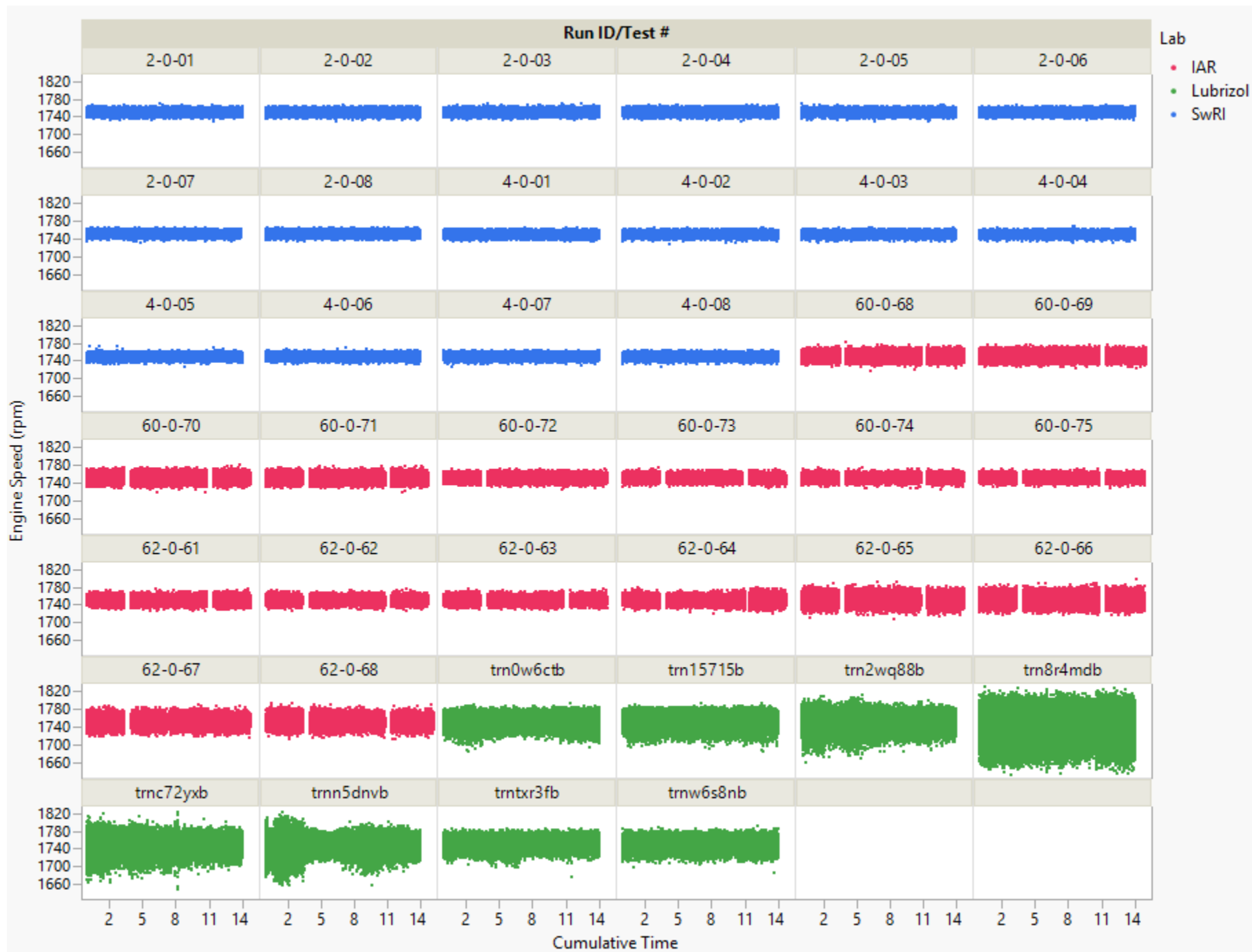
Build and operational differences do not appear to explain the residual variability

Operational Data Plots

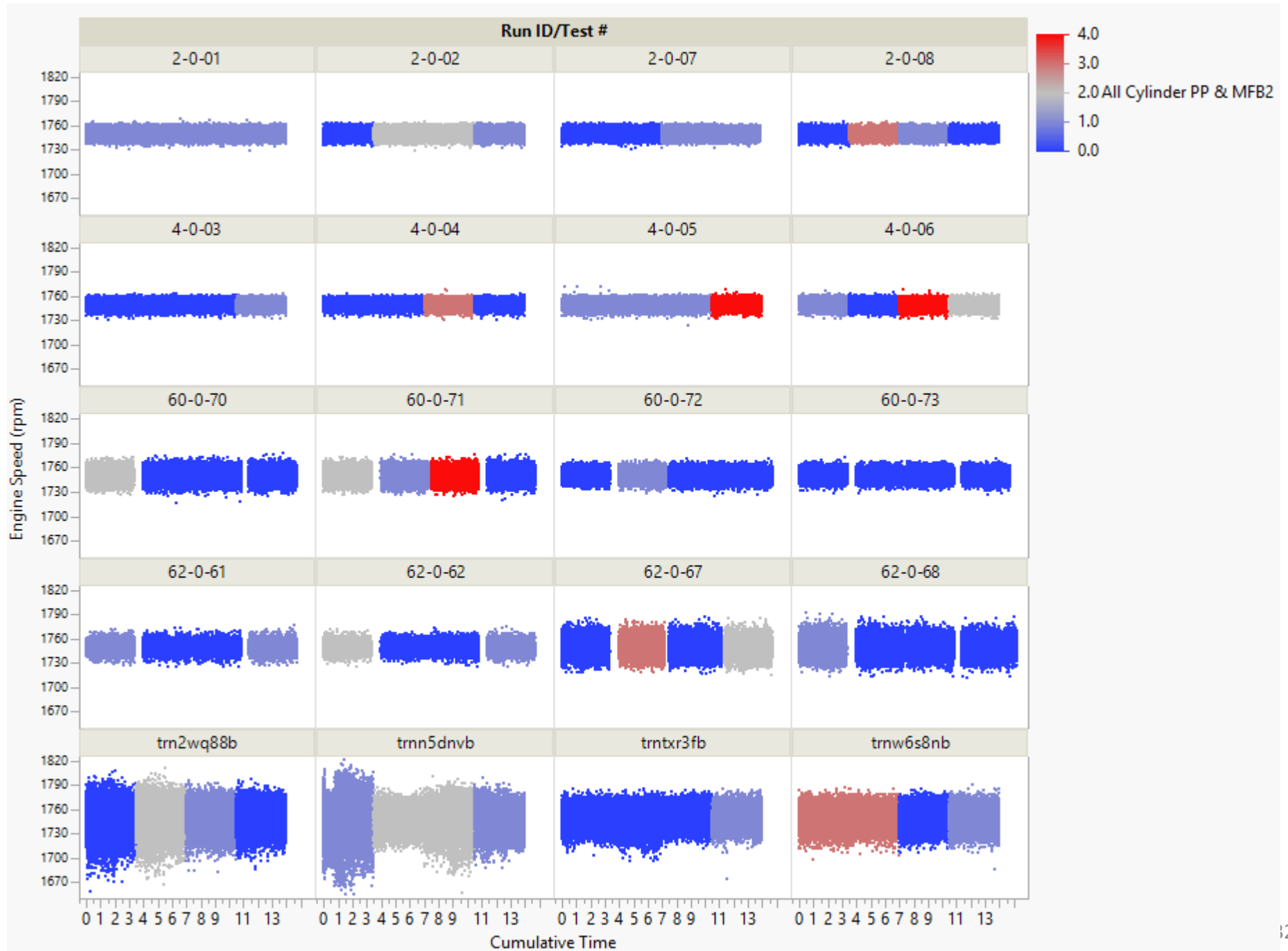
Overview

- Operational parameters are plotted versus cumulative time
 - Cumulative time is a combination of time from valid iterations A, B, C, and D; time at start of iteration A = 0hrs
- Each RunID/Test # is plotted in a separate pane
- Each parameter has plots with a legend for both lab and number of LSPI events (a.k.a. All Cylinder PP & MFB2)
- CAN data are plotted with and without stand 62

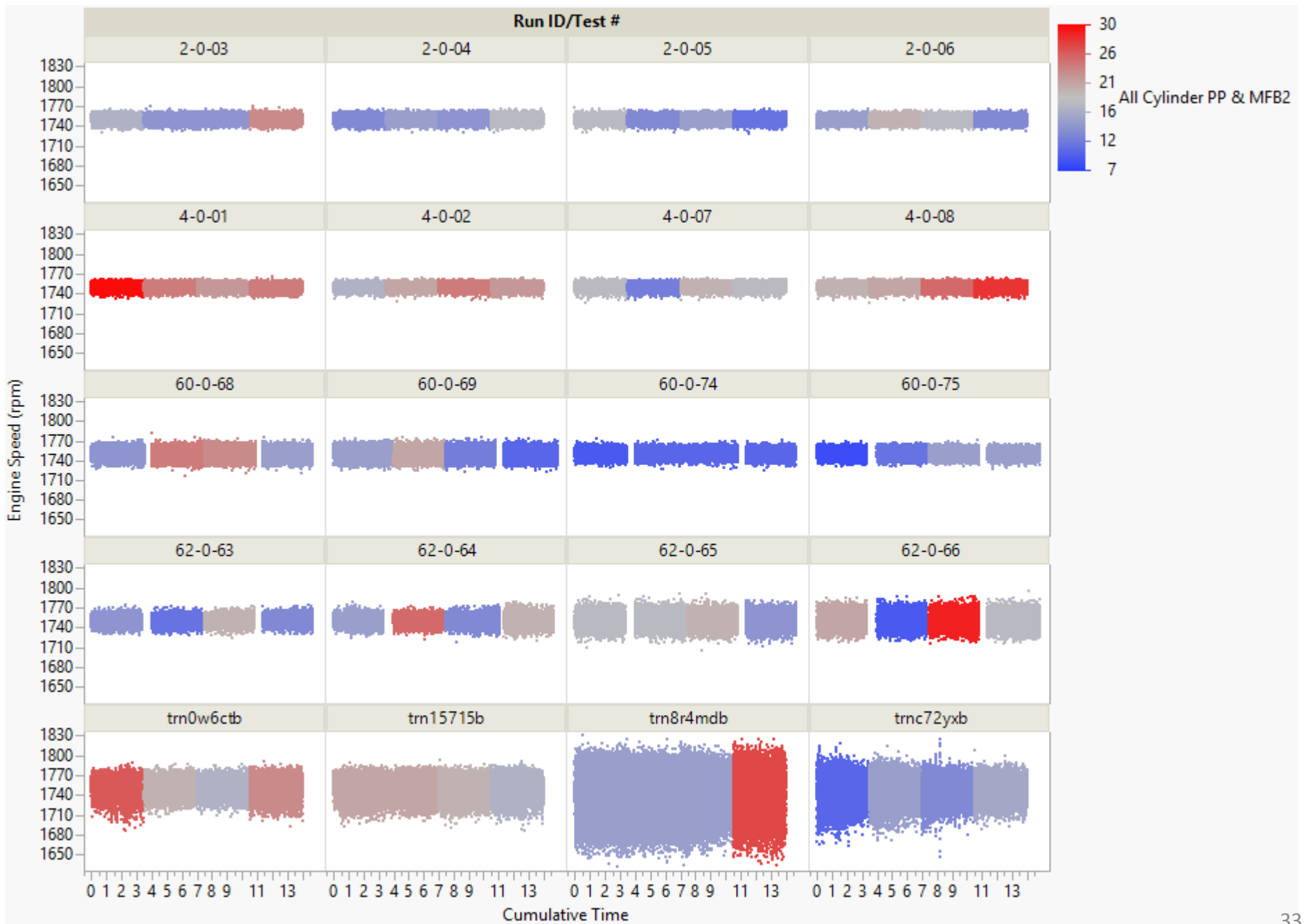
Engine Speed



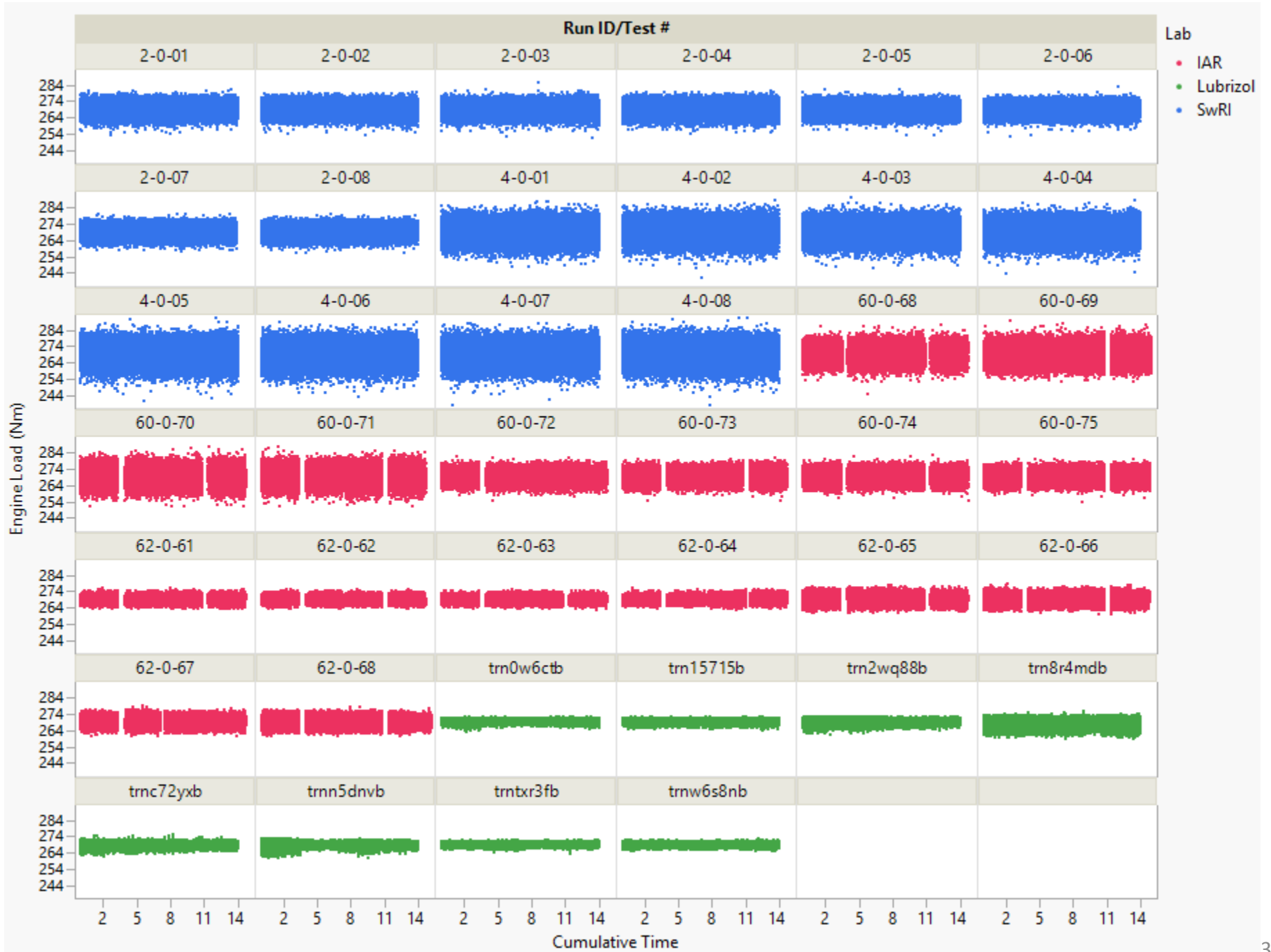
Low Event Oil



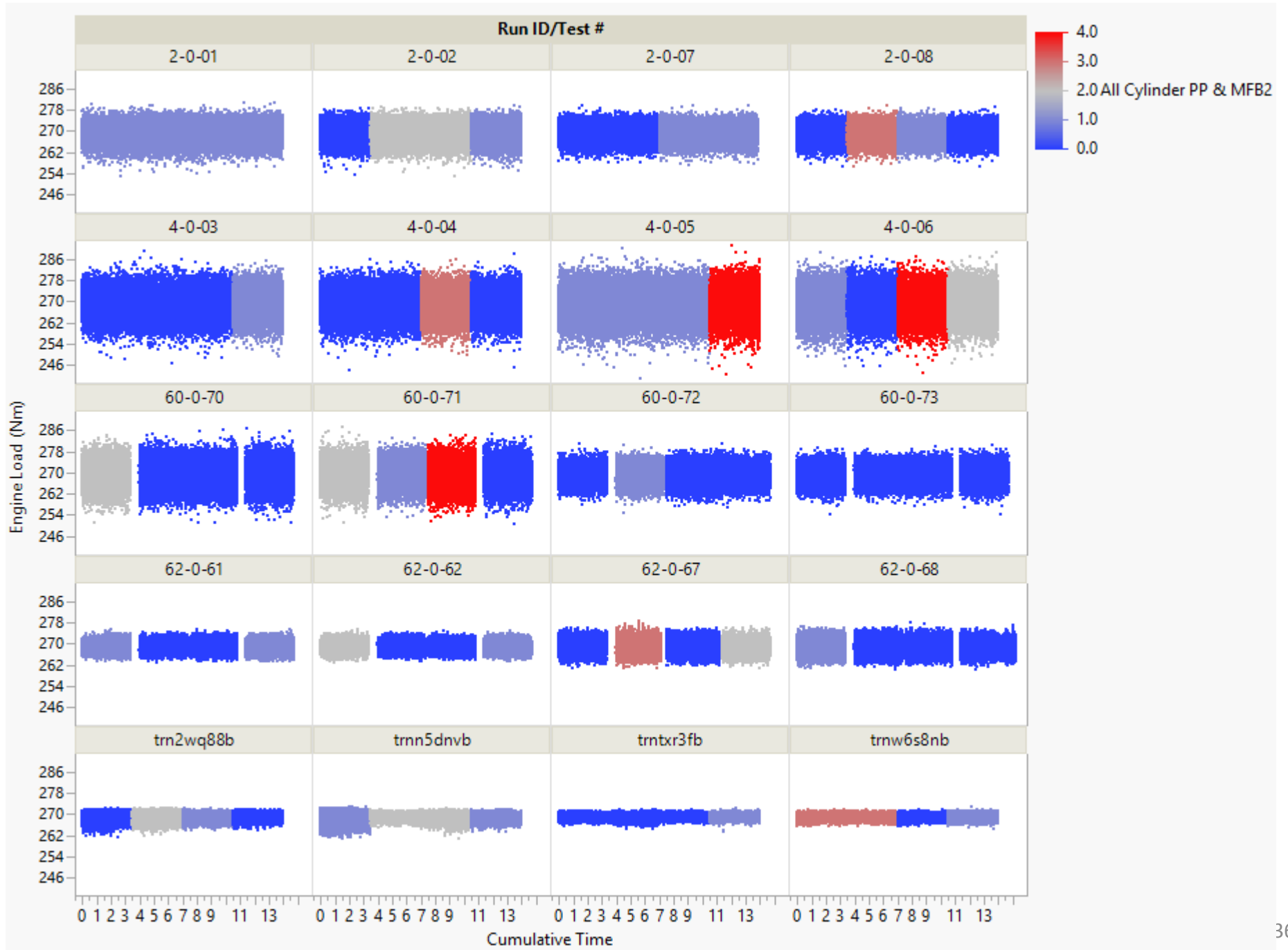
High Event Oil



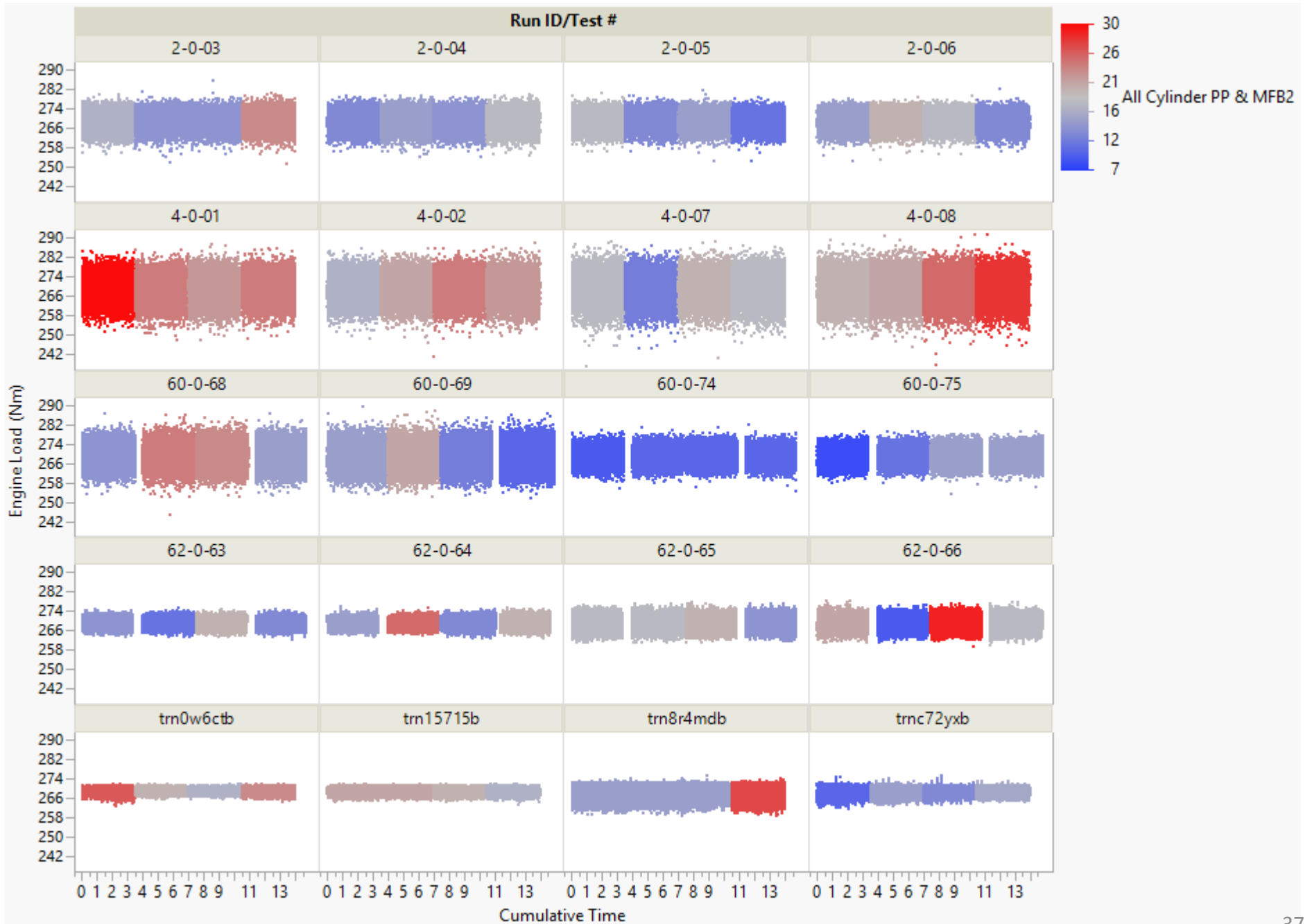
Engine Load



Low Event Oil



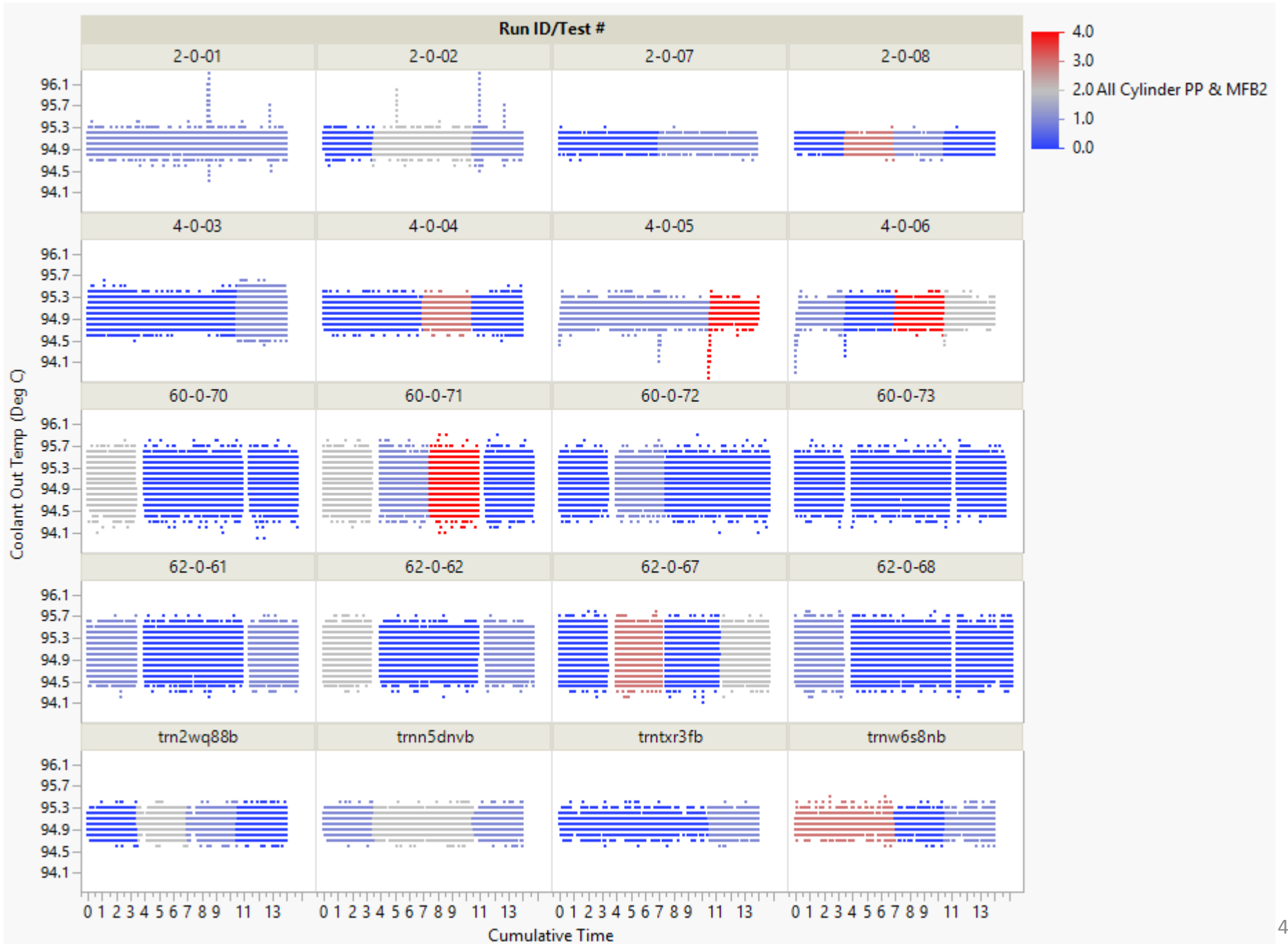
High Event Oil



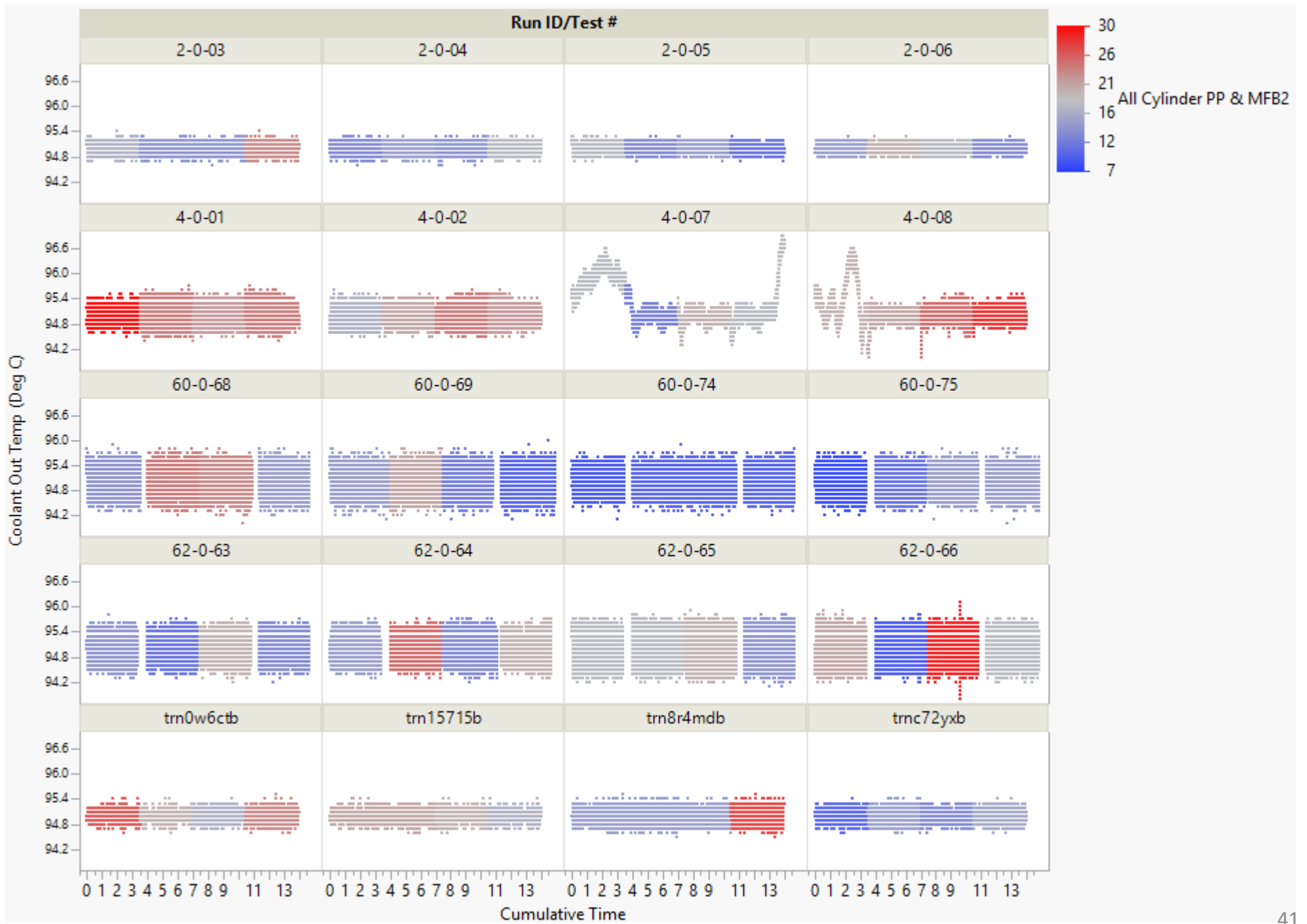
Coolant Out Temperature



Low Event Oil



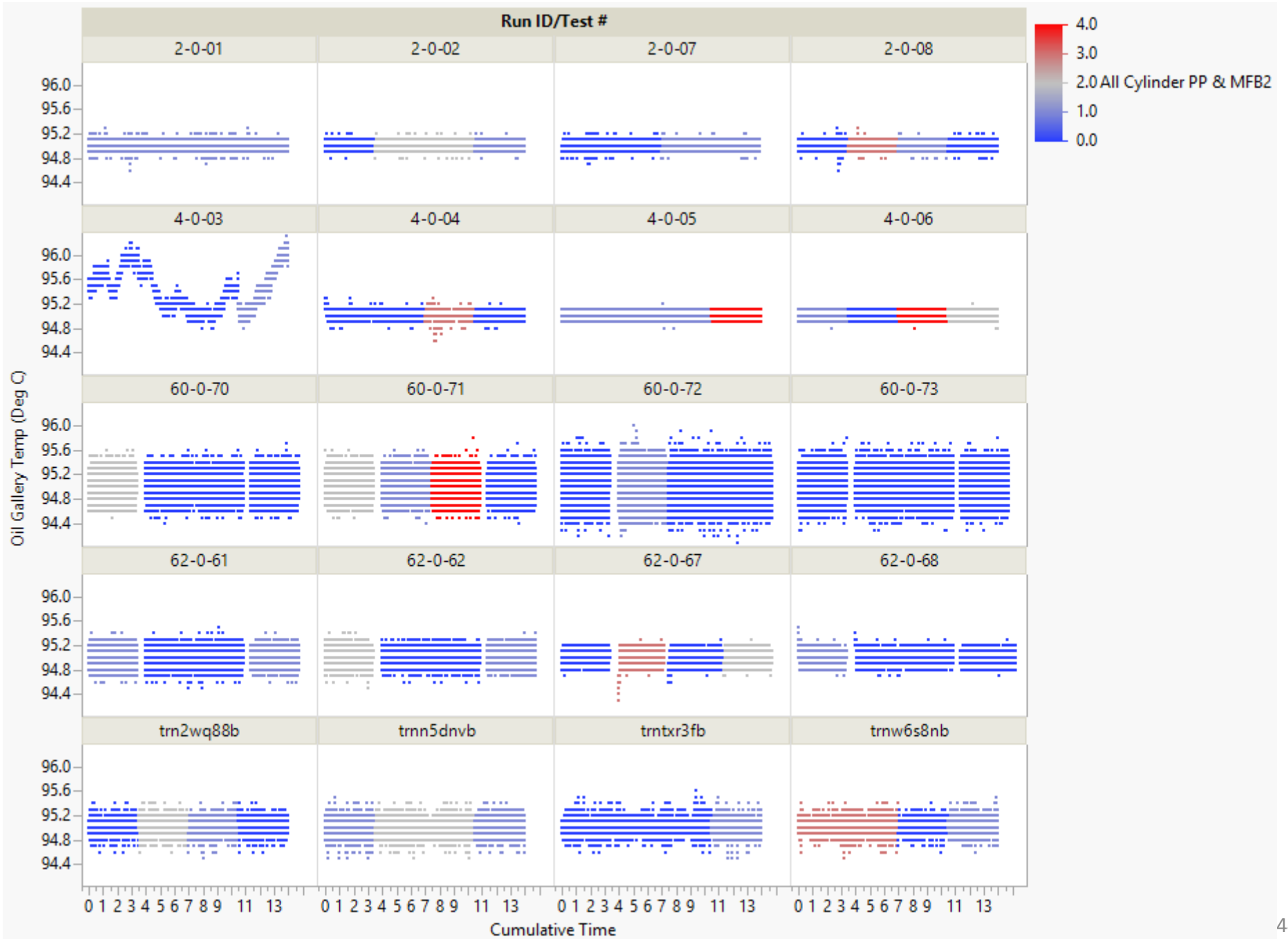
High Event Oil



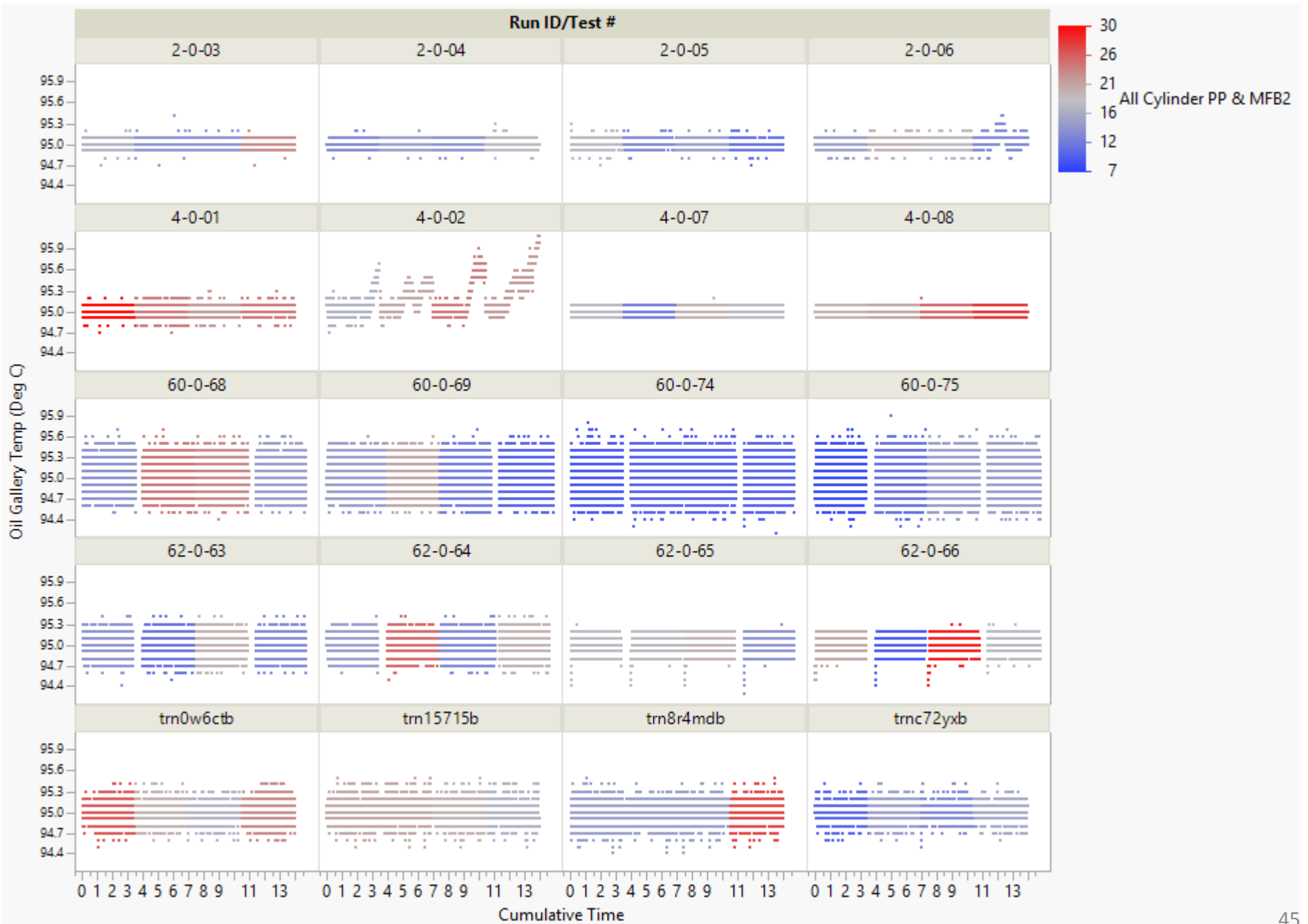
Oil Gallery Temperature



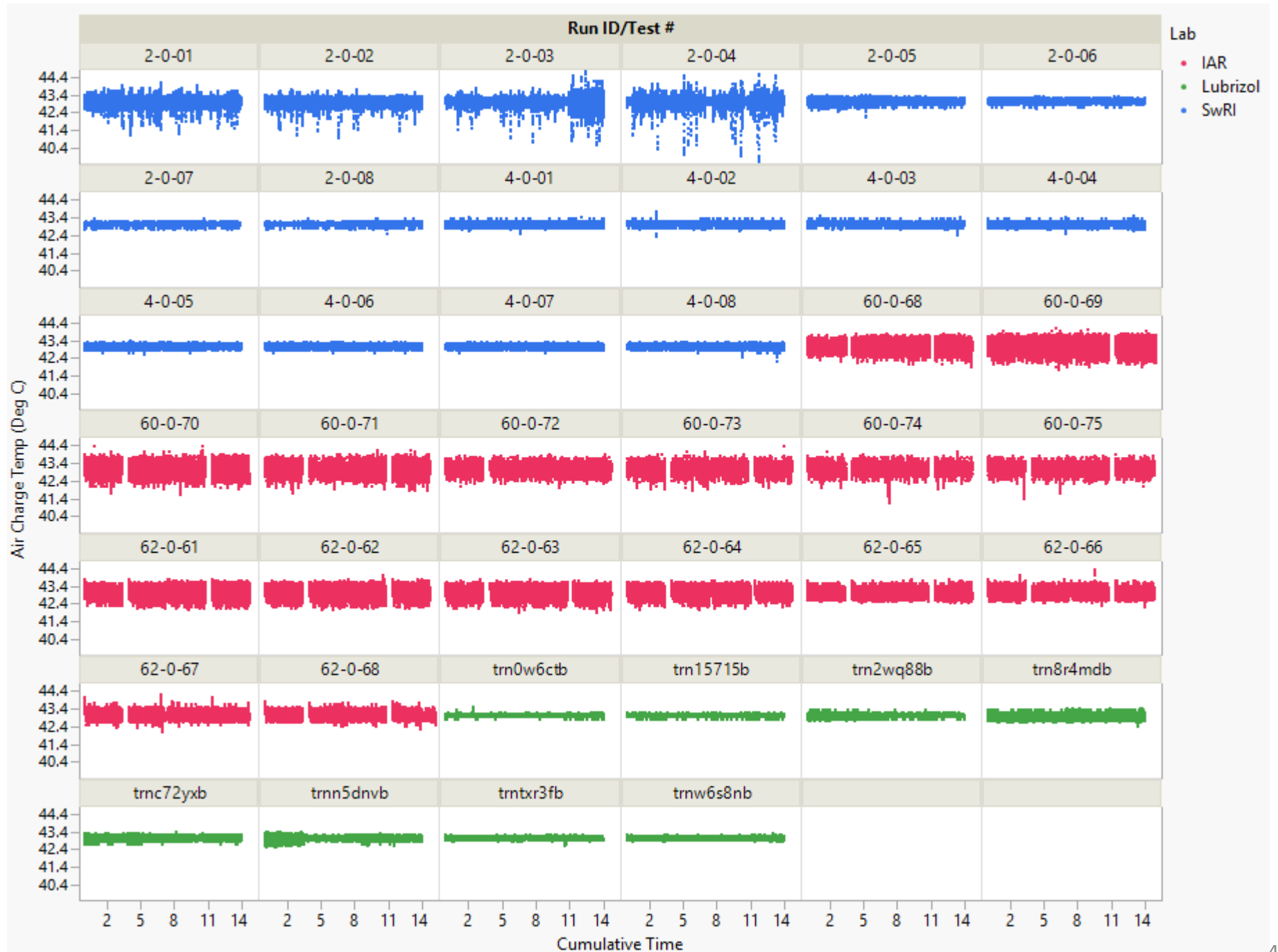
Low Event Oil



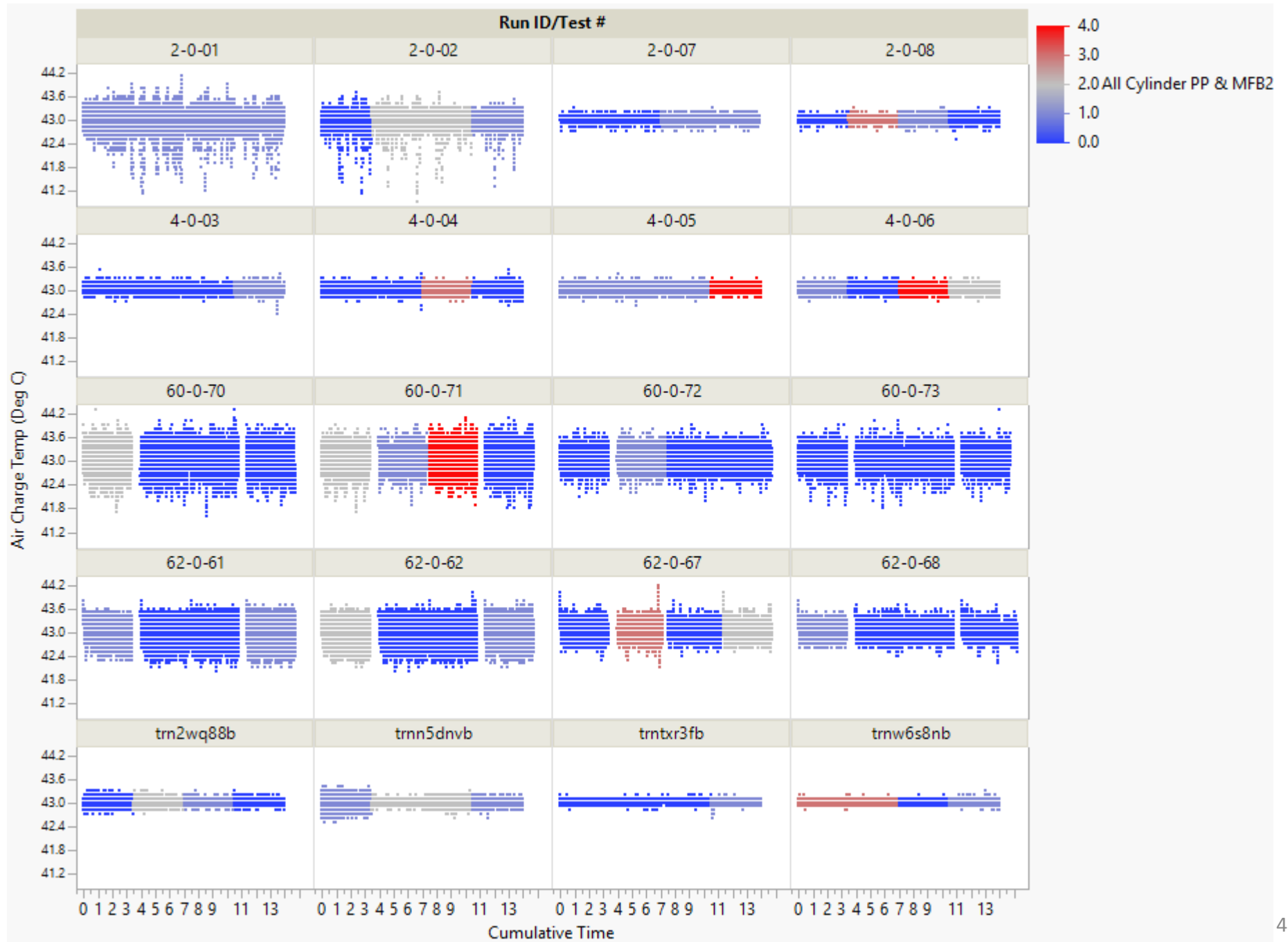
High Event Oil



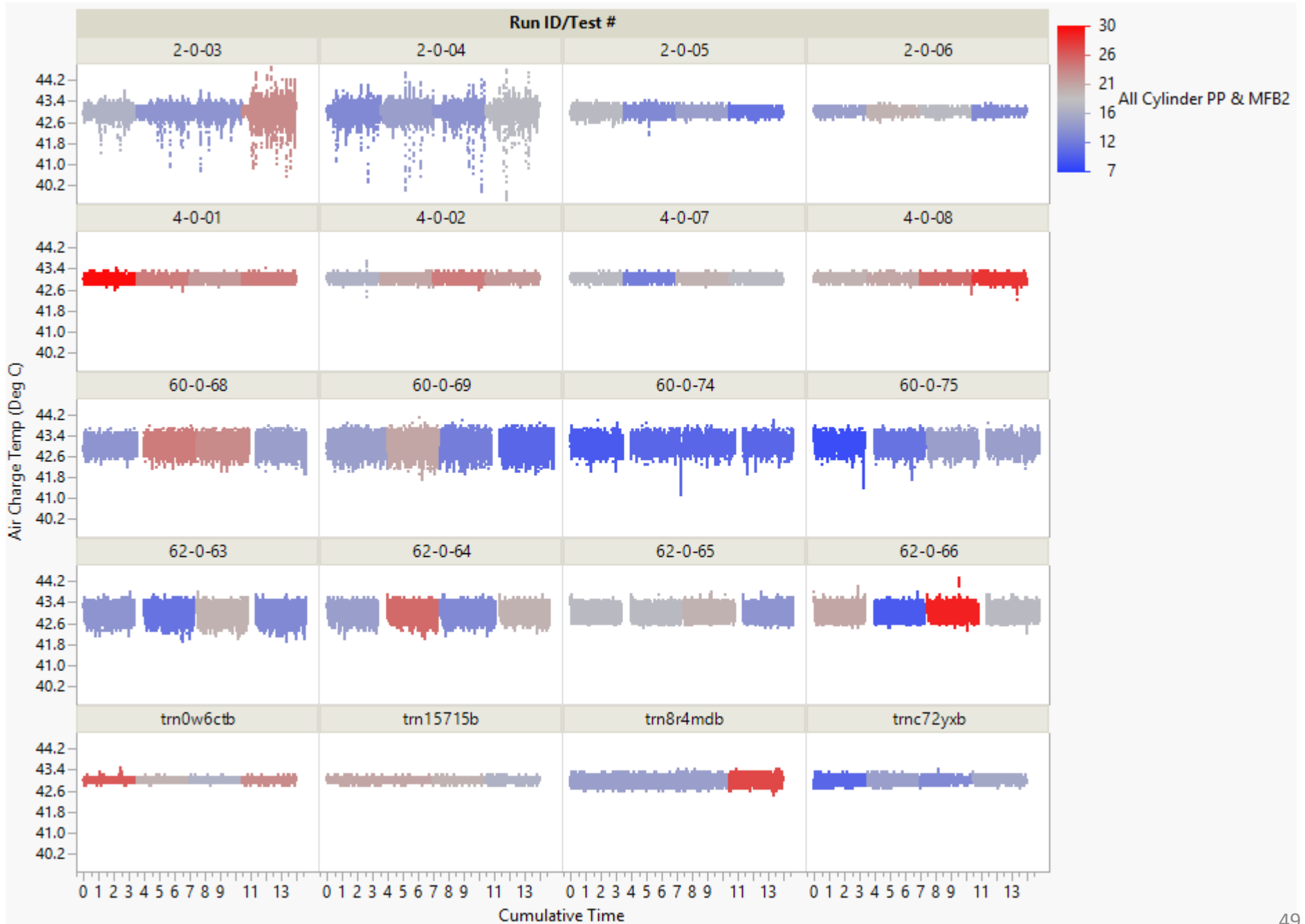
Air Charge Temperature



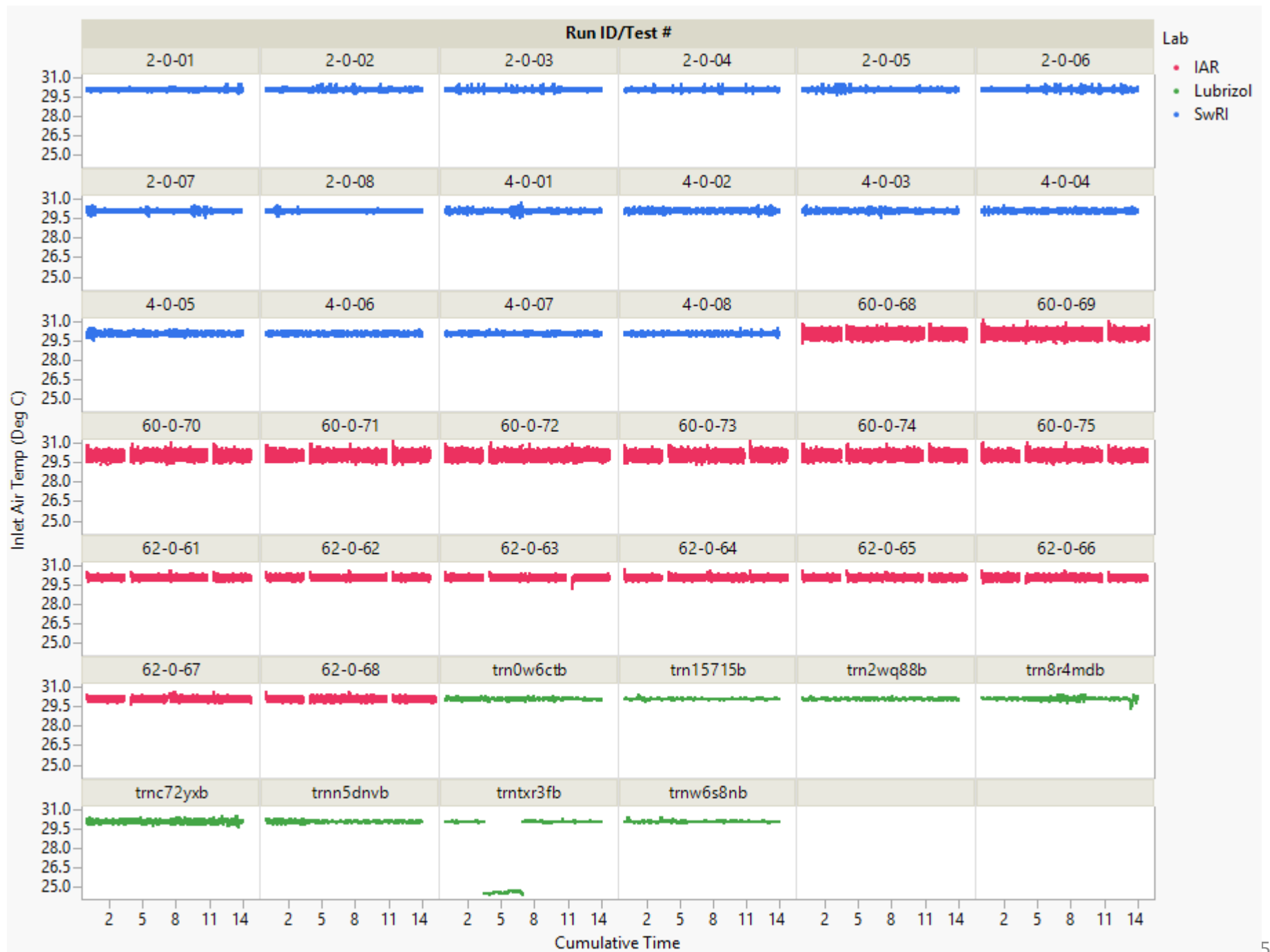
Low Event Oil



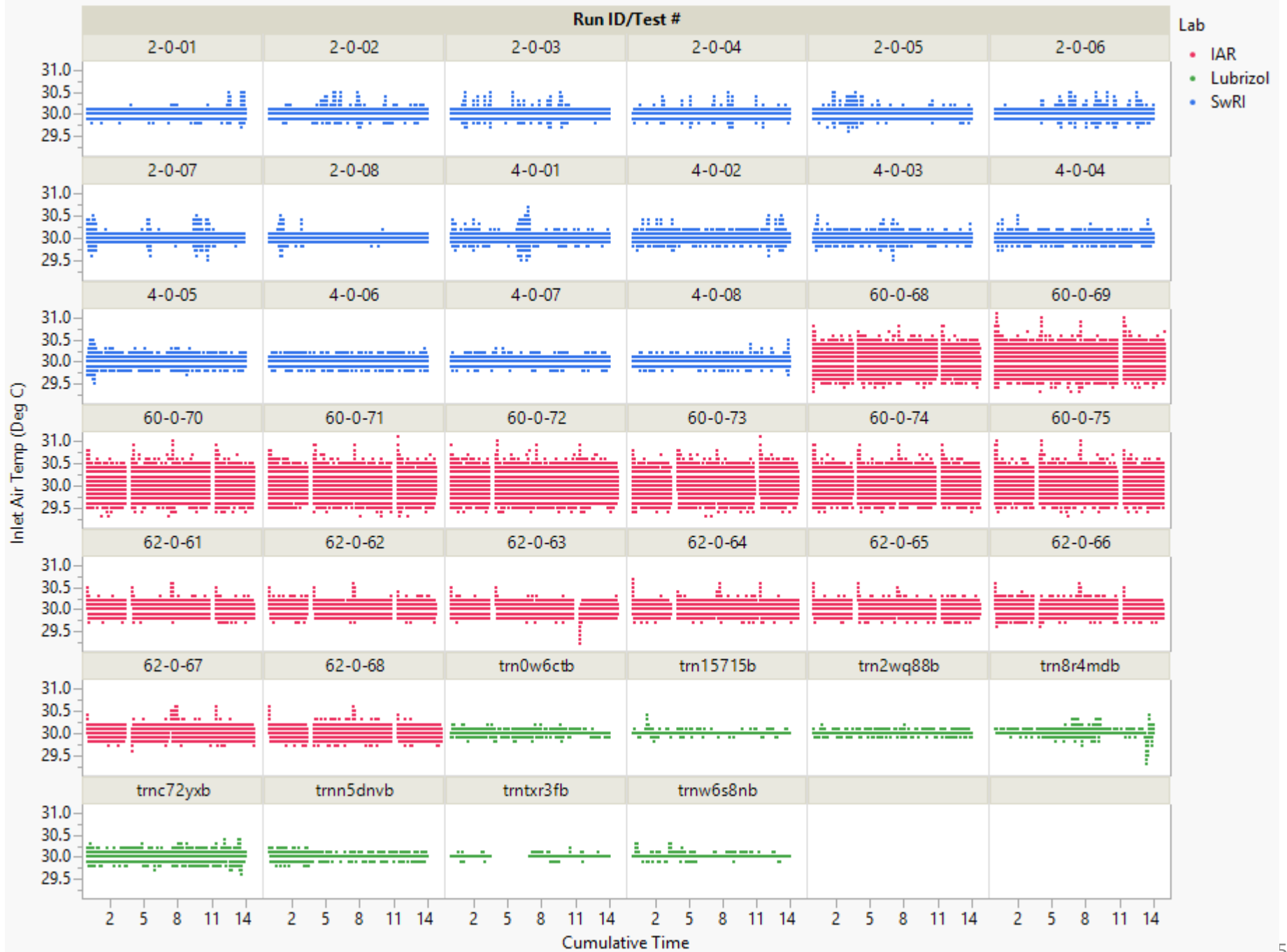
High Event Oil



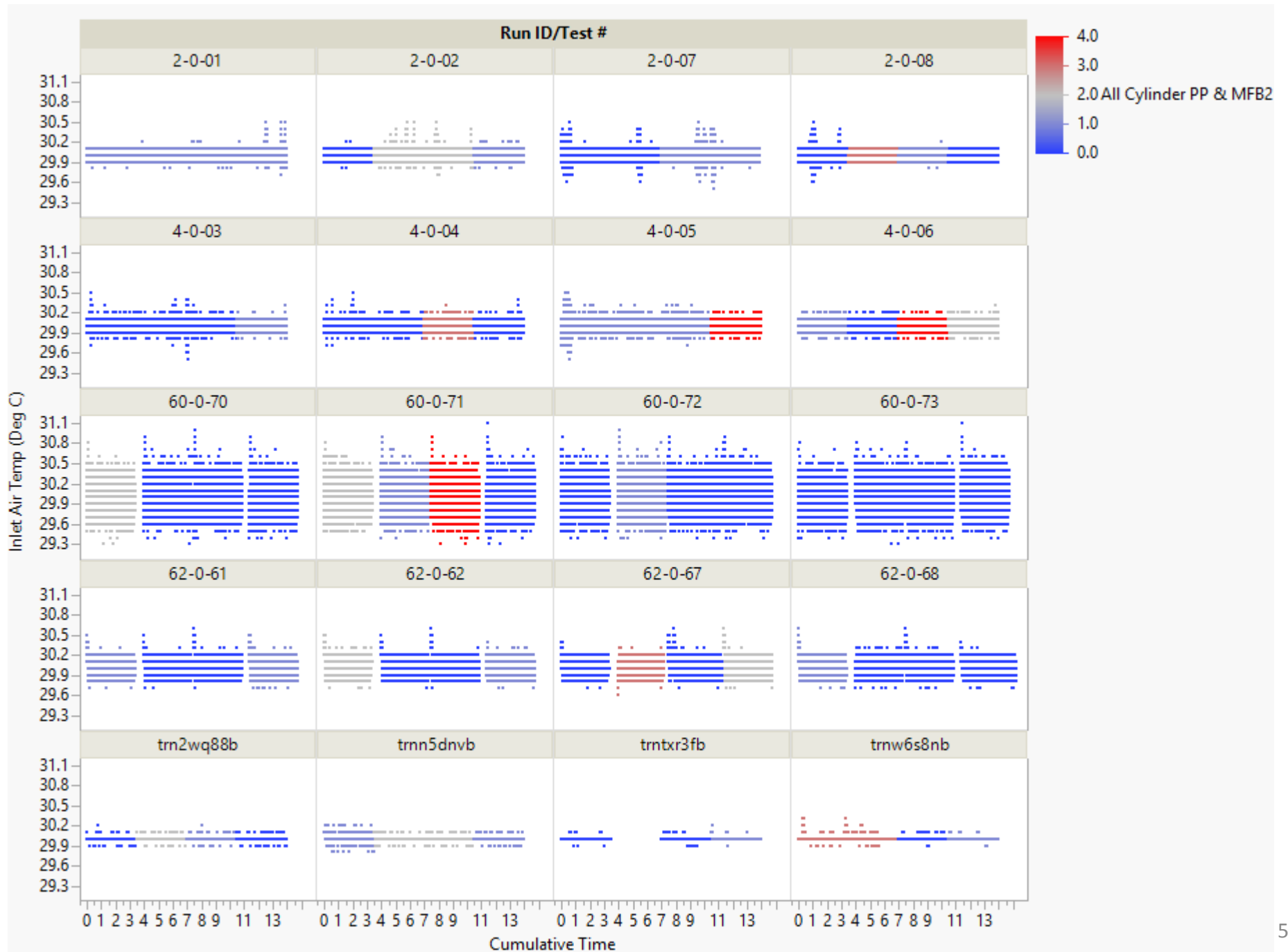
Inlet Air Temperature



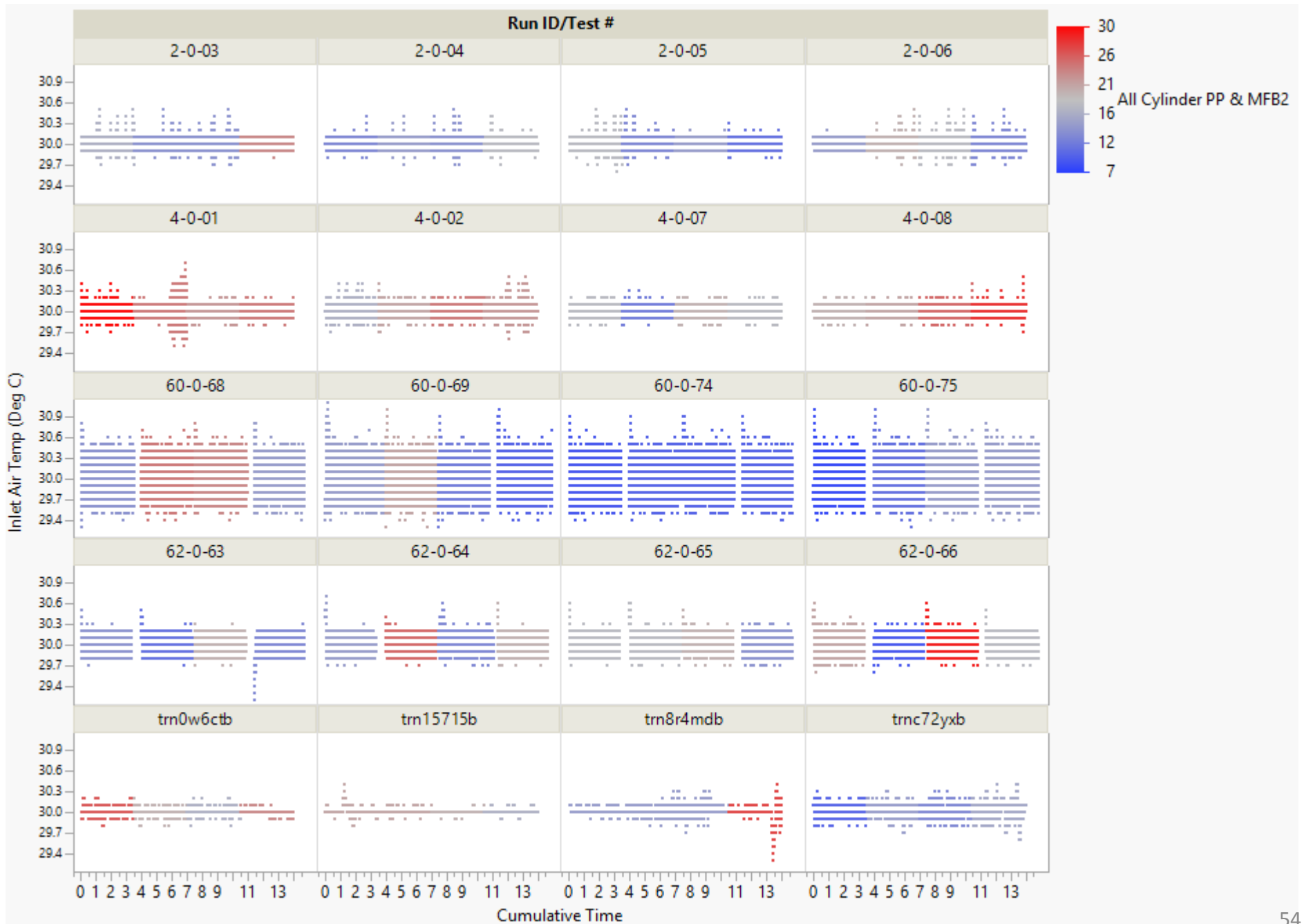
ZOOMED IN



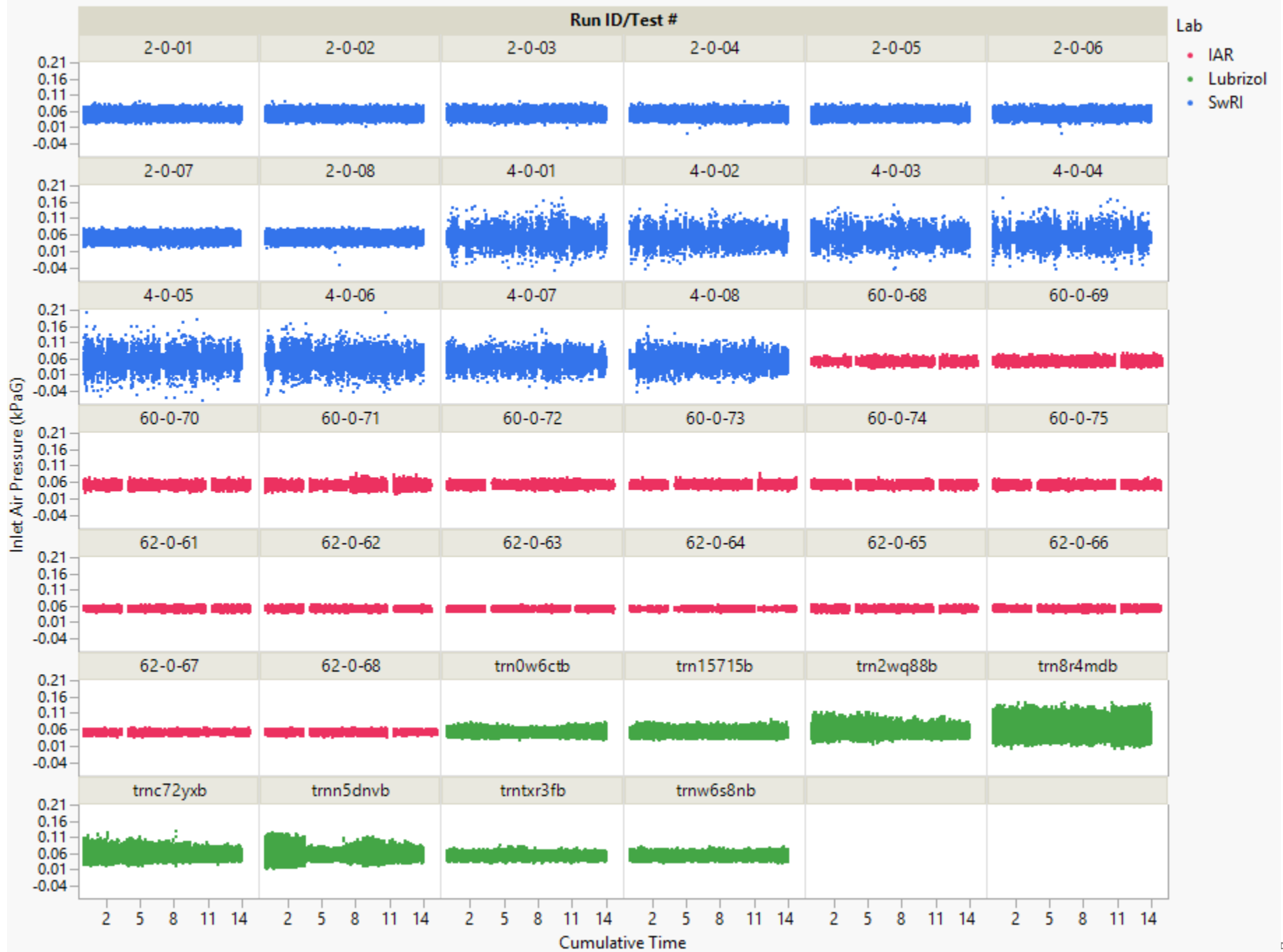
Low Event Oil



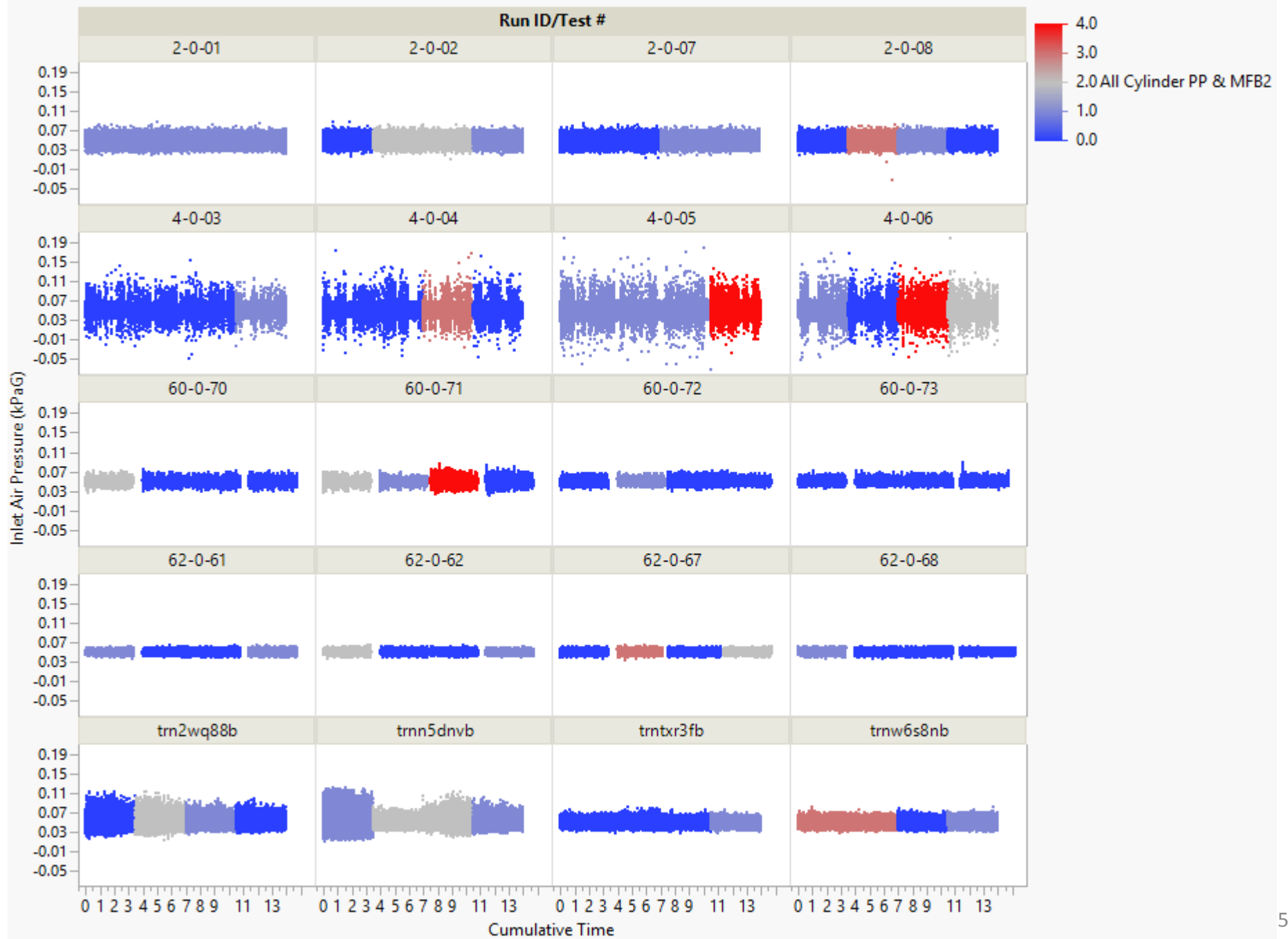
High Event Oil



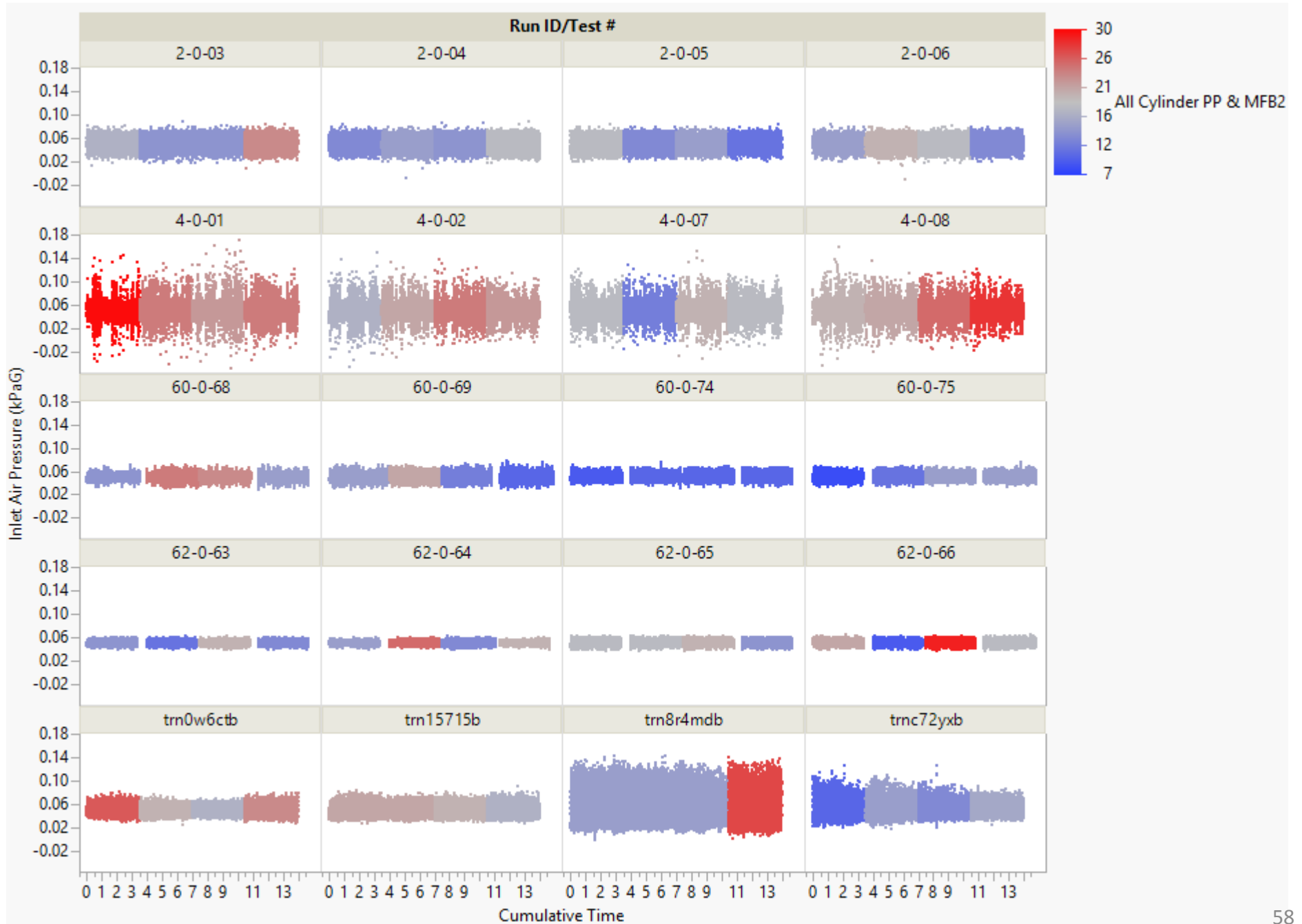
Inlet Air Pressure



Low Event Oil



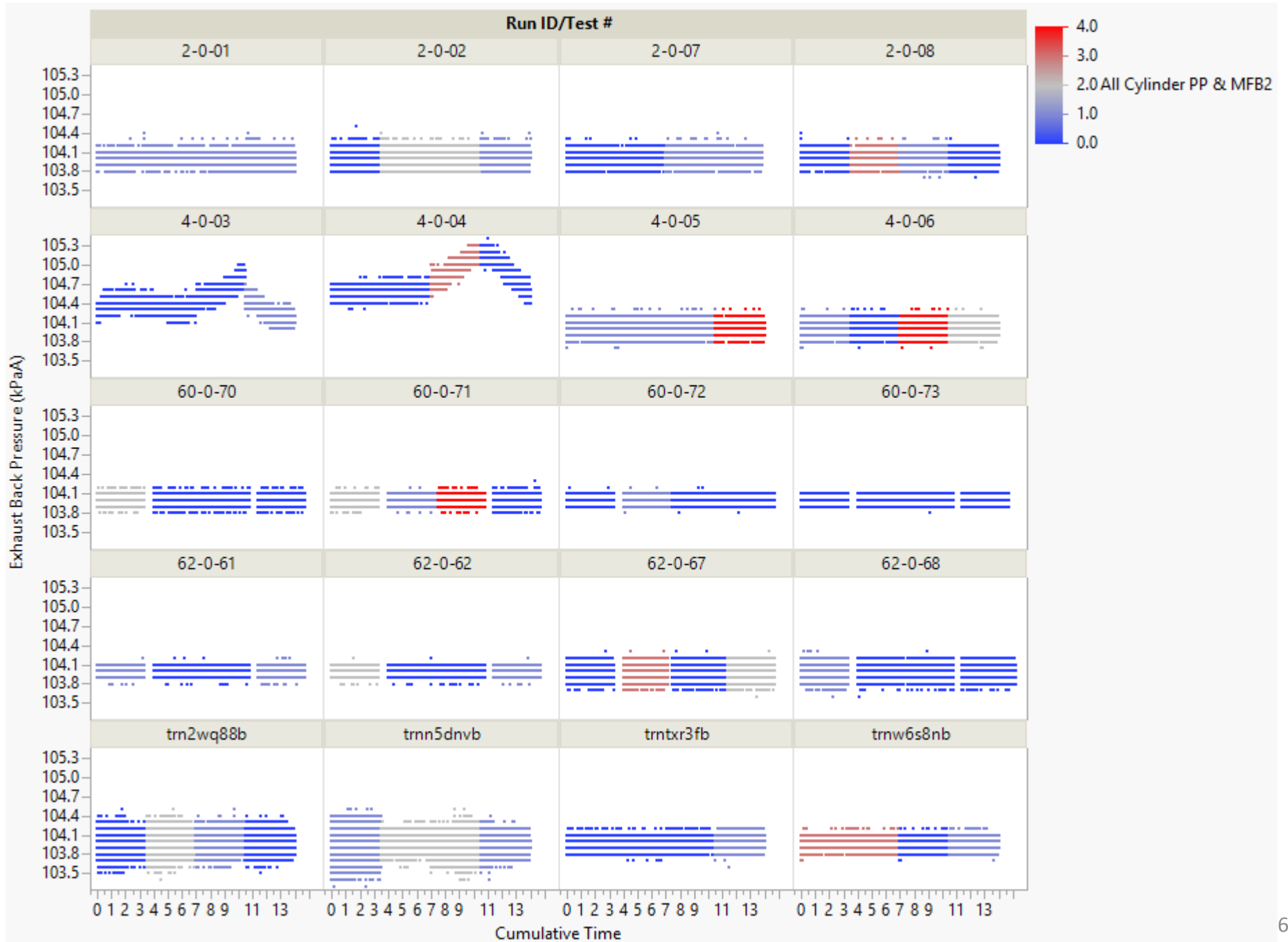
High Event Oil



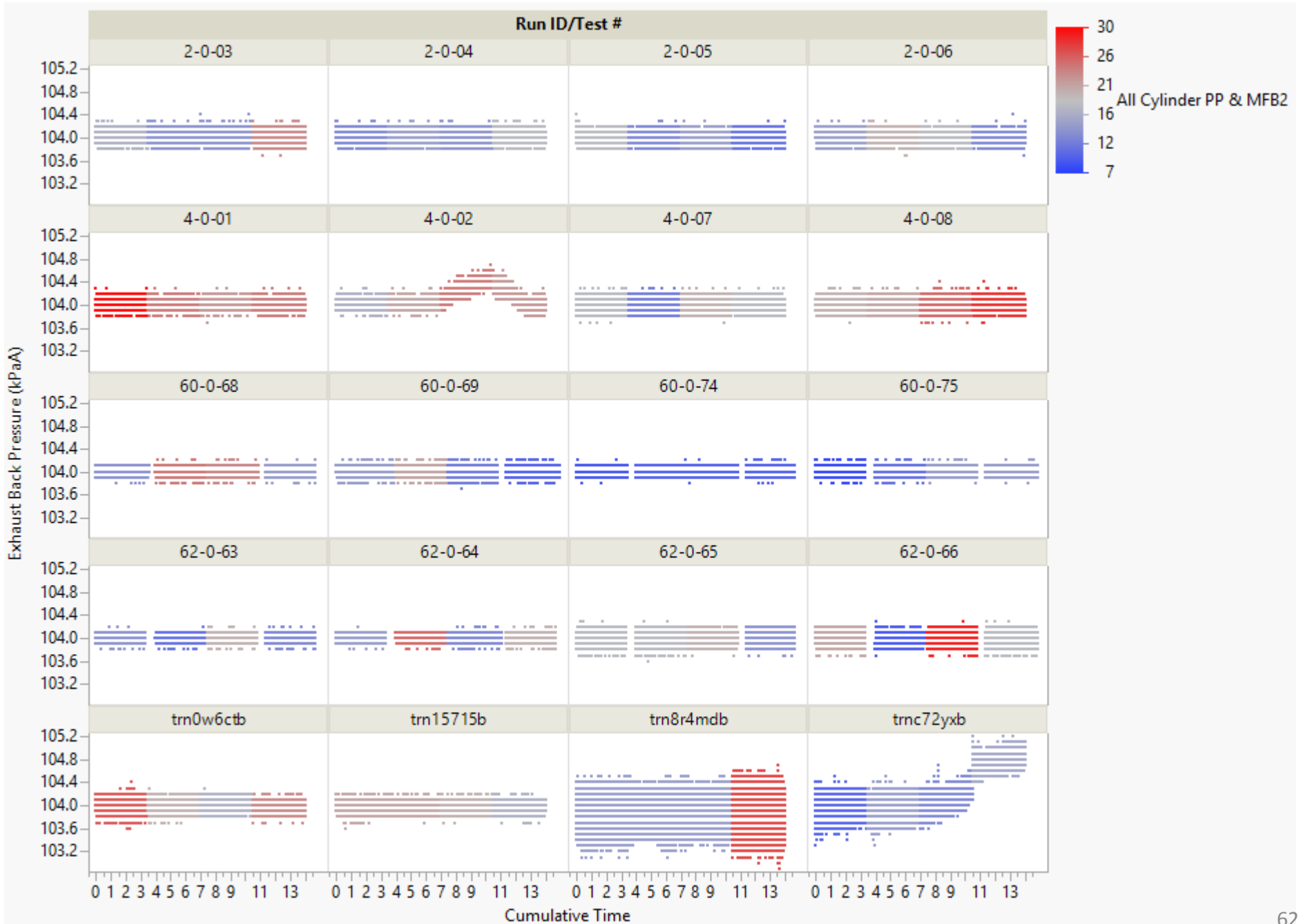
Exhaust Back Pressure



Low Event Oil

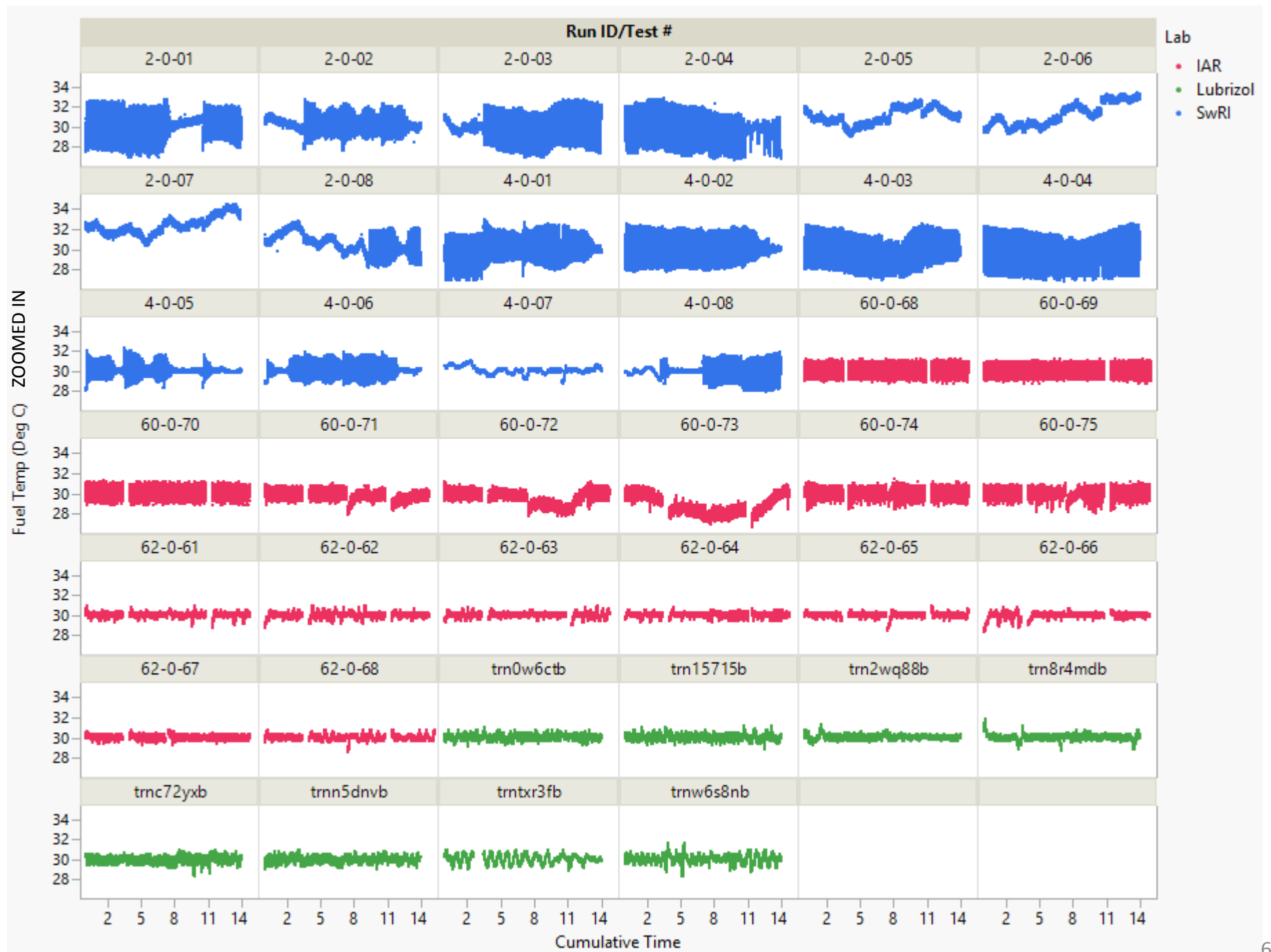


High Event Oil

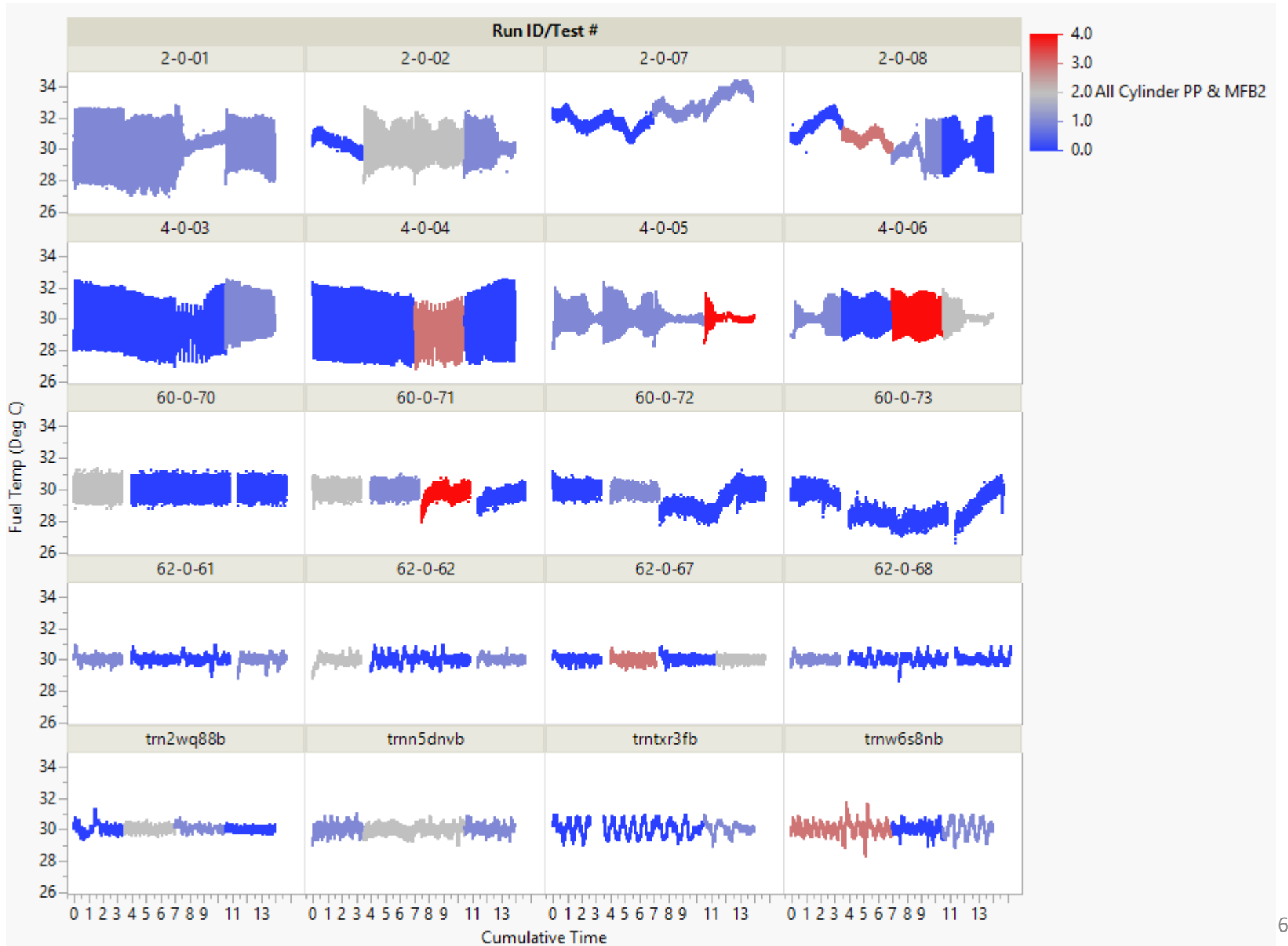


Fuel Temperature

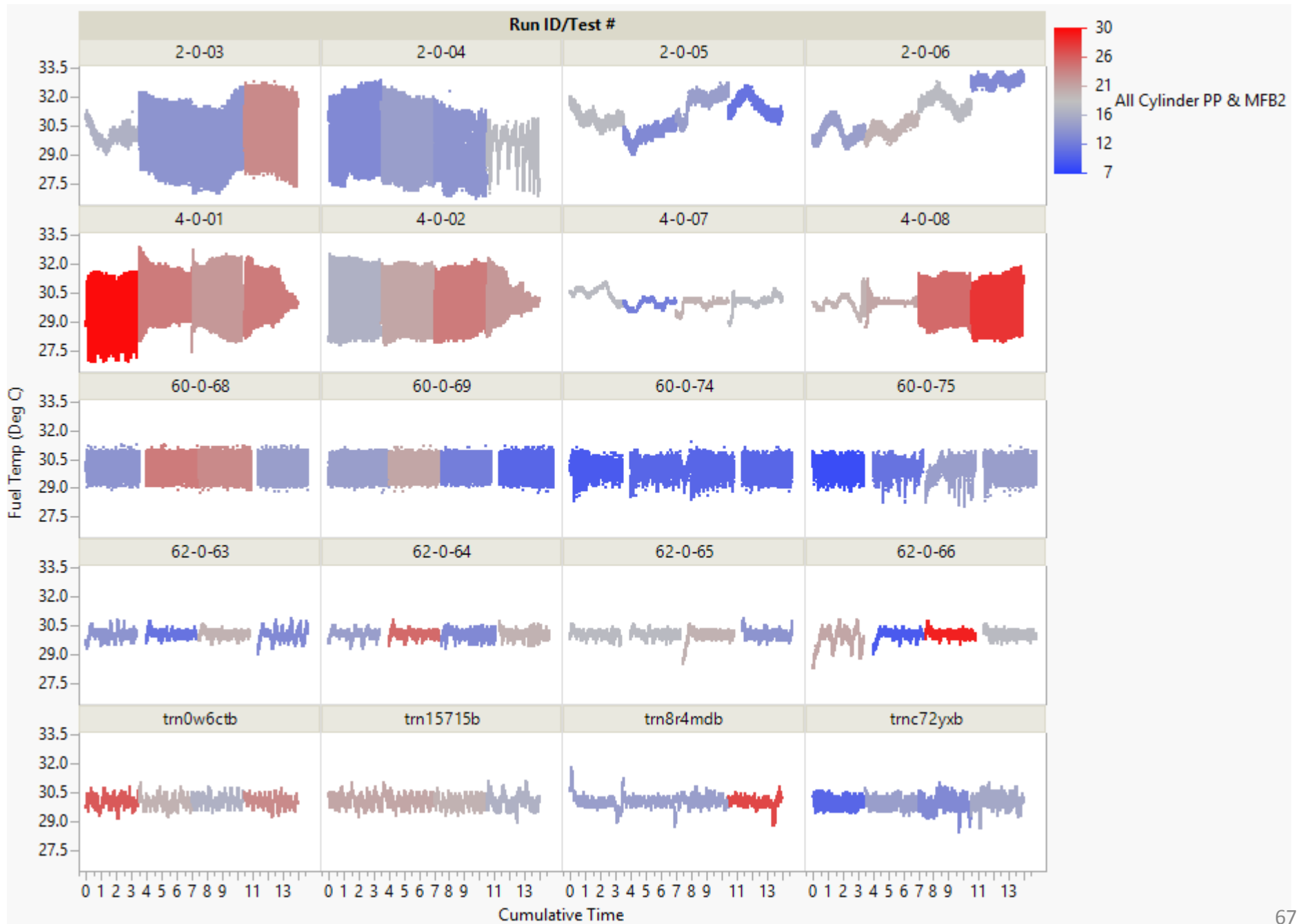




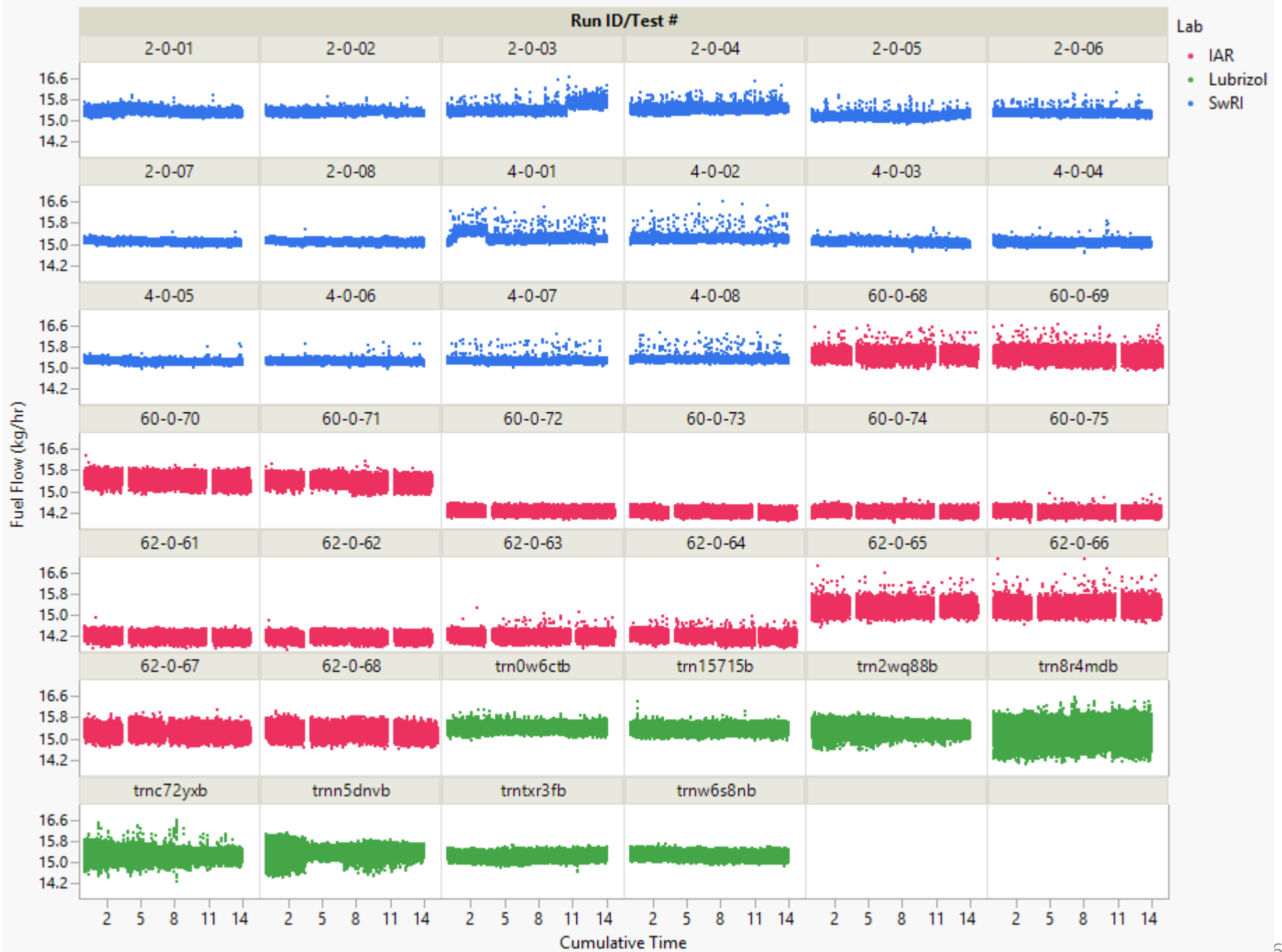
Low Event Oil



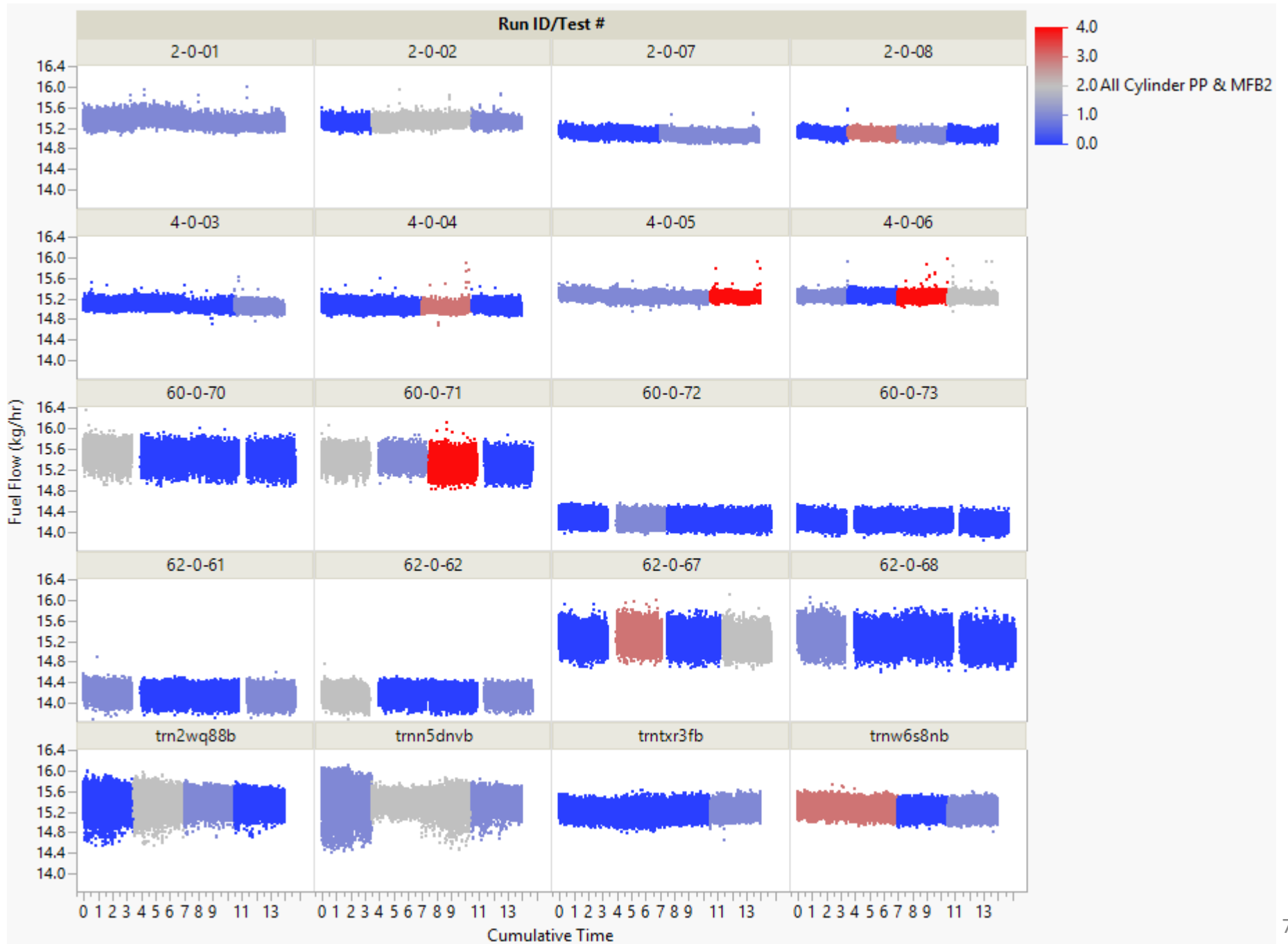
High Event Oil



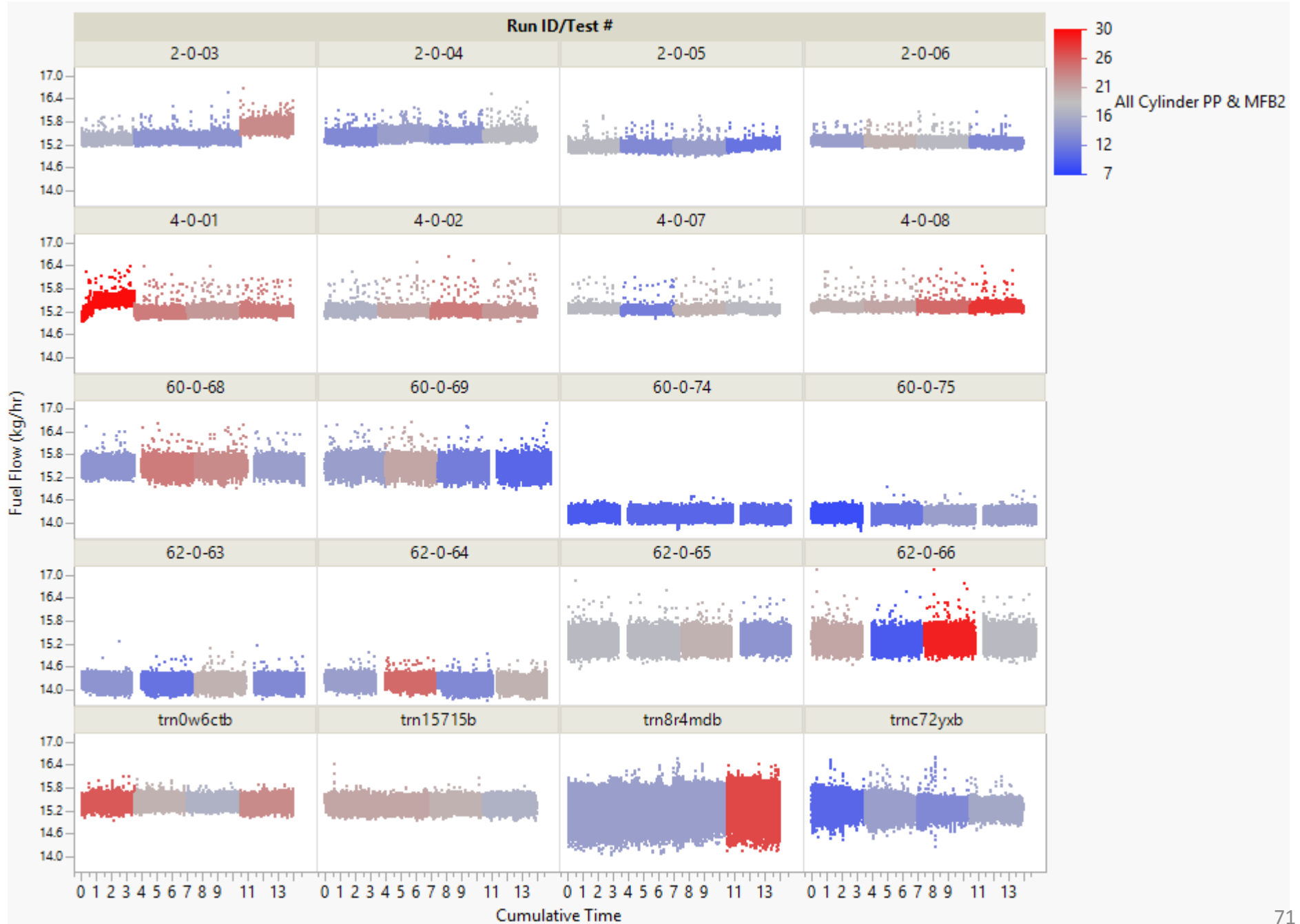
Fuel Flow



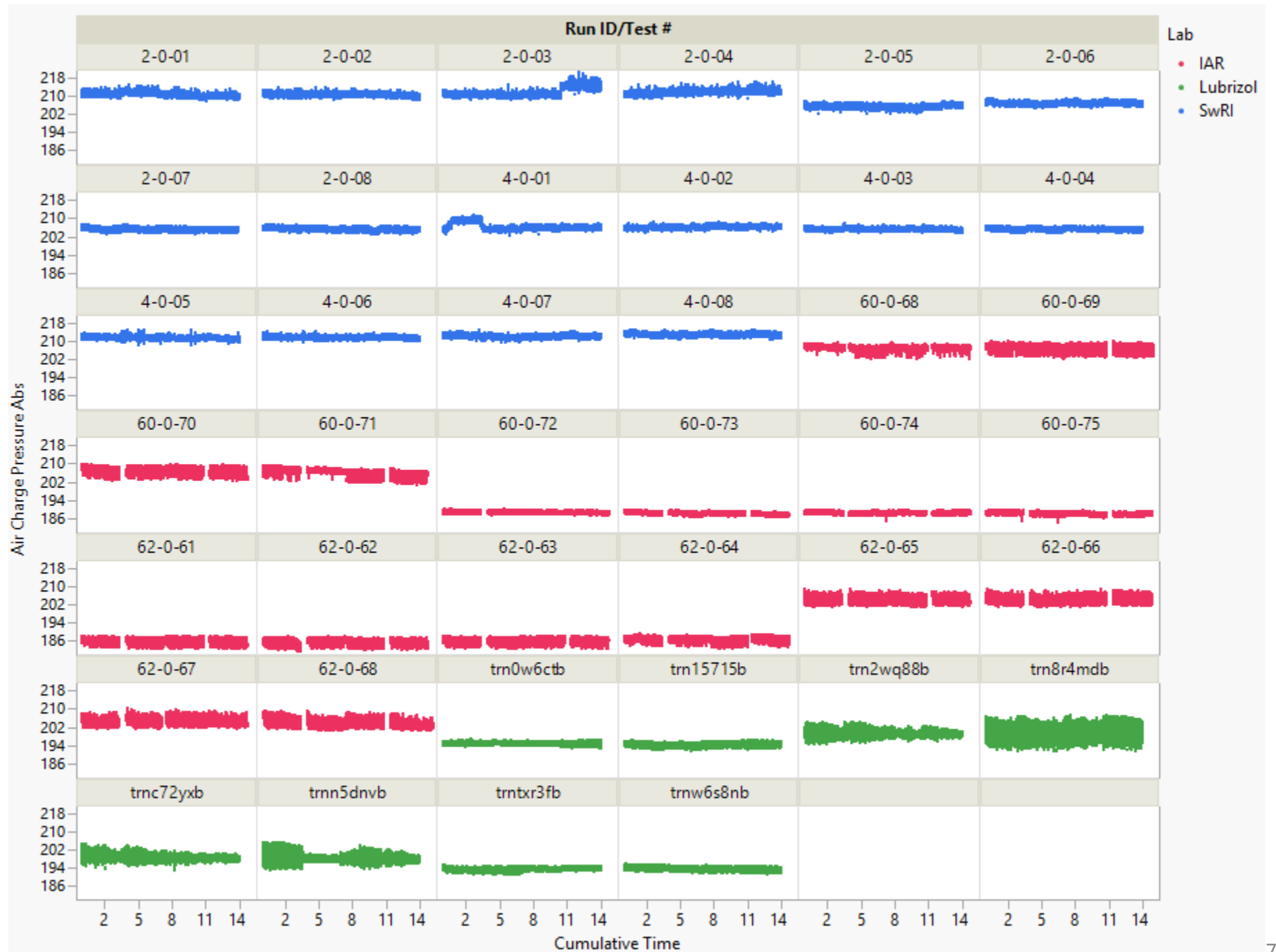
Low Event Oil



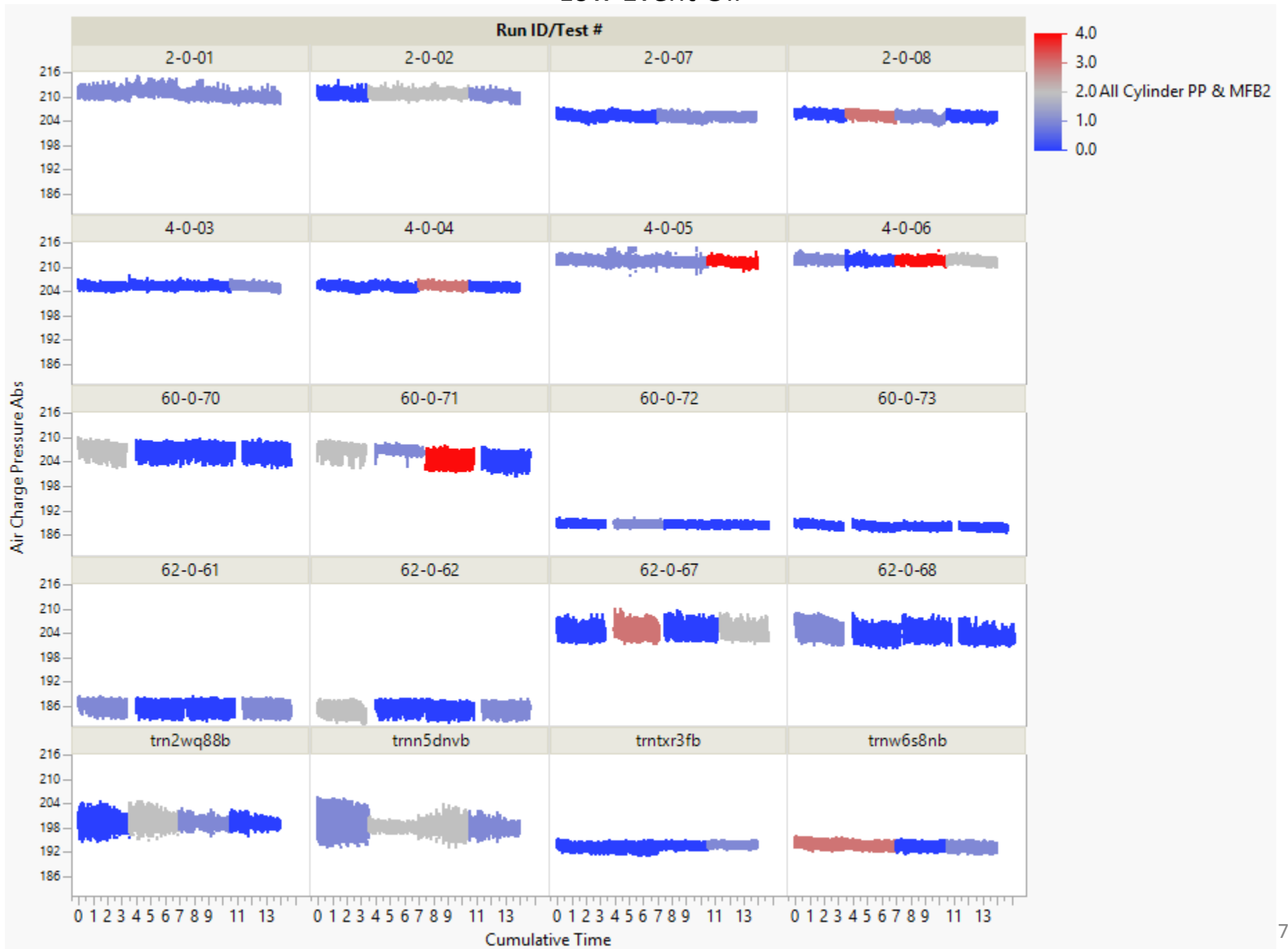
High Event Oil



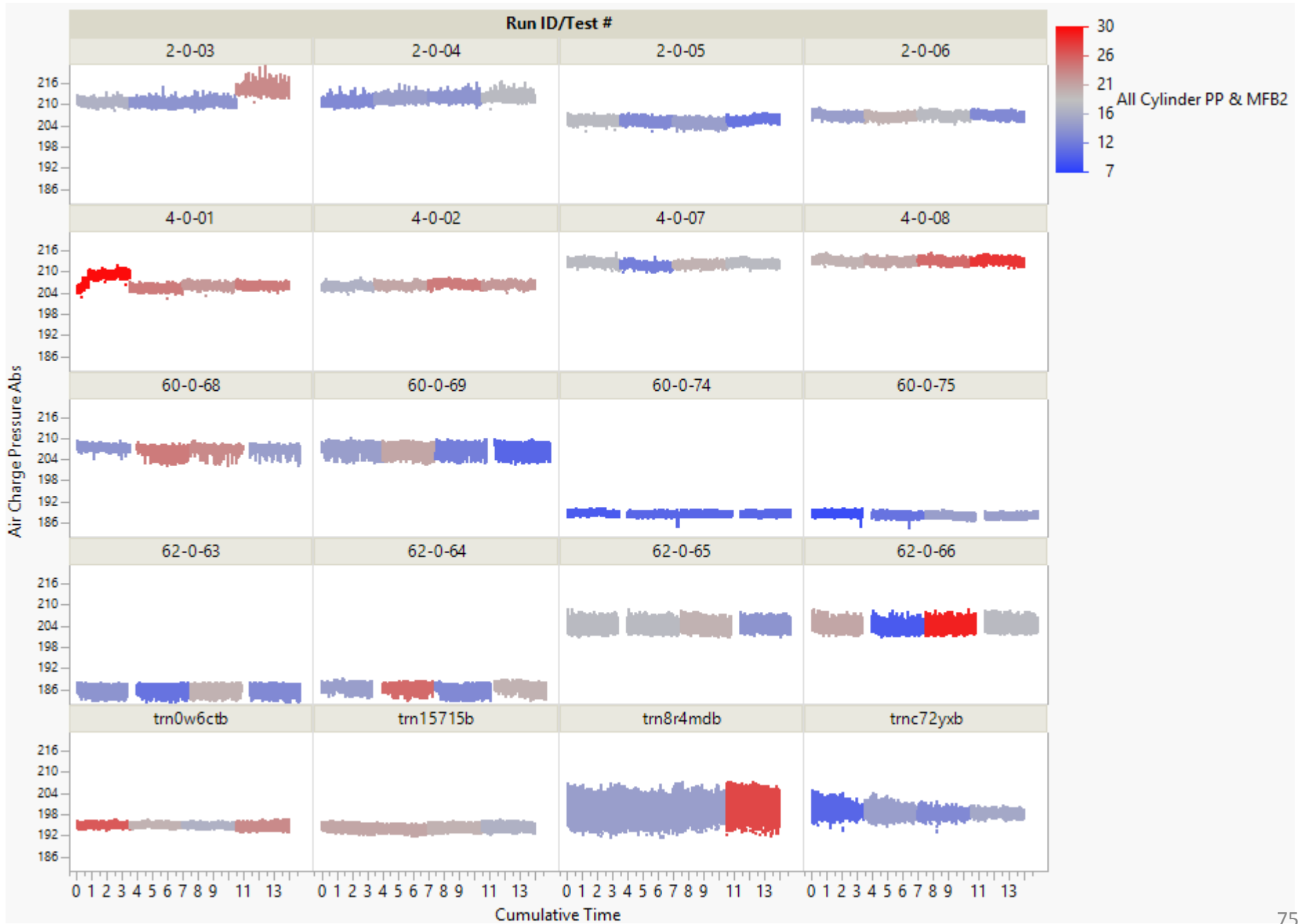
Air Charge Pressure



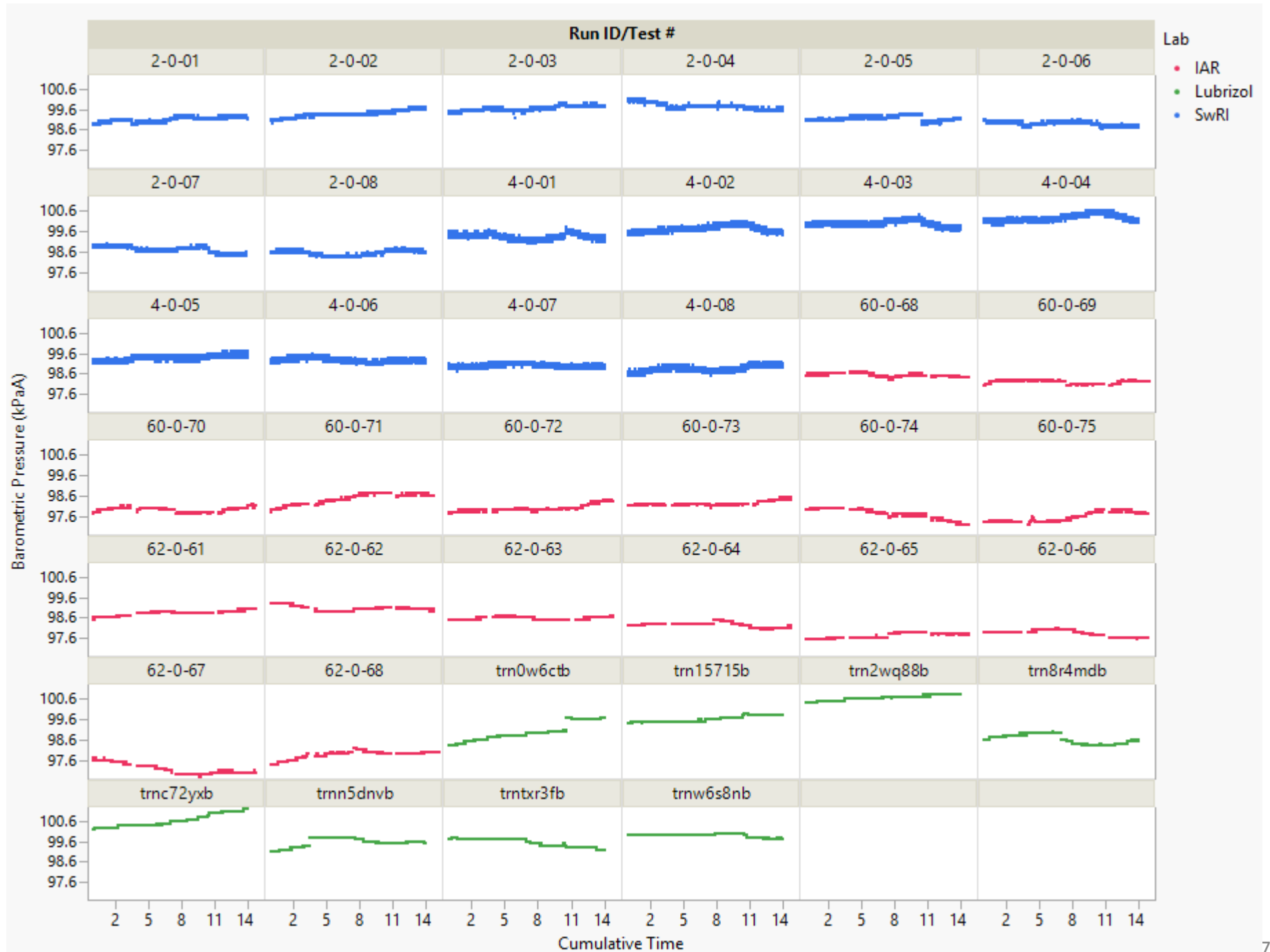
Low Event Oil



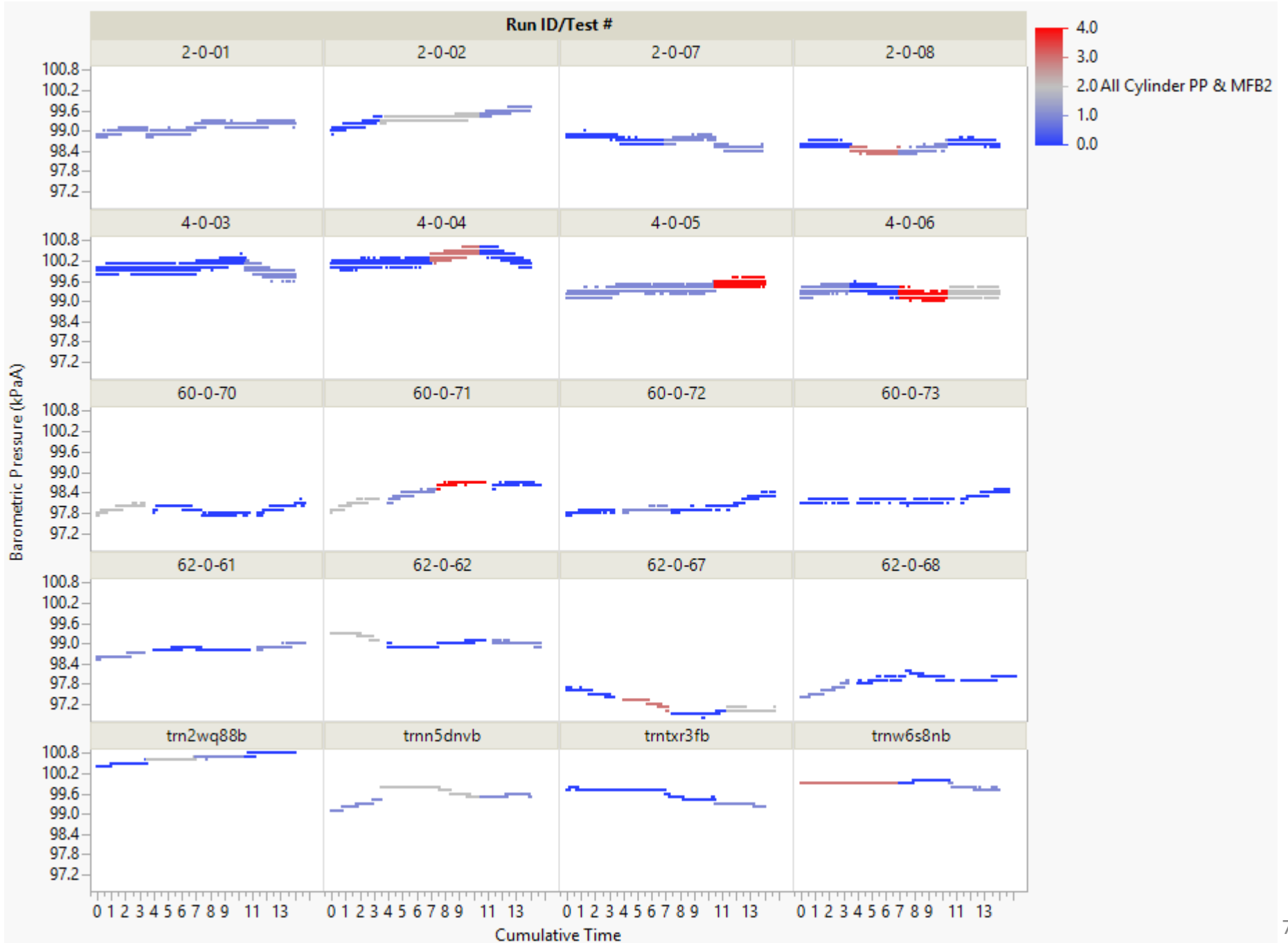
High Event Oil



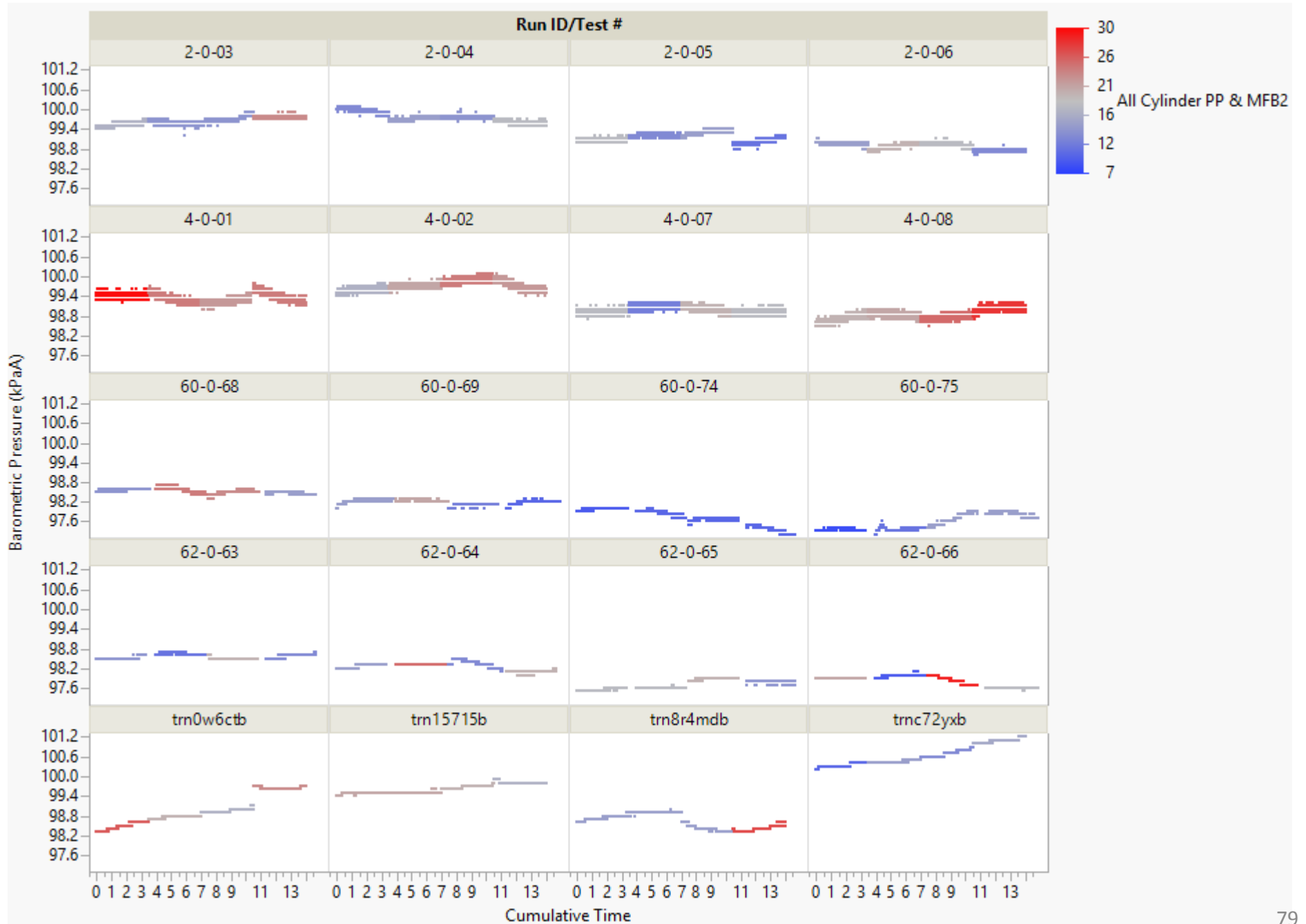
Barometric Pressure



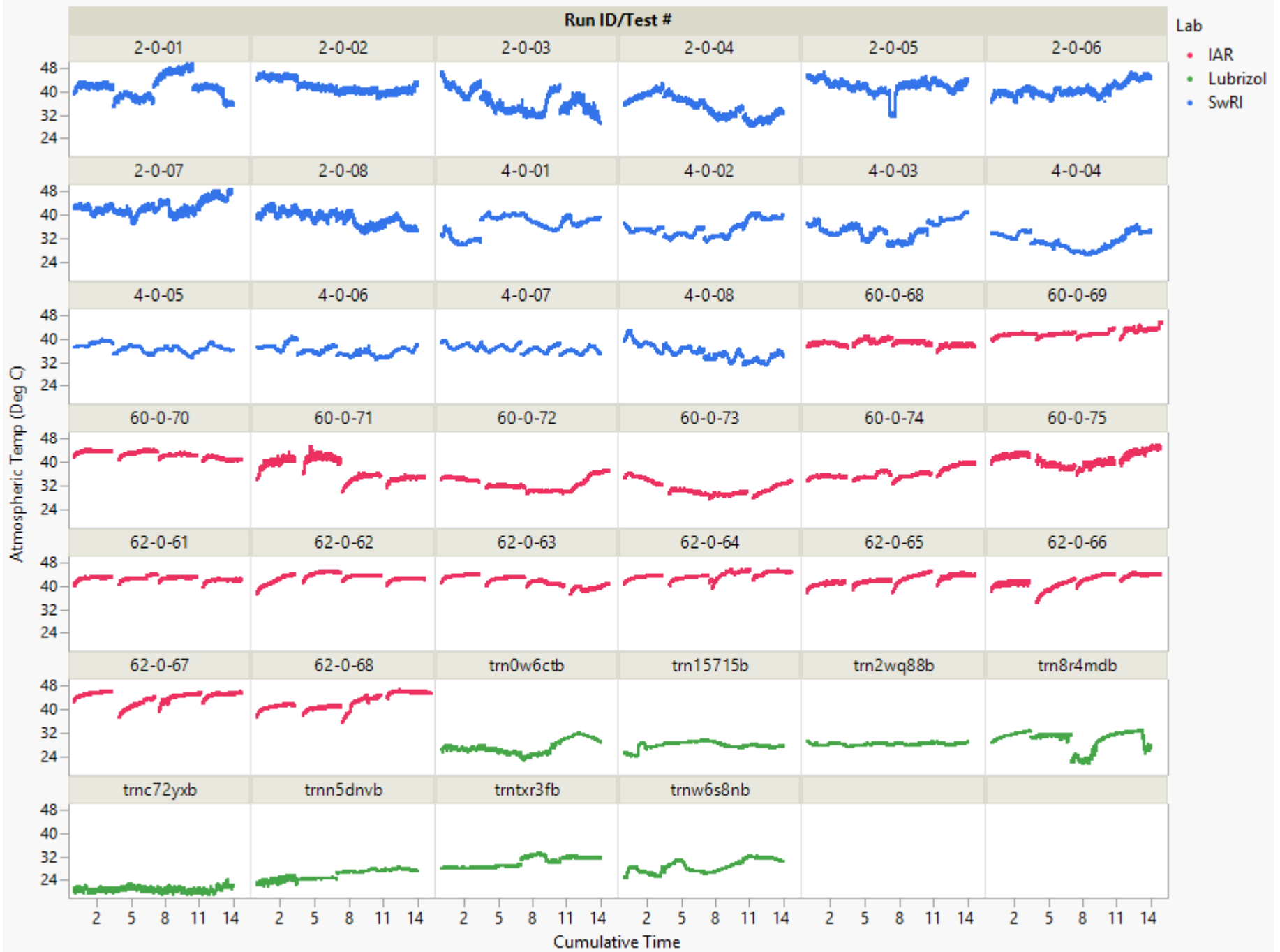
Low Event Oil



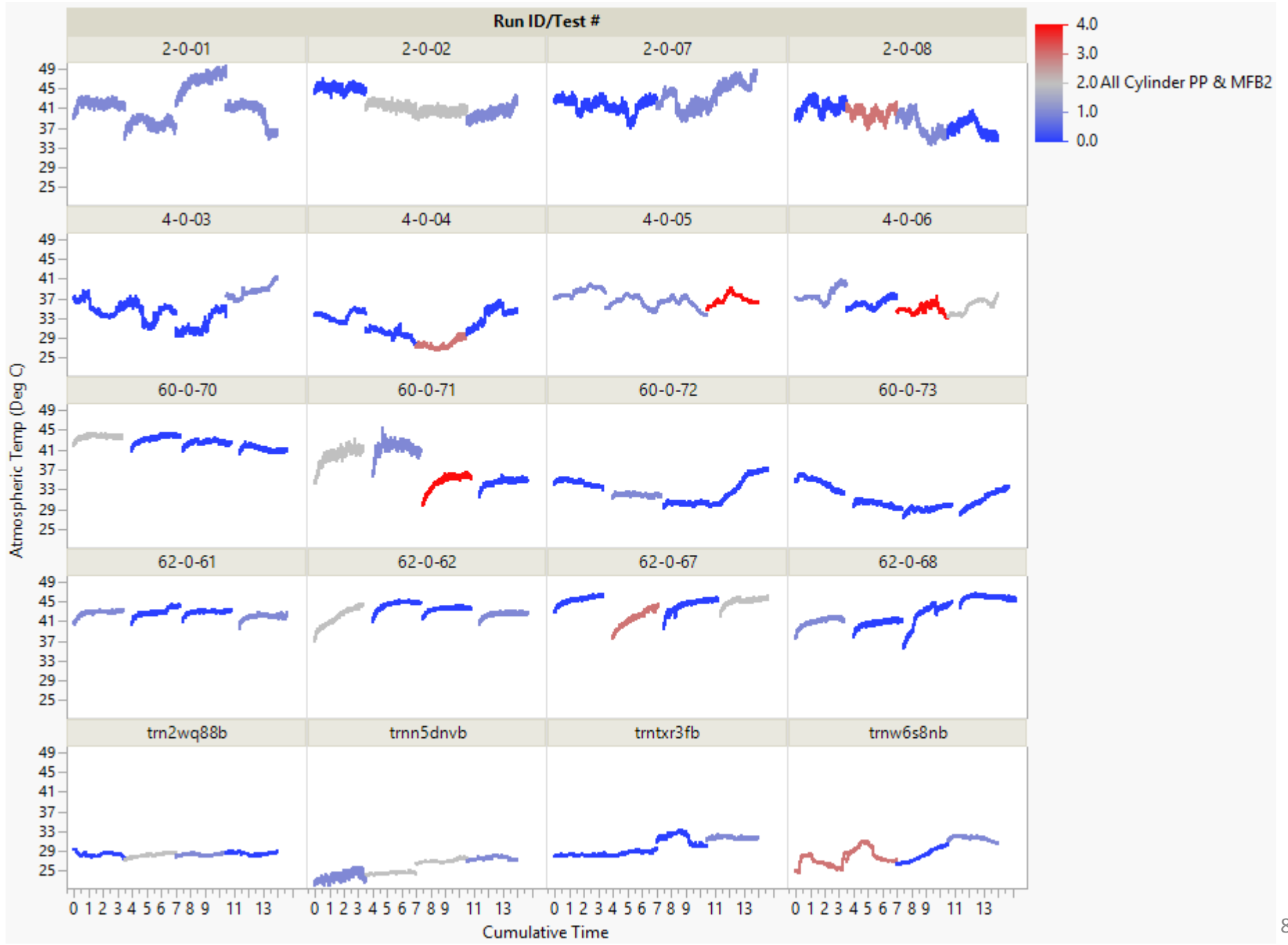
High Event Oil



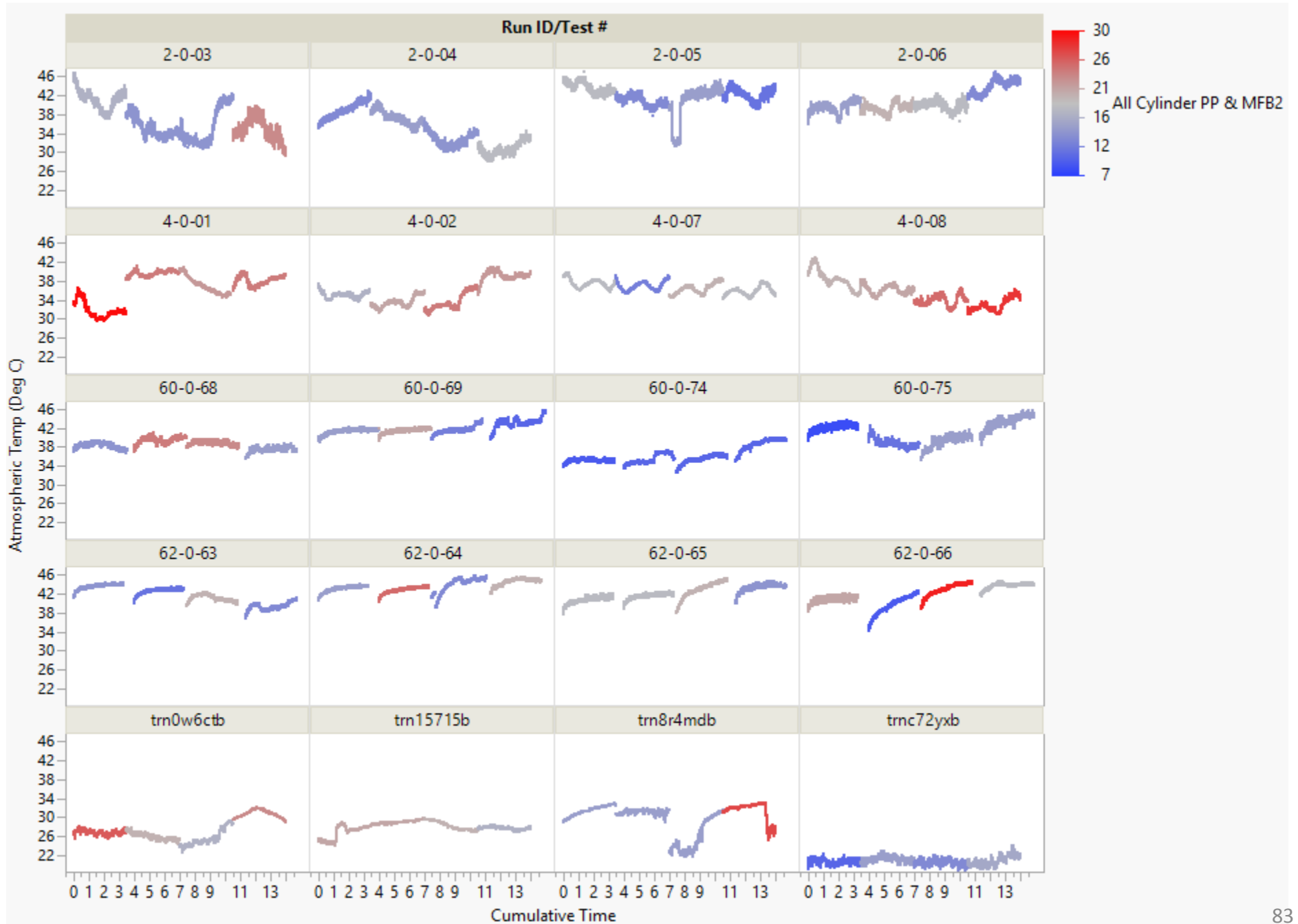
Atmospheric Temp



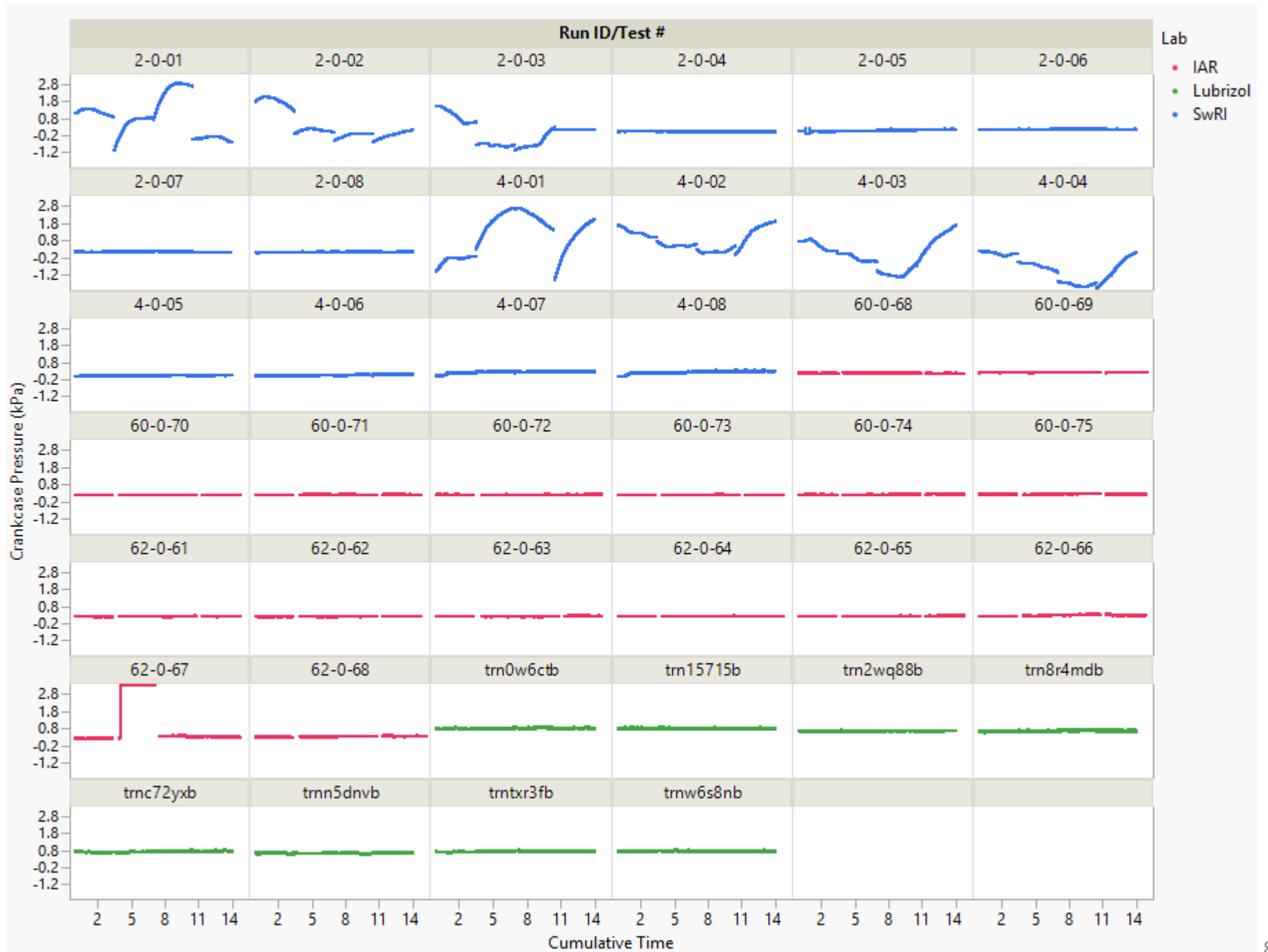
Low Event Oil

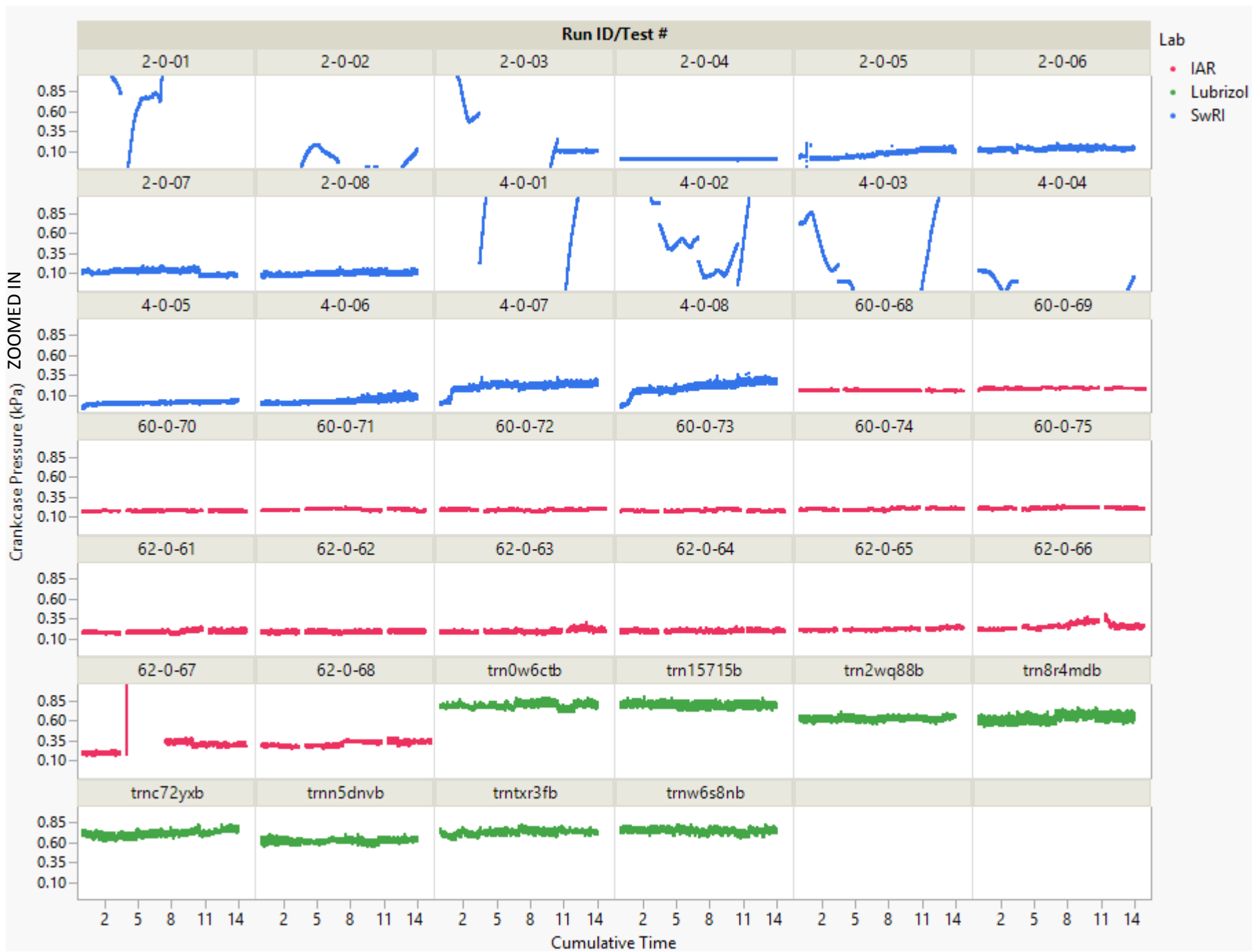


High Event Oil

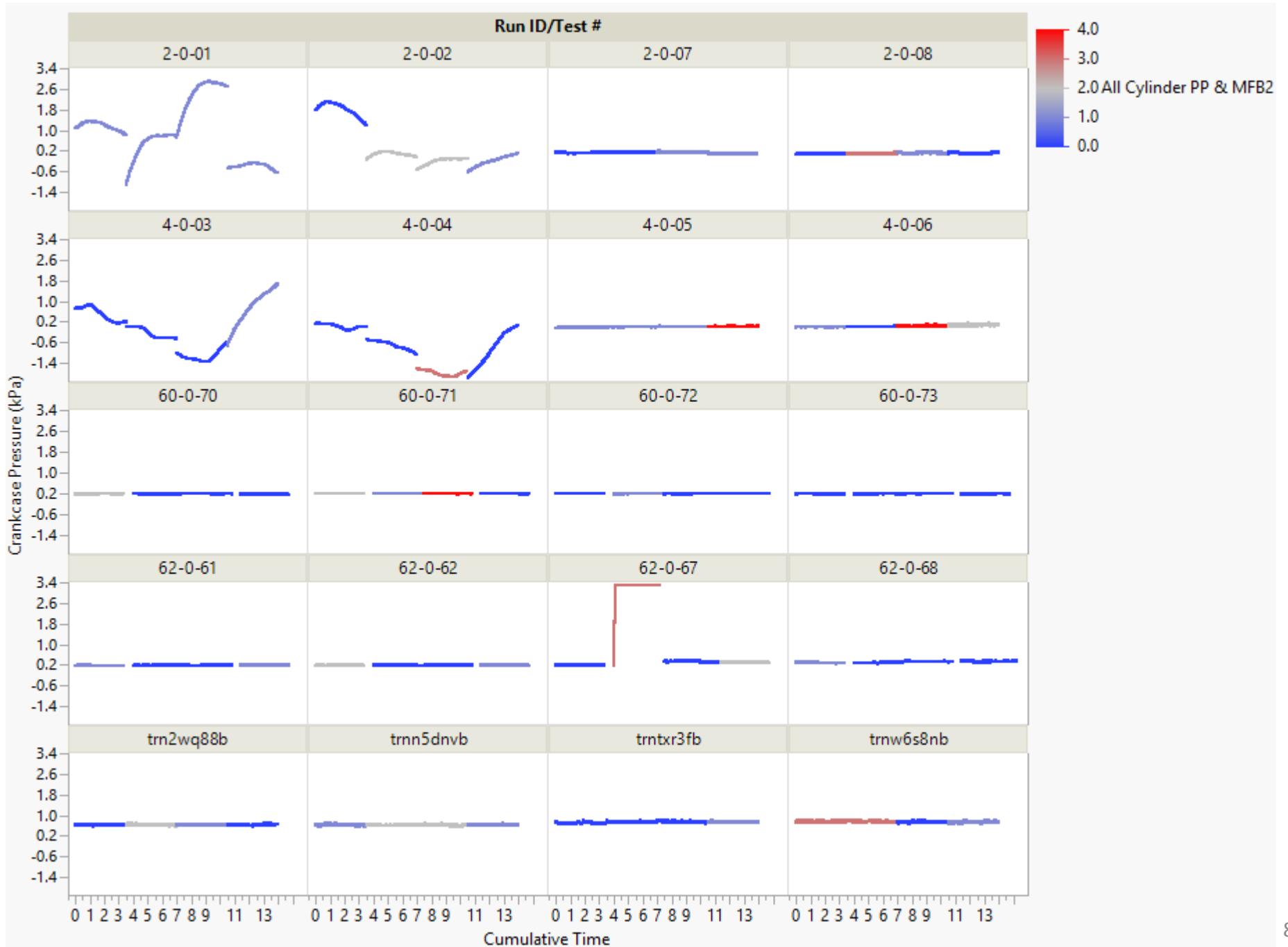


Crankcase Pressure

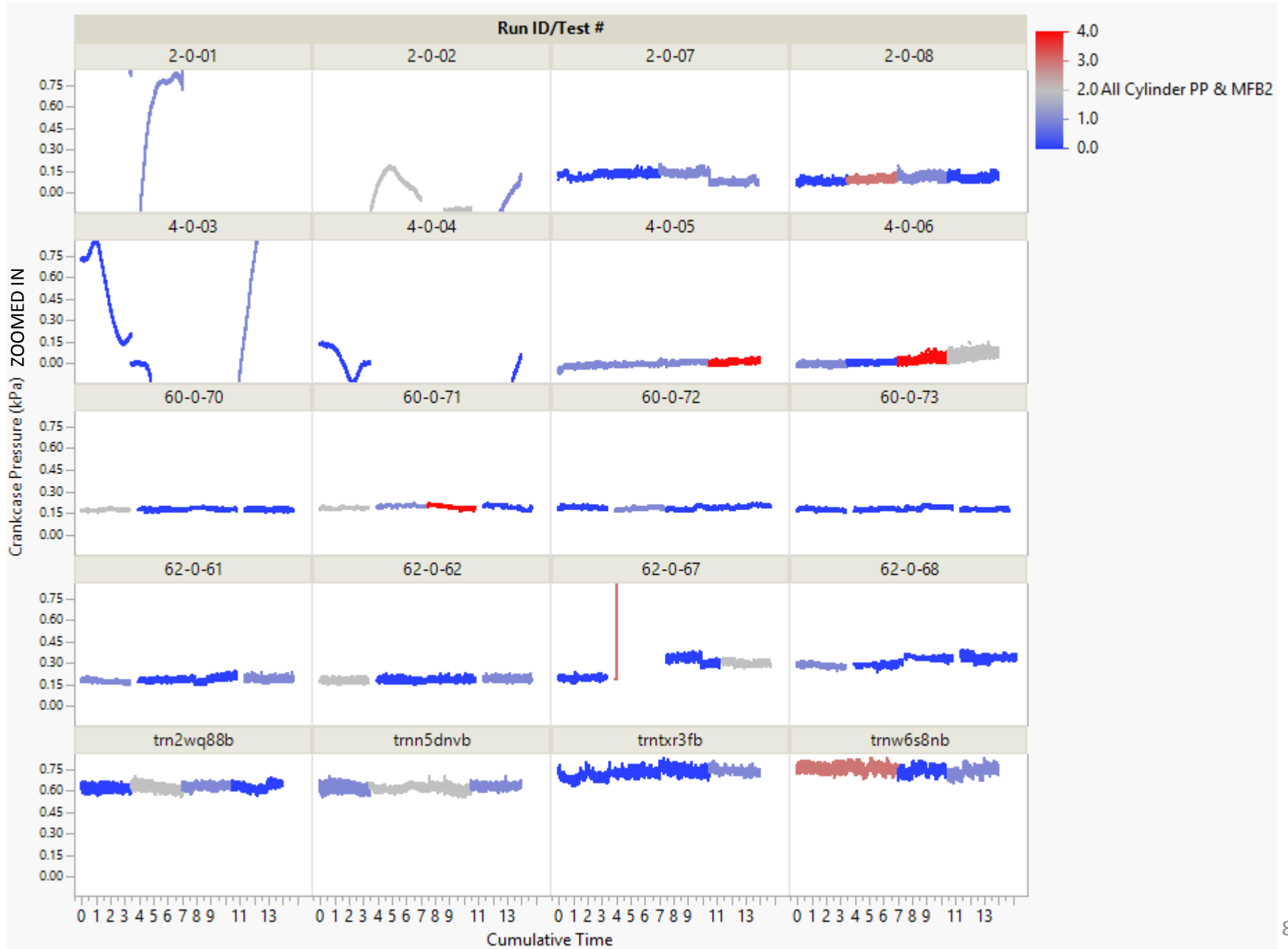




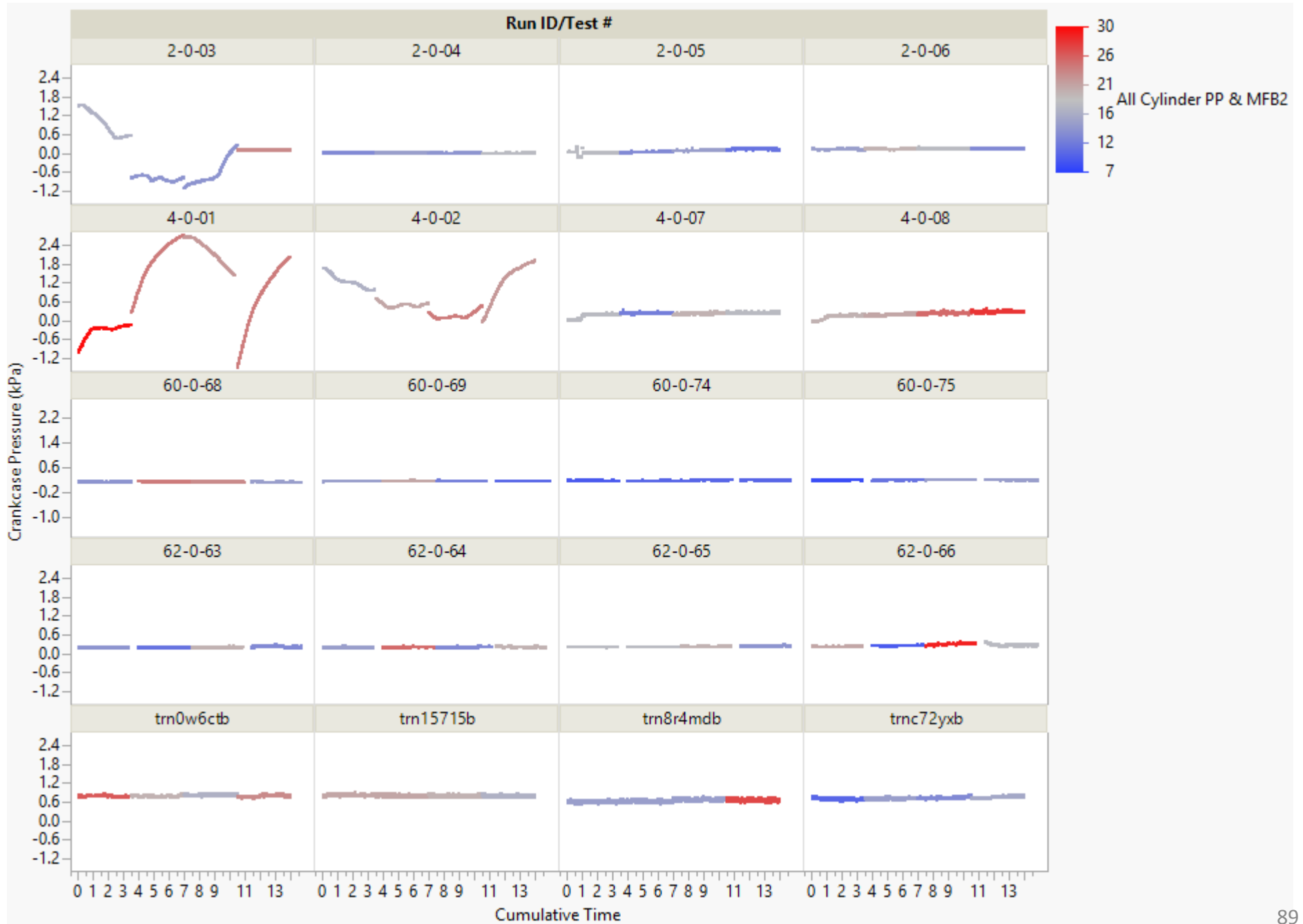
Low Event Oil



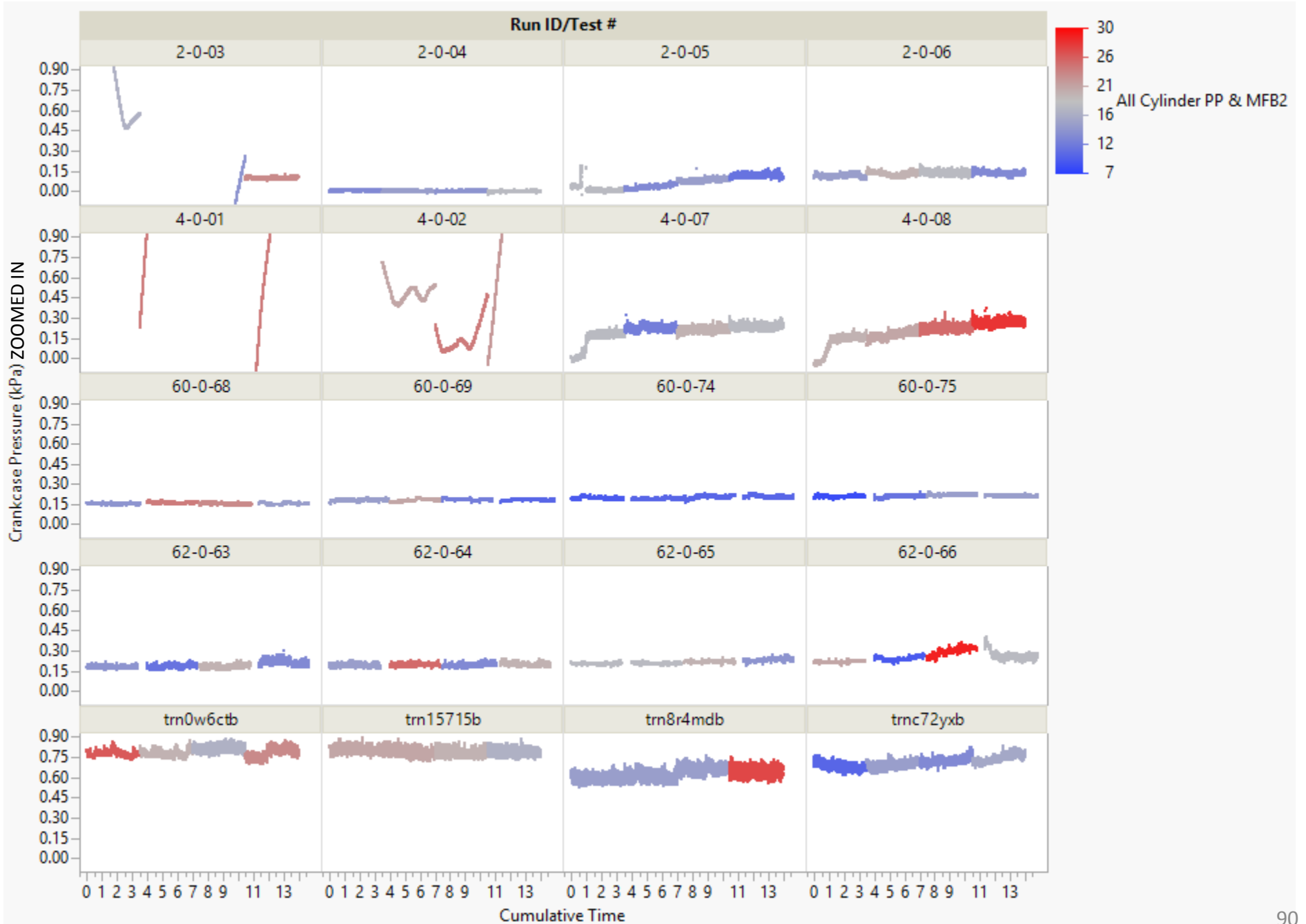
Low Event Oil



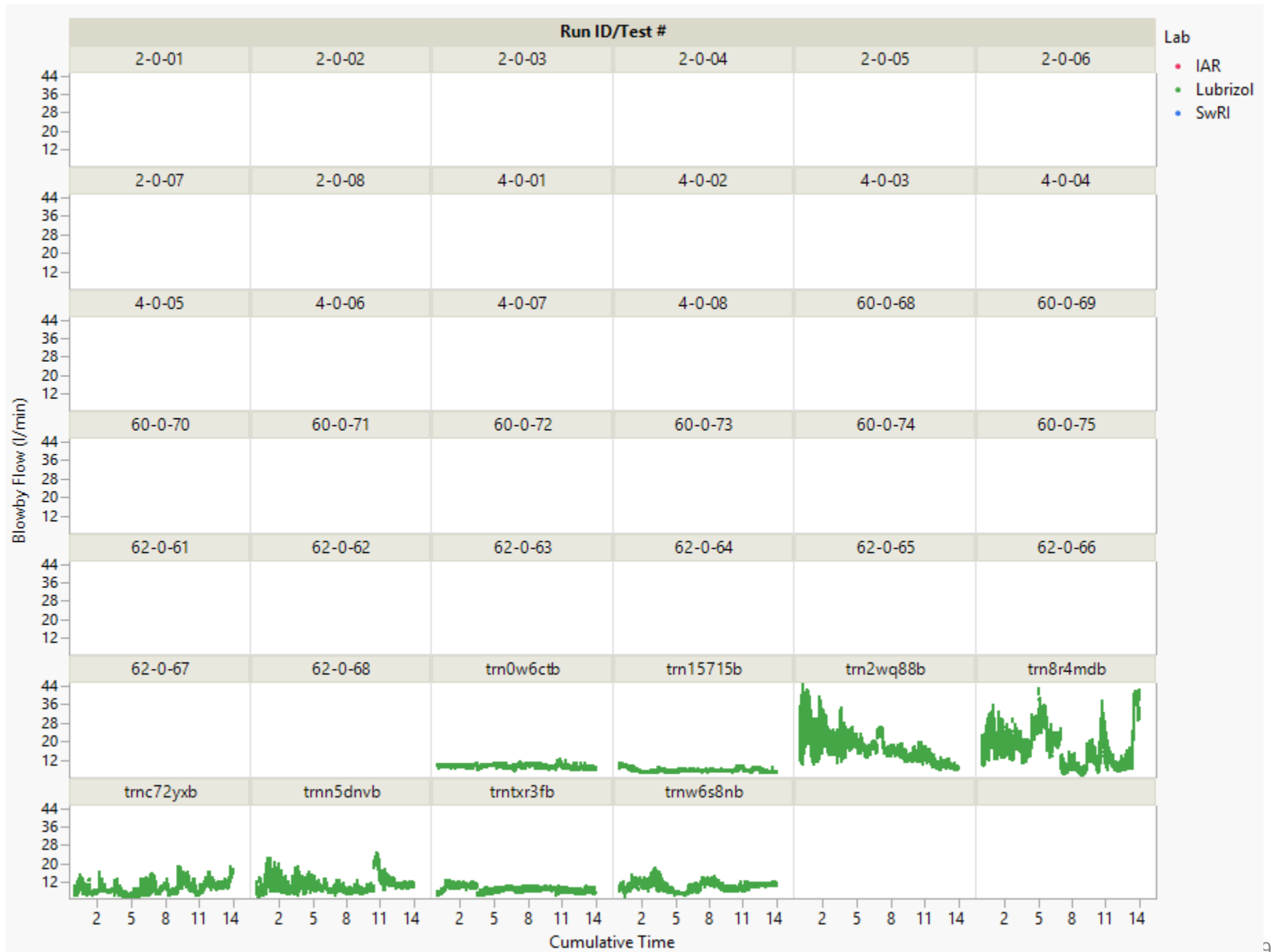
High Event Oil



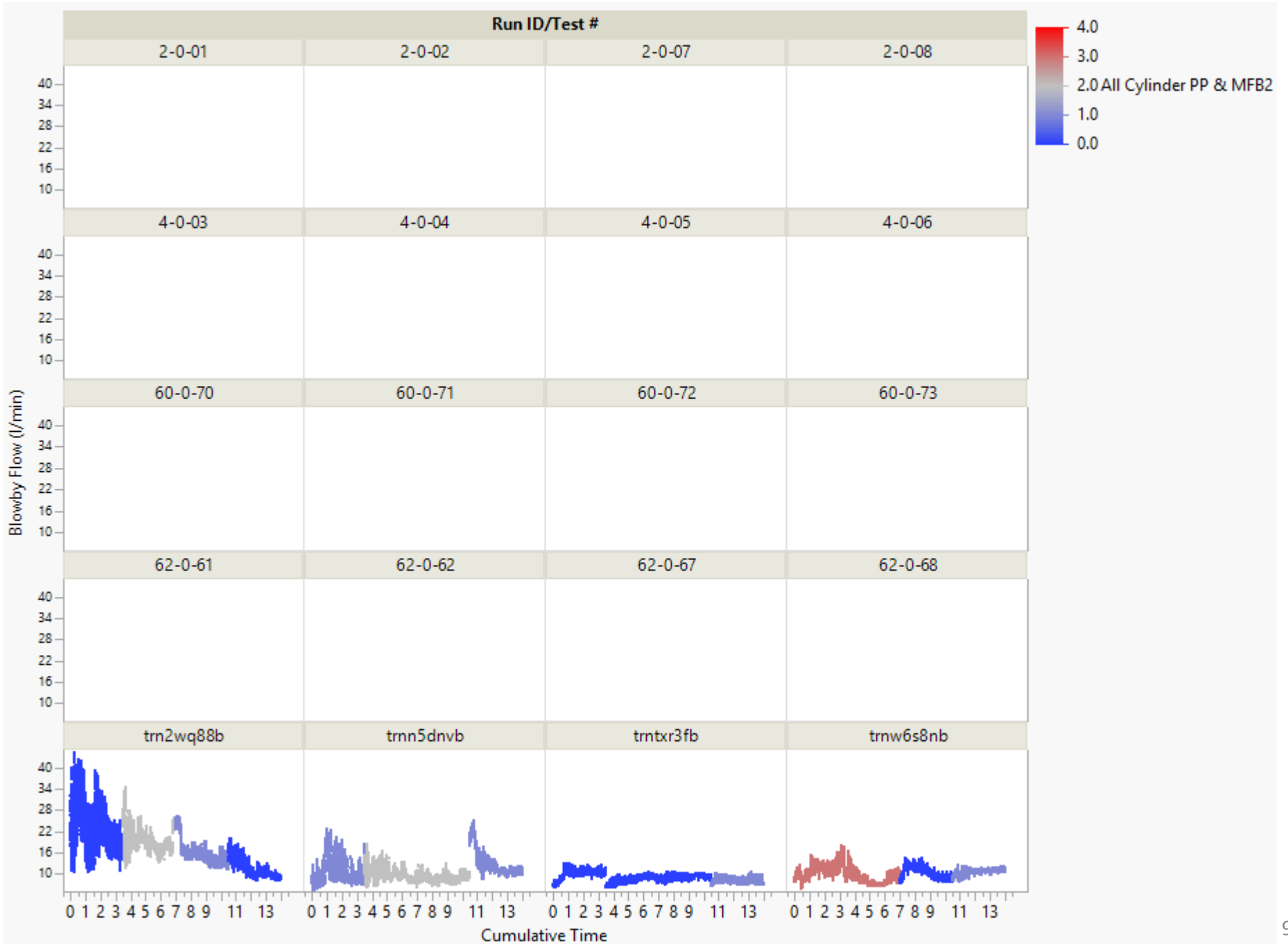
High Event Oil



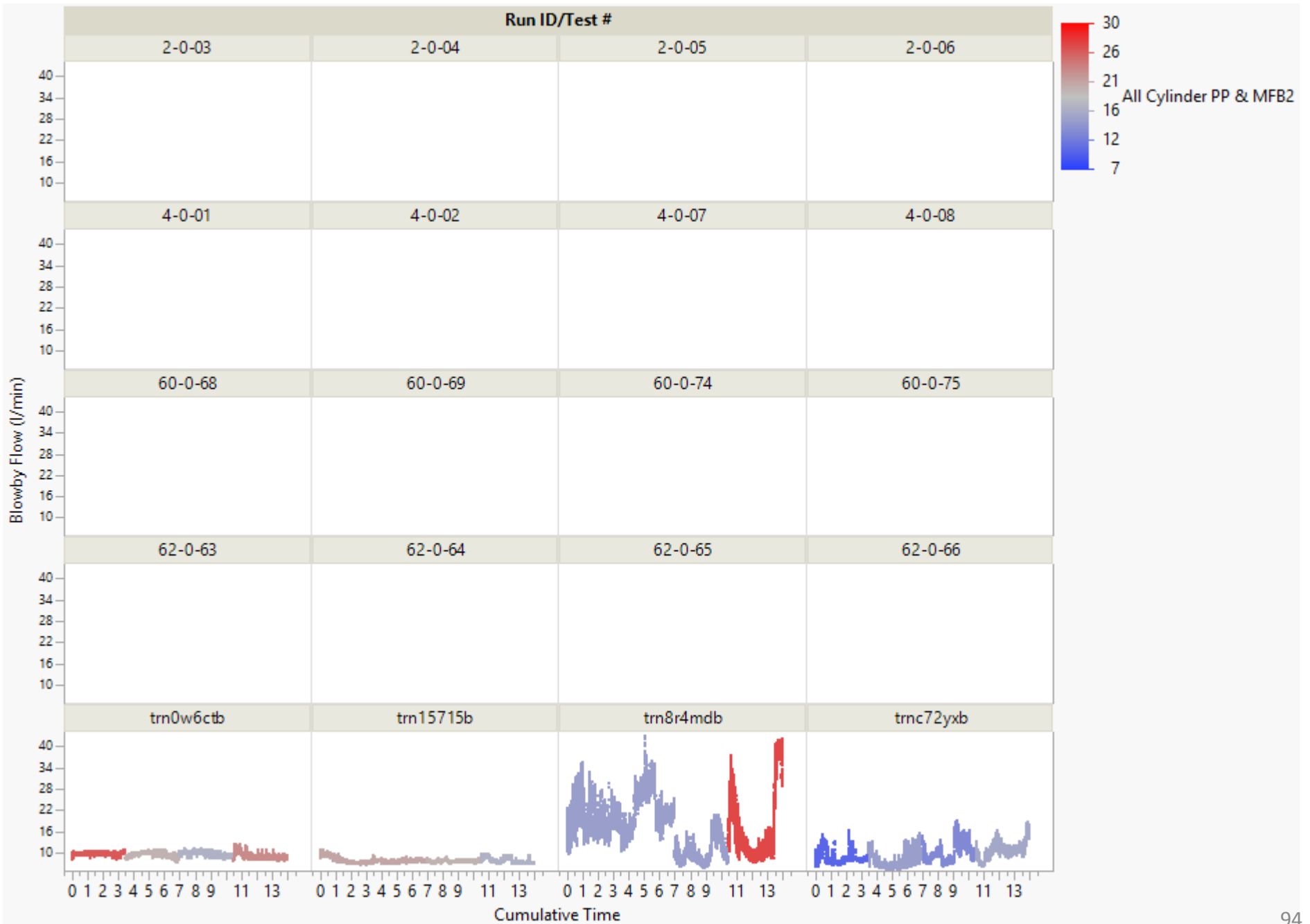
Blowby Flow



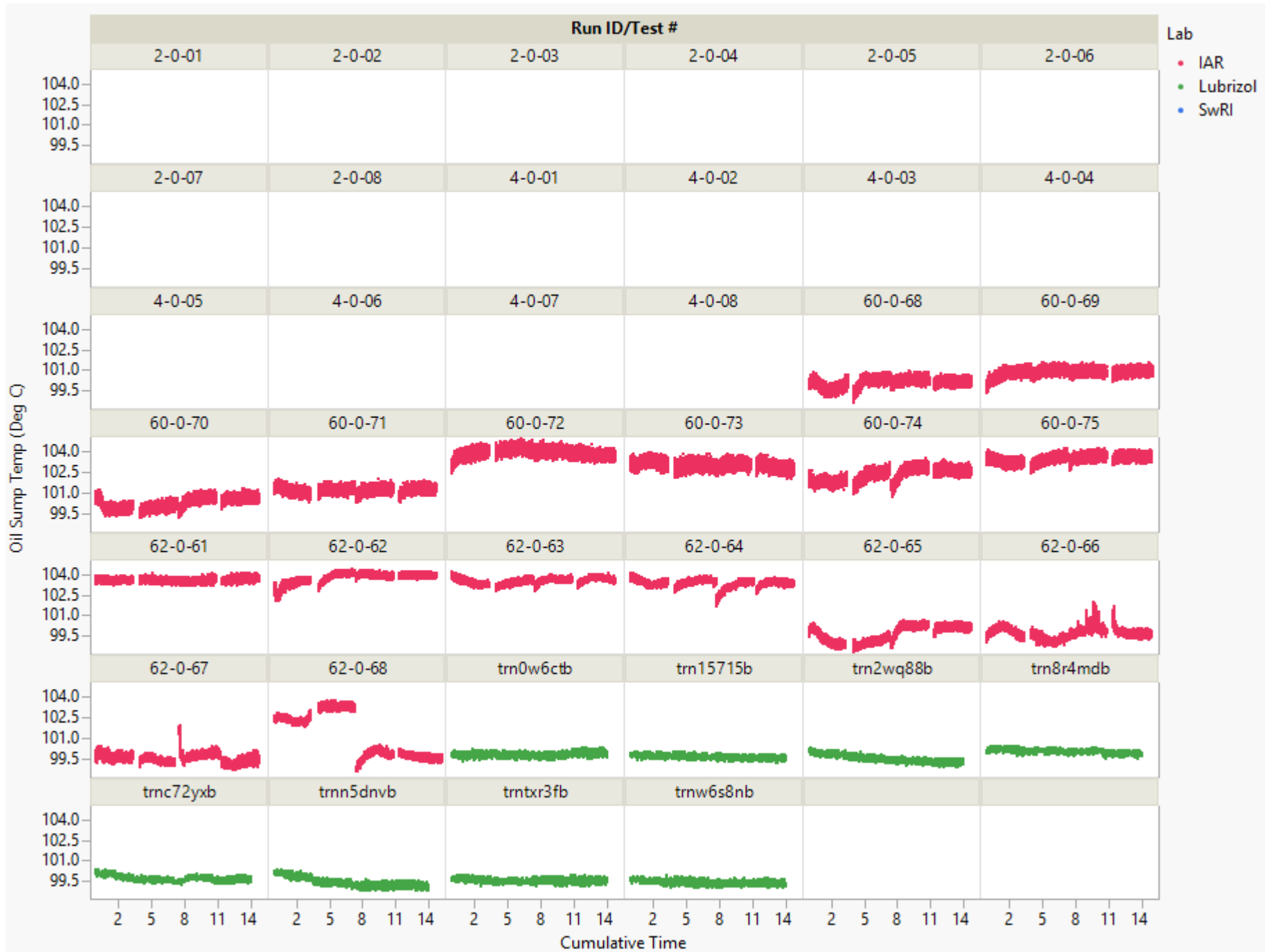
Low Event Oil



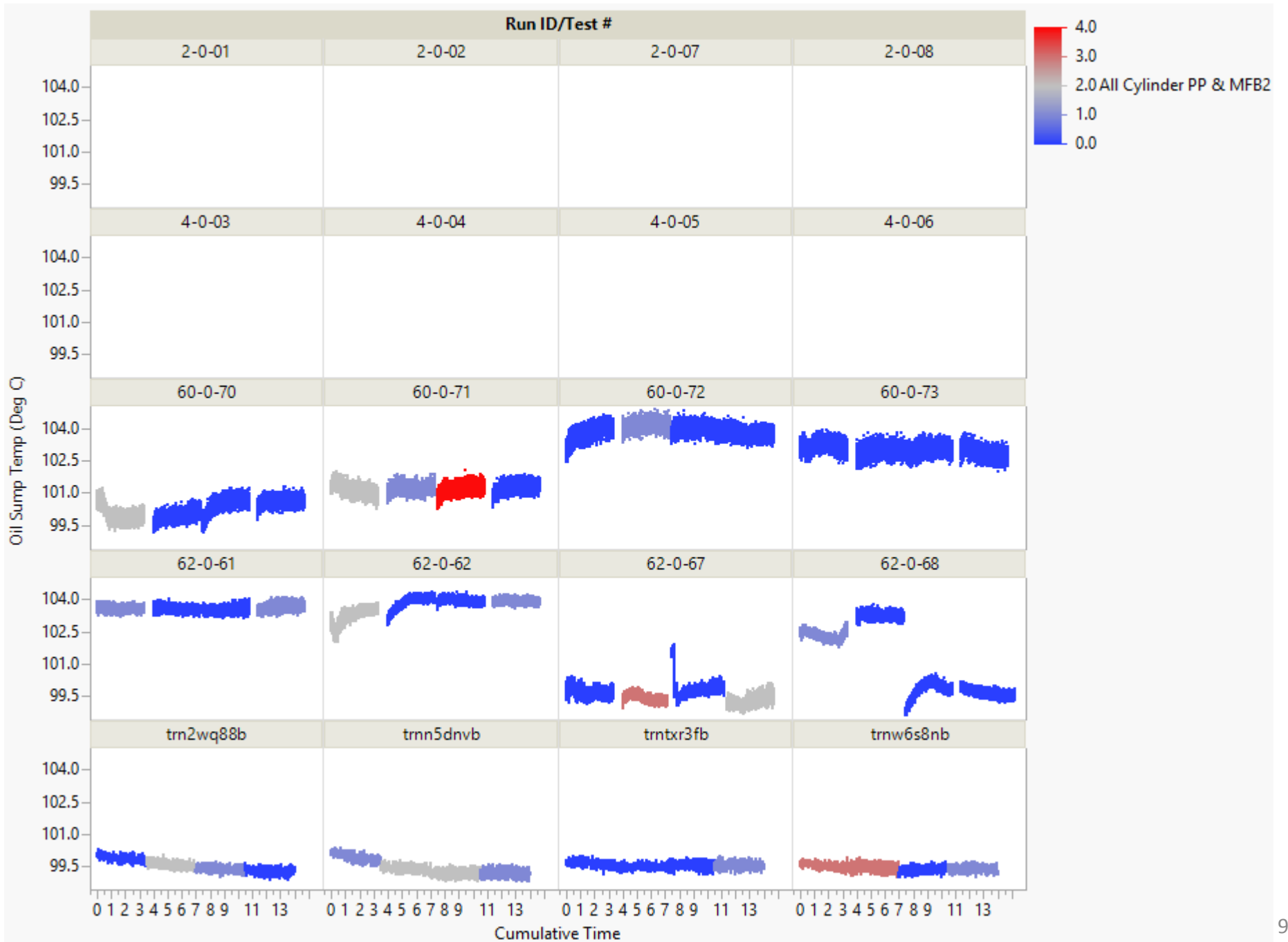
High Event Oil



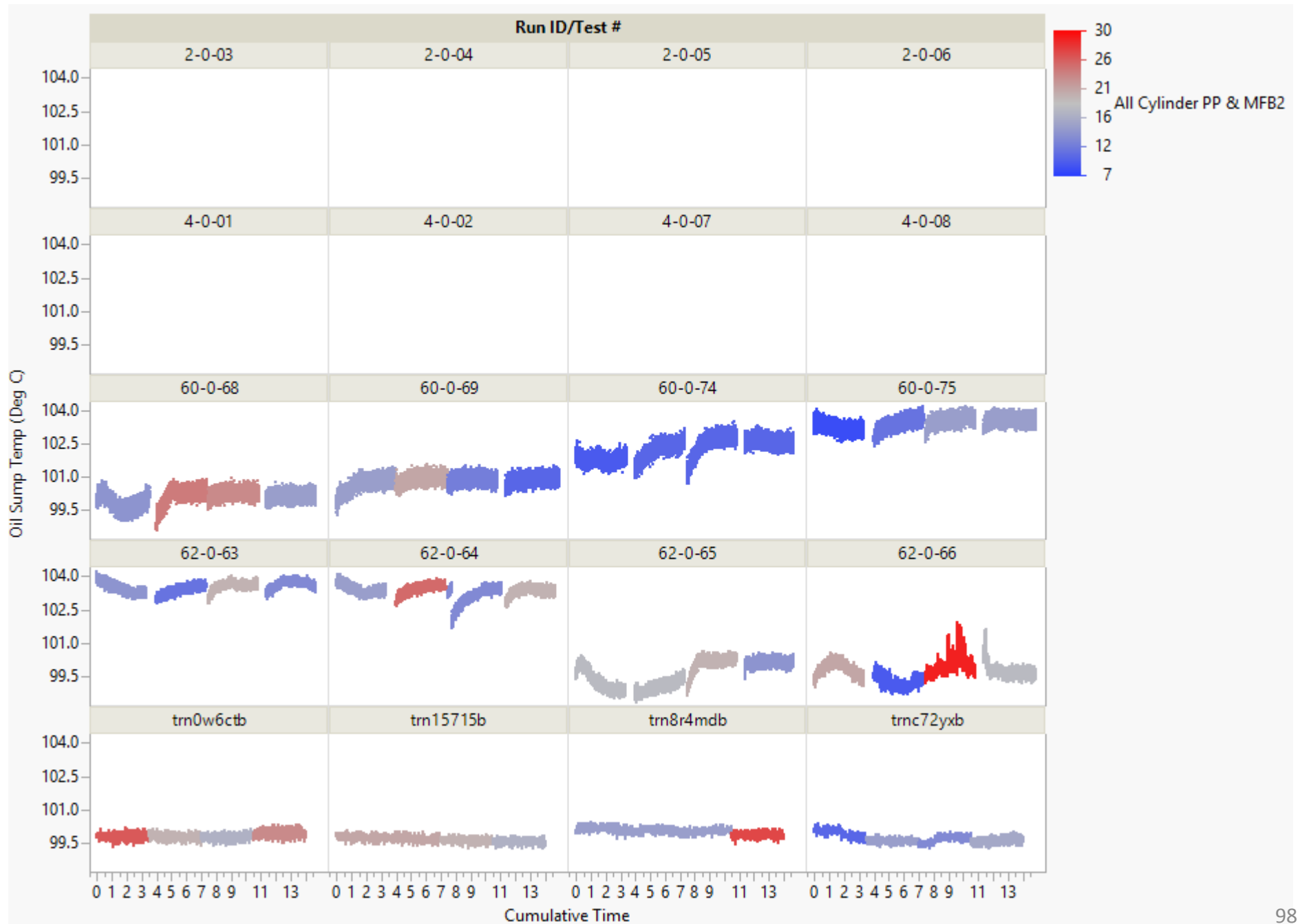
Oil Sump Temp



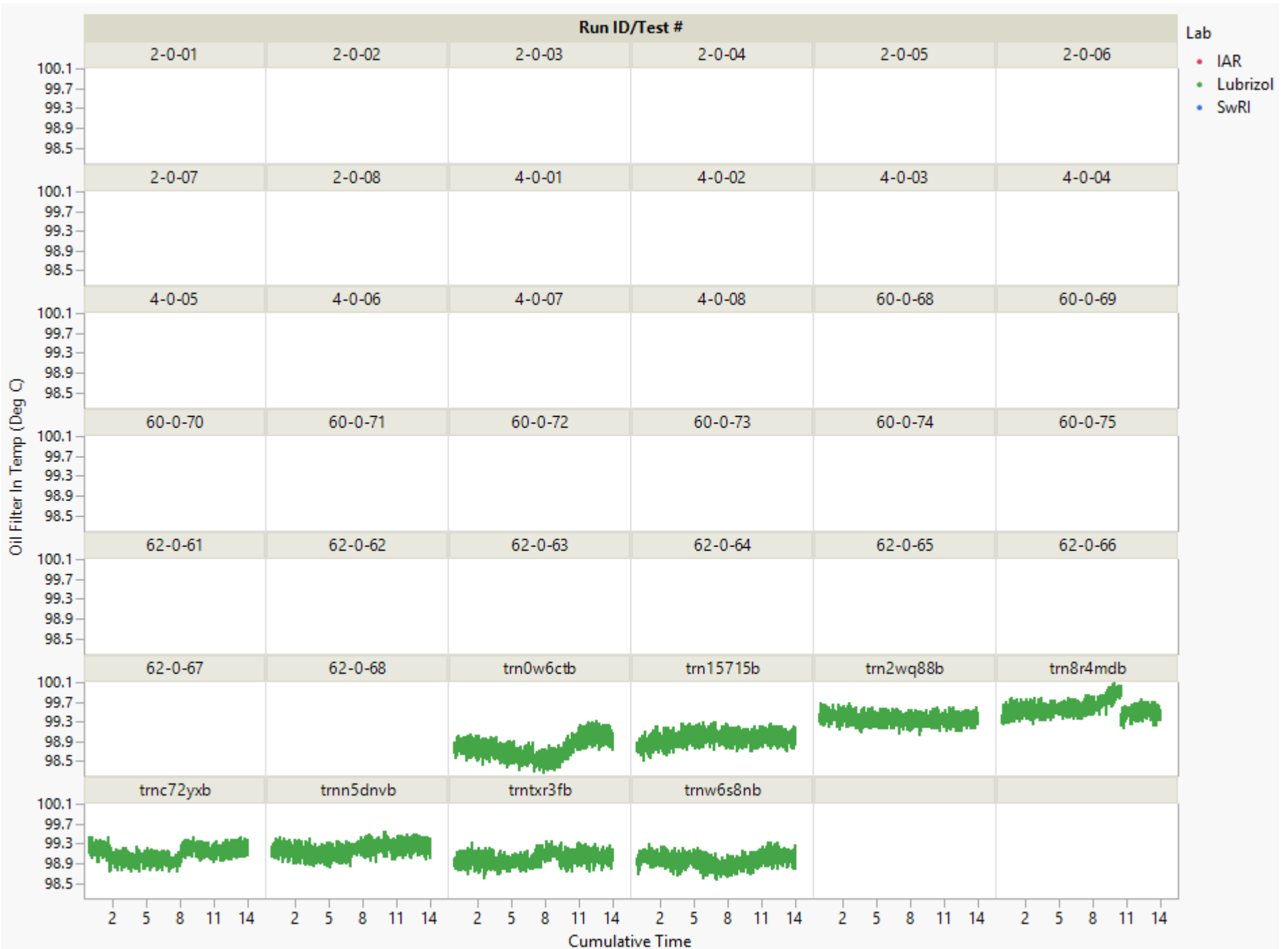
Low Event Oil



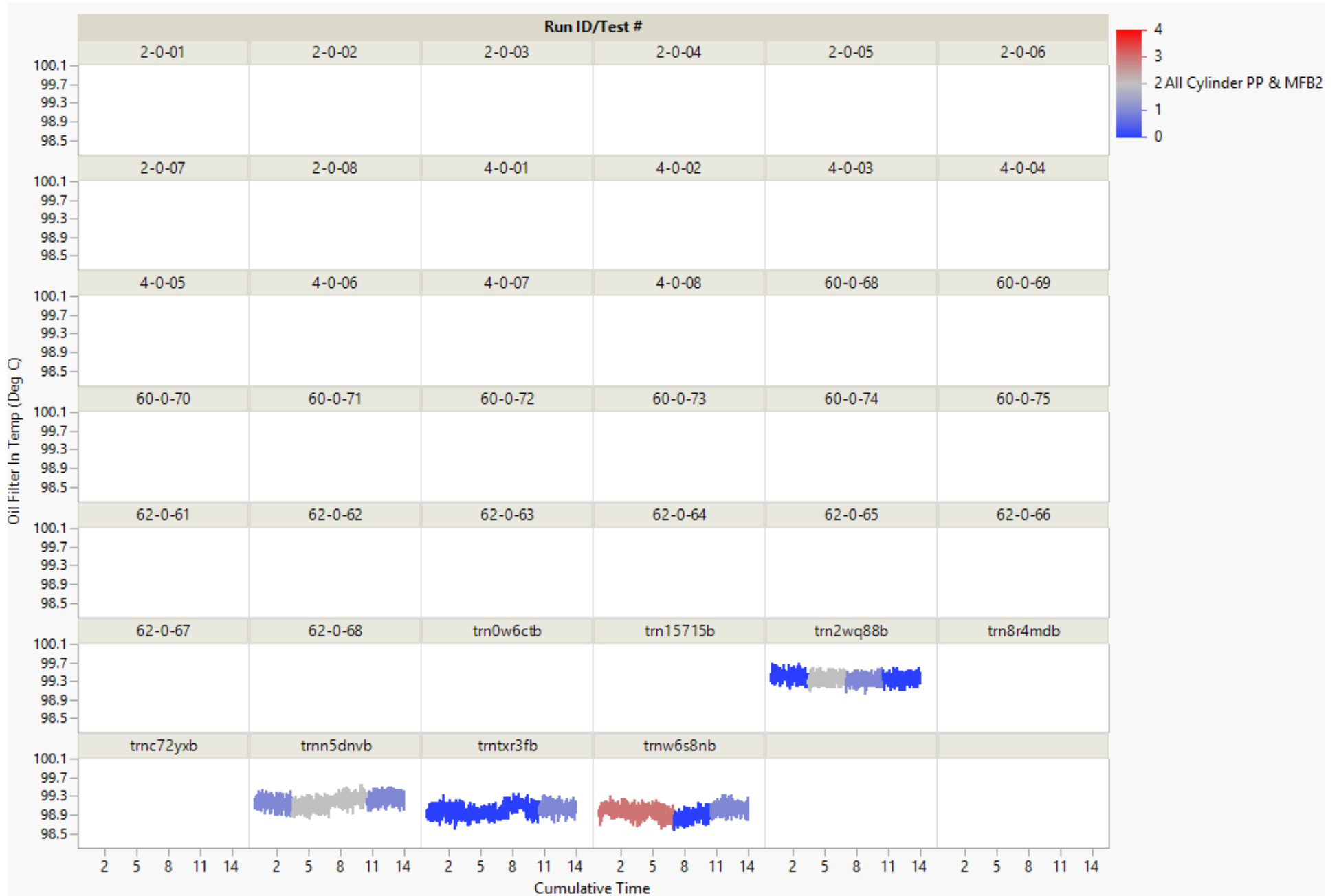
High Event Oil



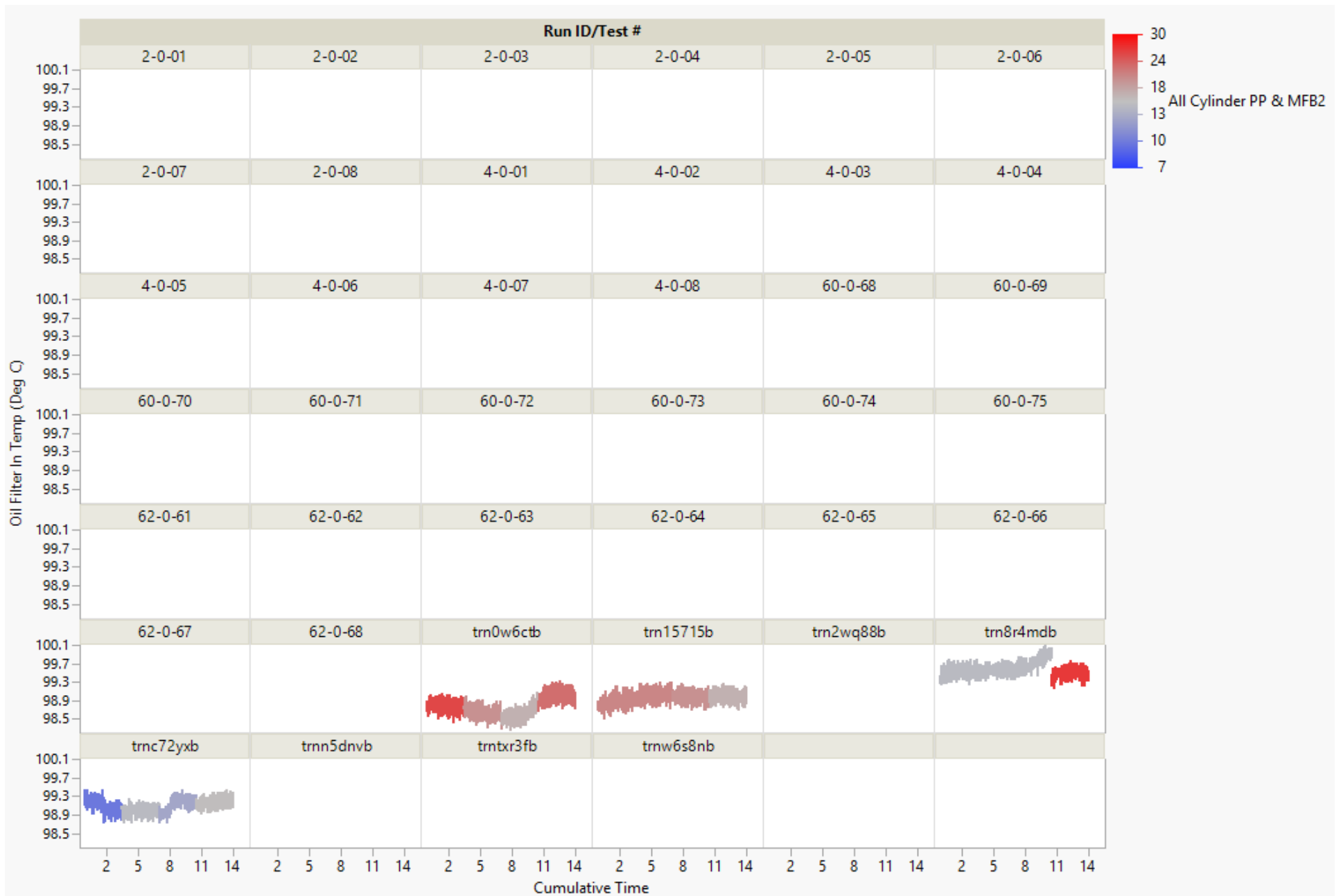
Oil Fiter In Temp



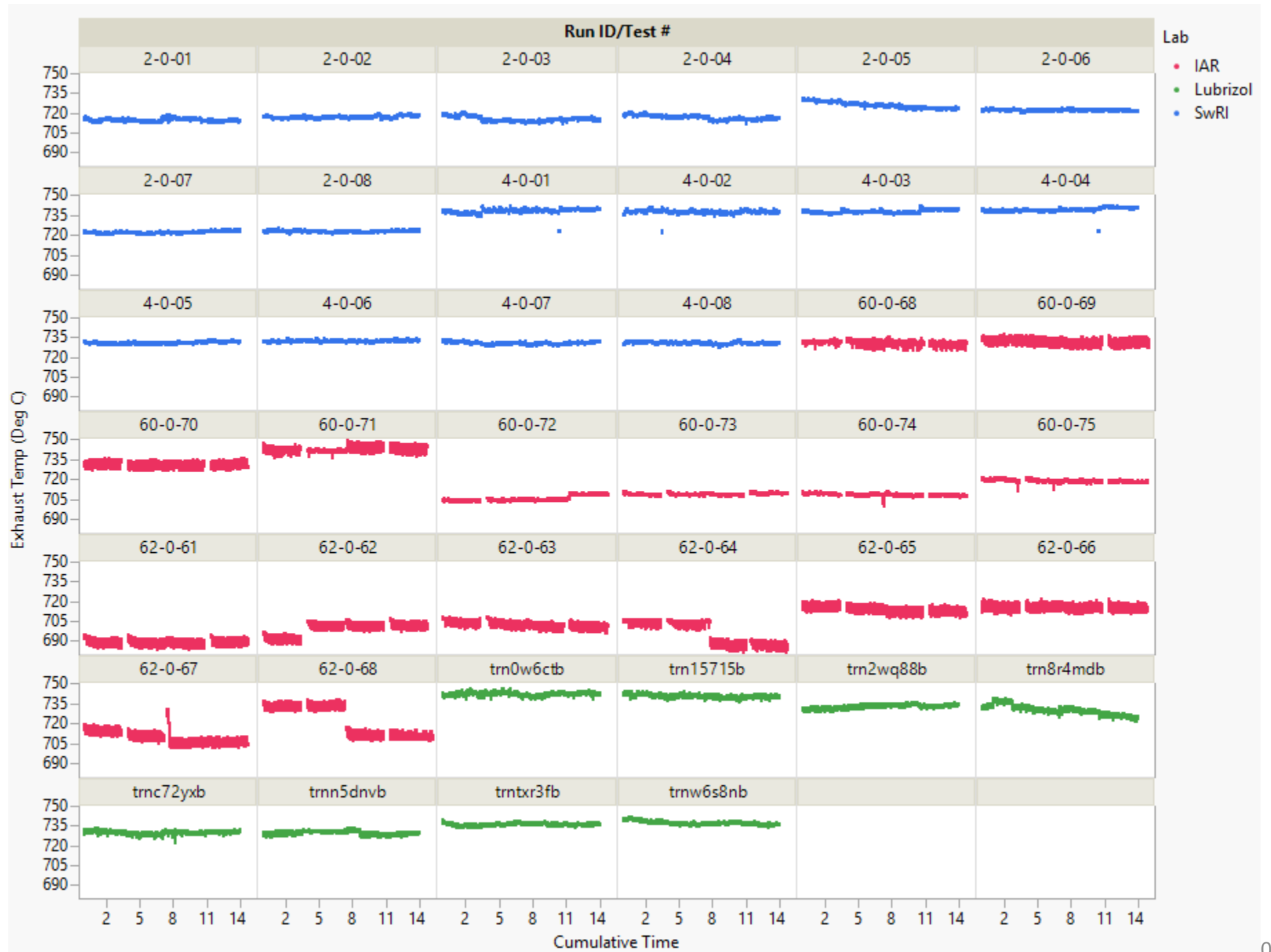
Low Event Oil



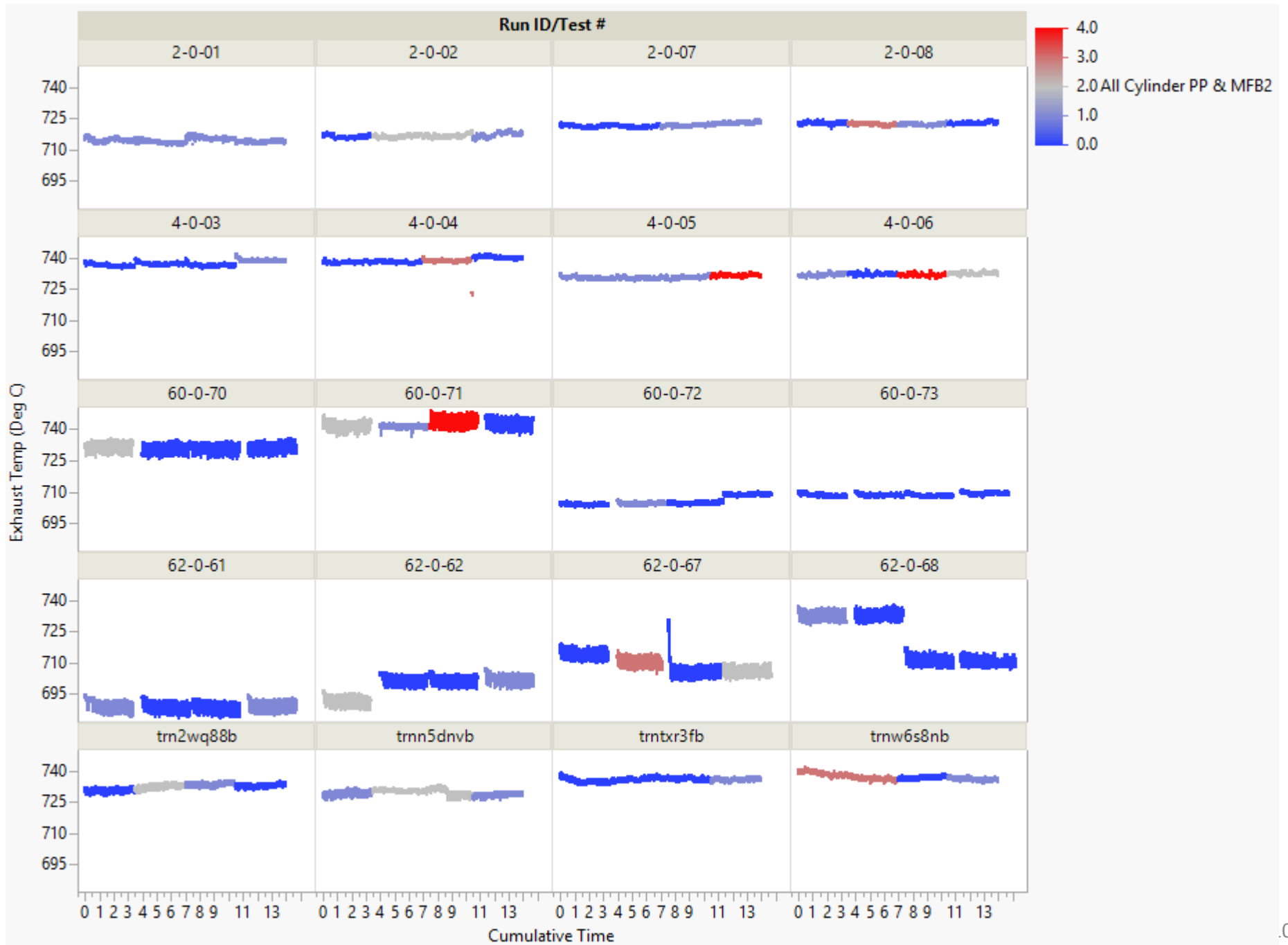
High Event Oil



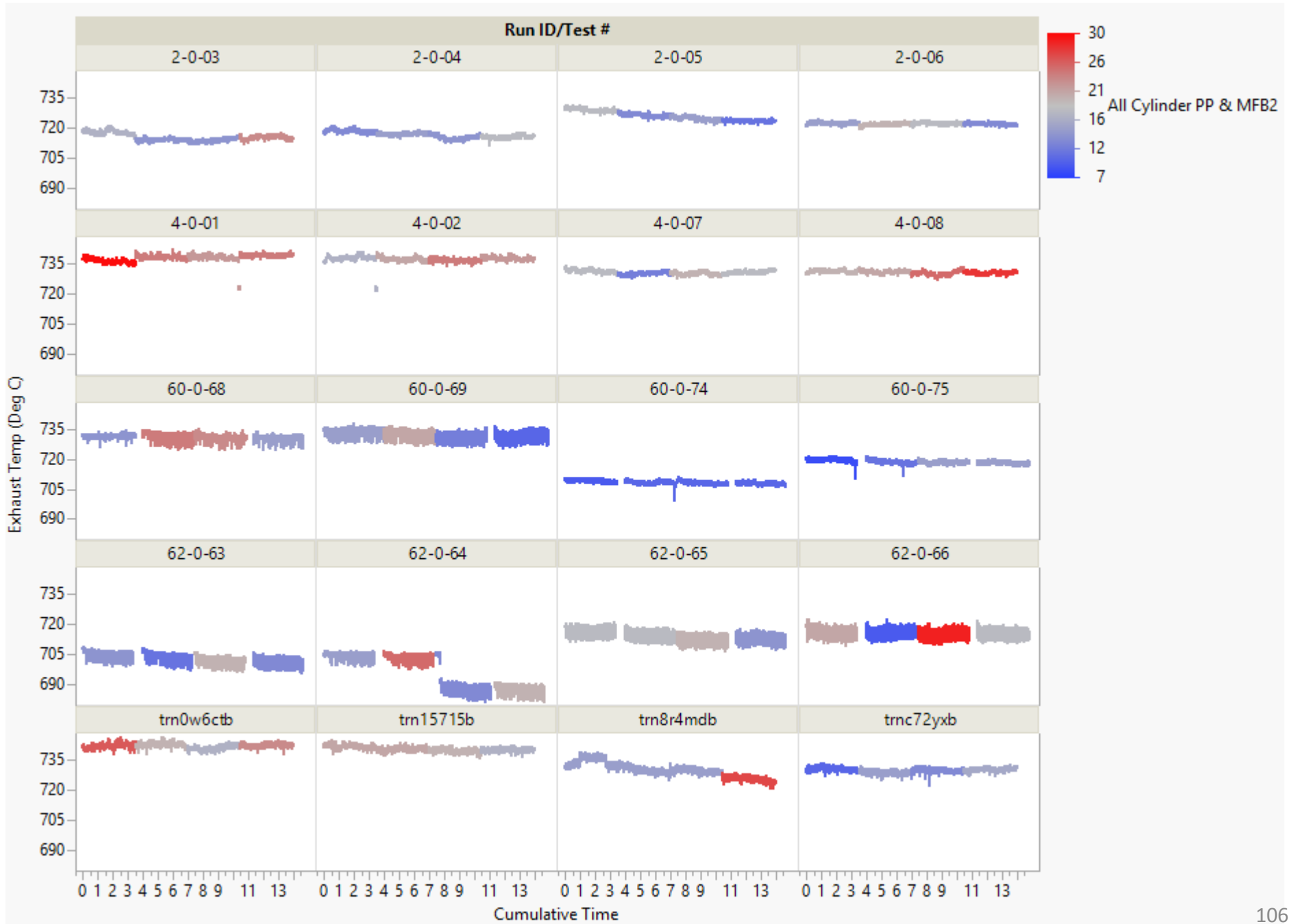
Exhaust Temp



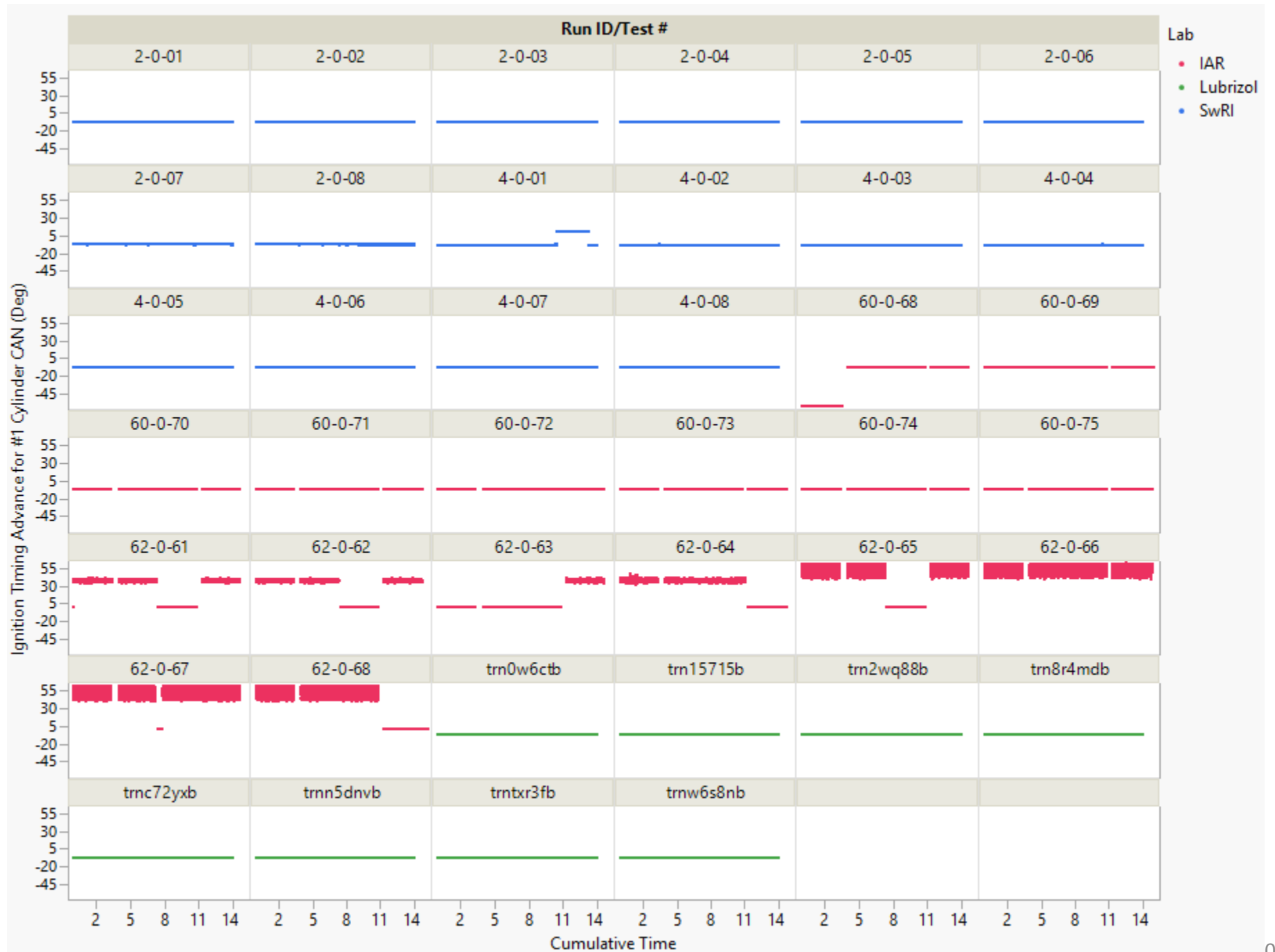
Low Event Oil

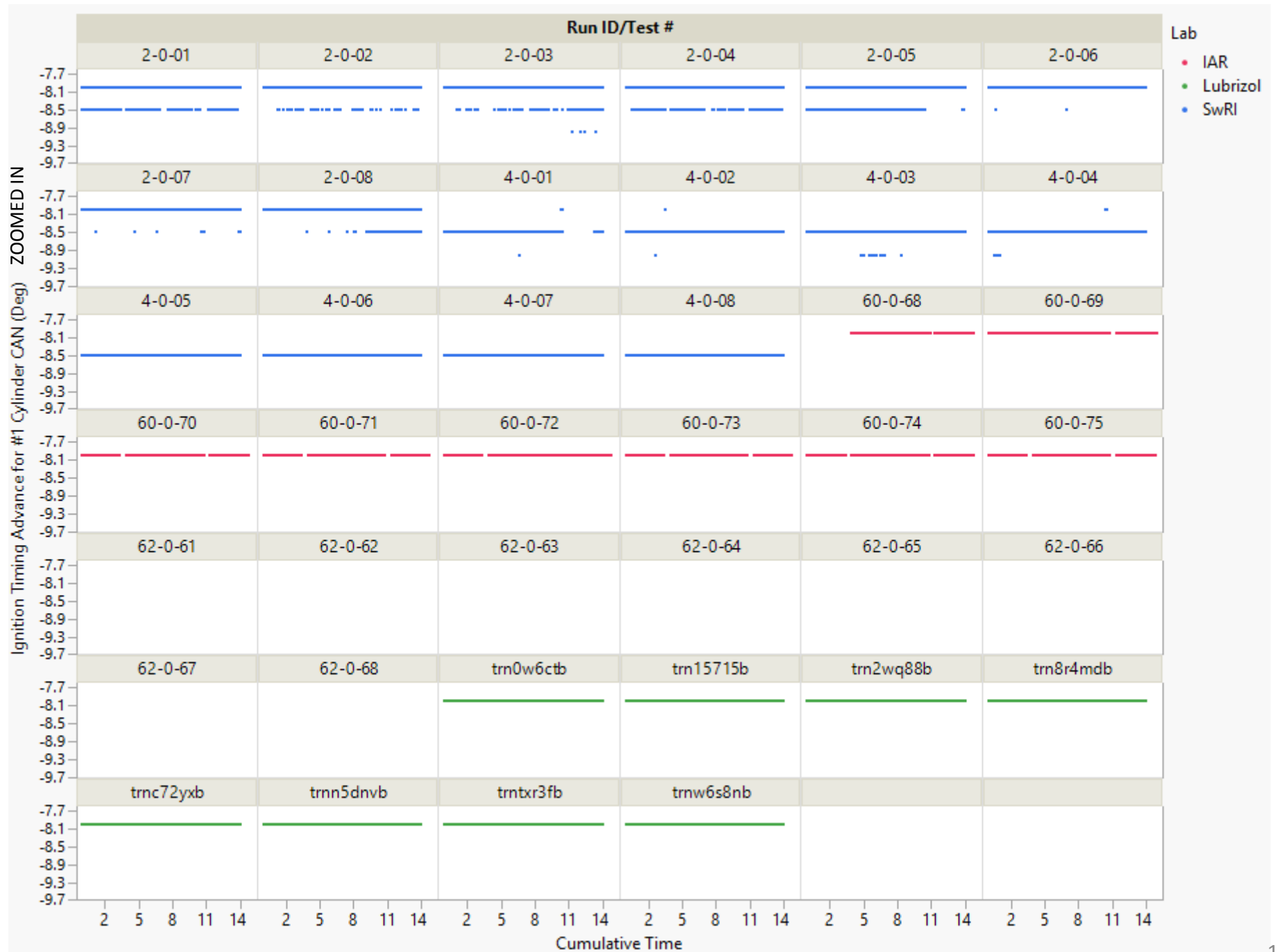


High Event Oil

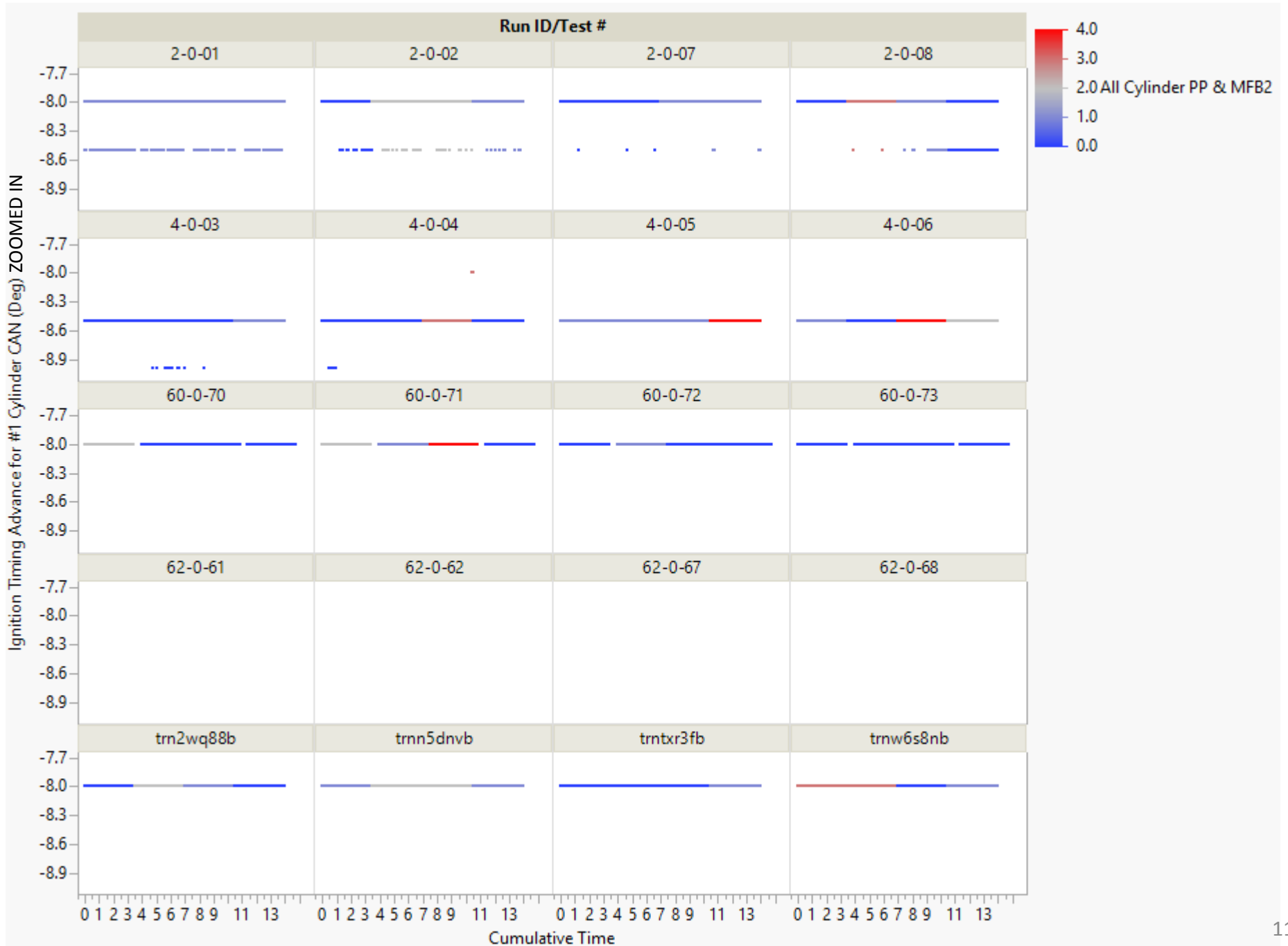


Ignition Timing Advance for #1 Cylinder CAN

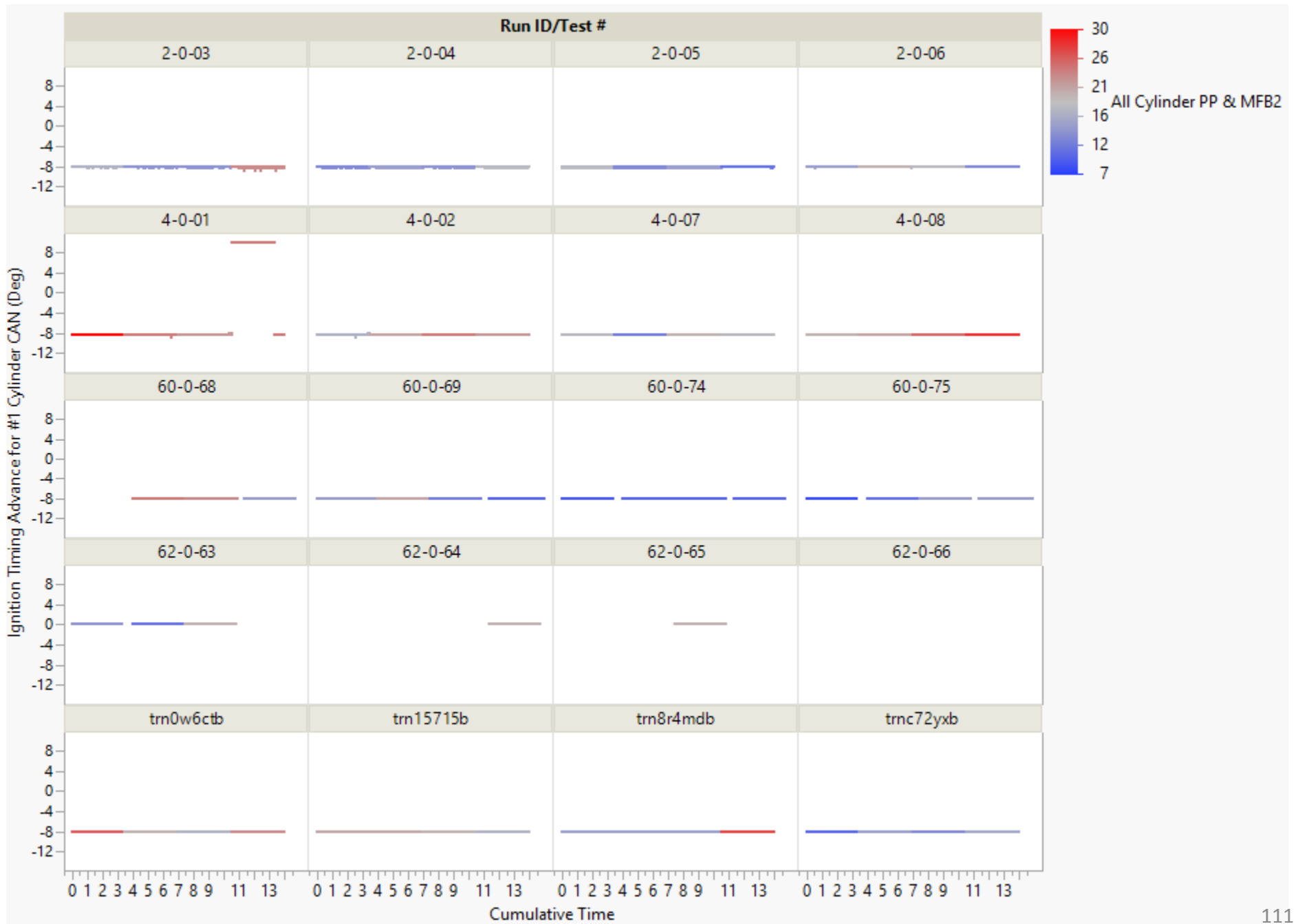




Low Event Oil



High Event Oil

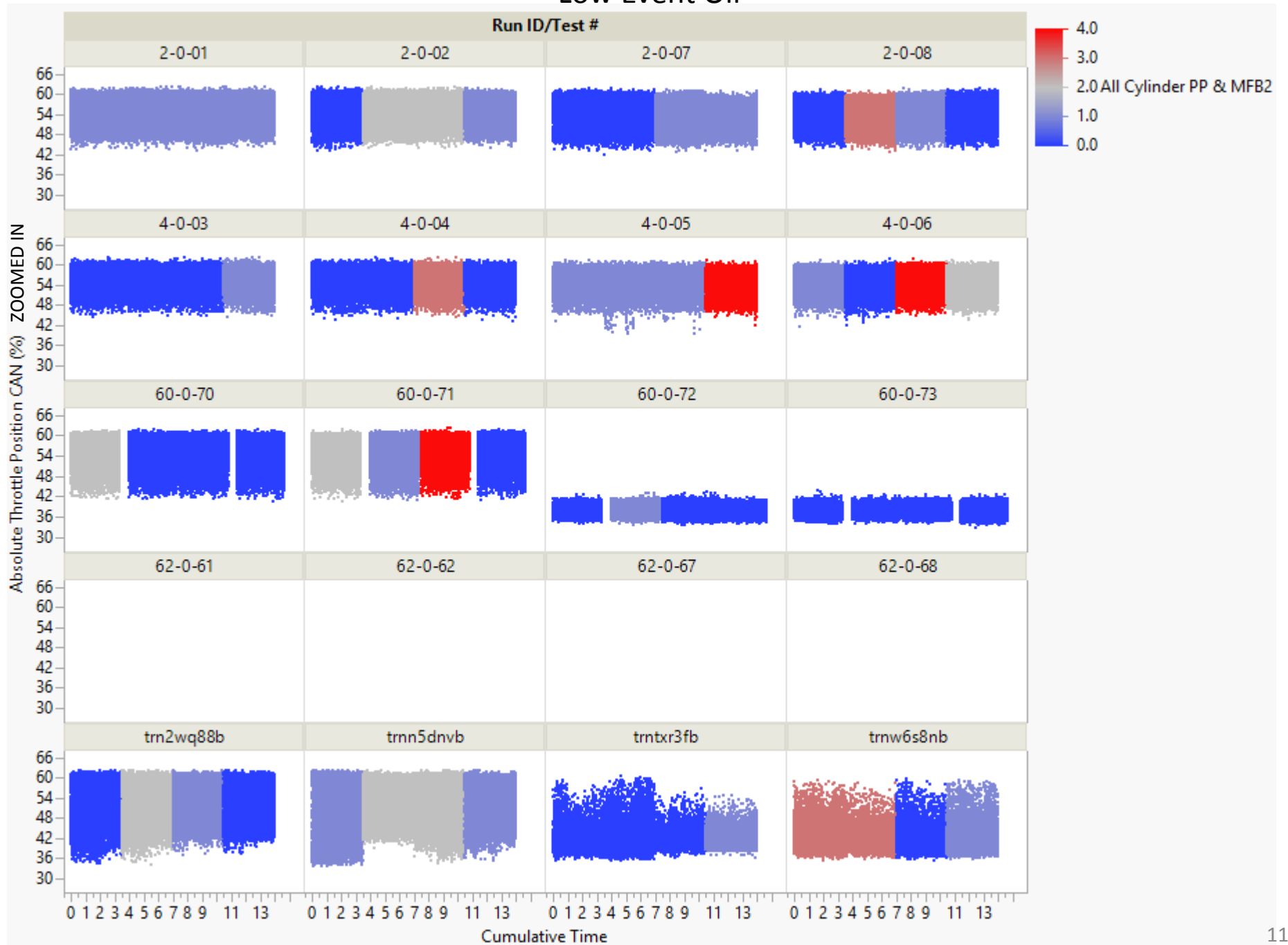


Absolute Throttle Position CAN

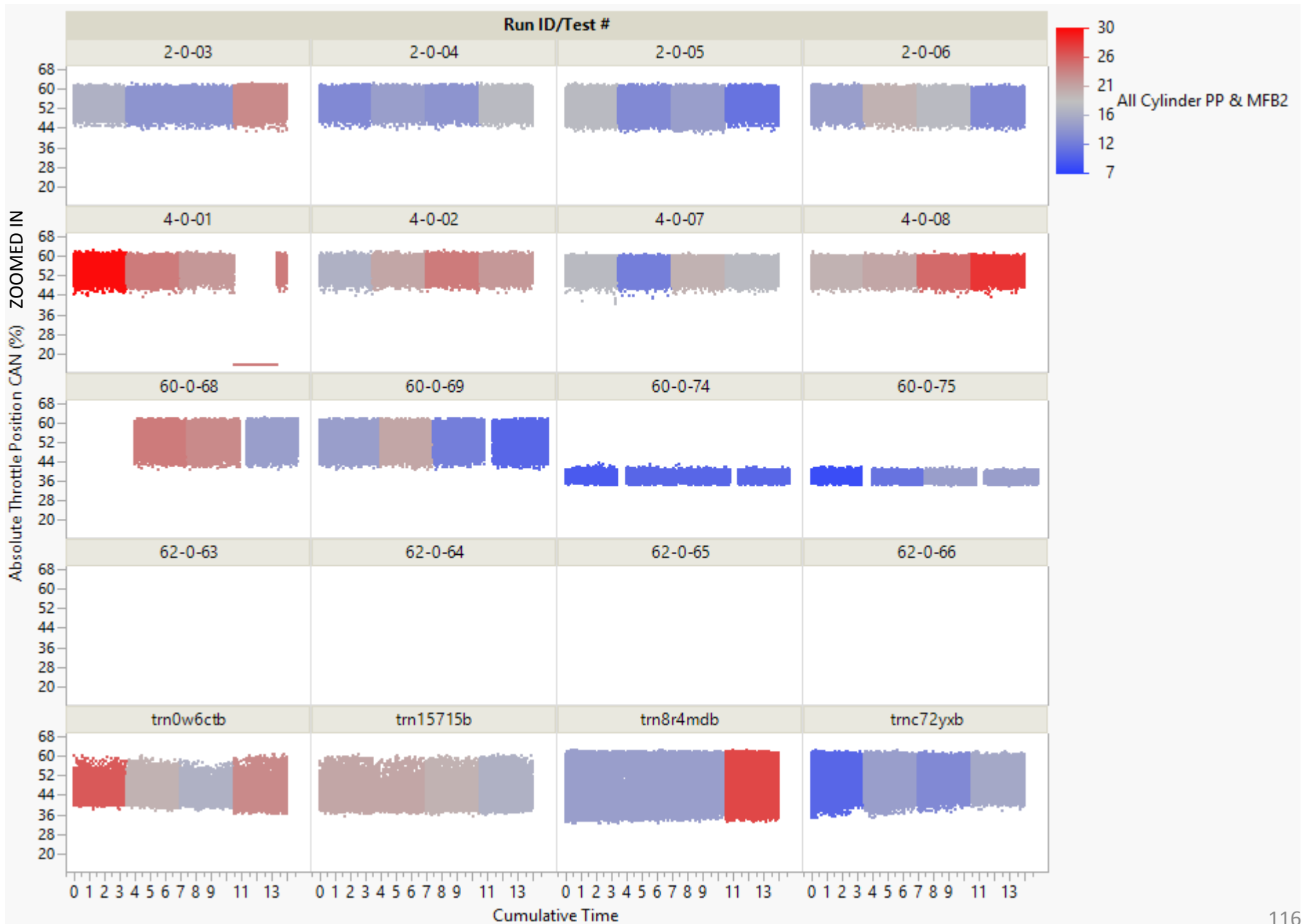




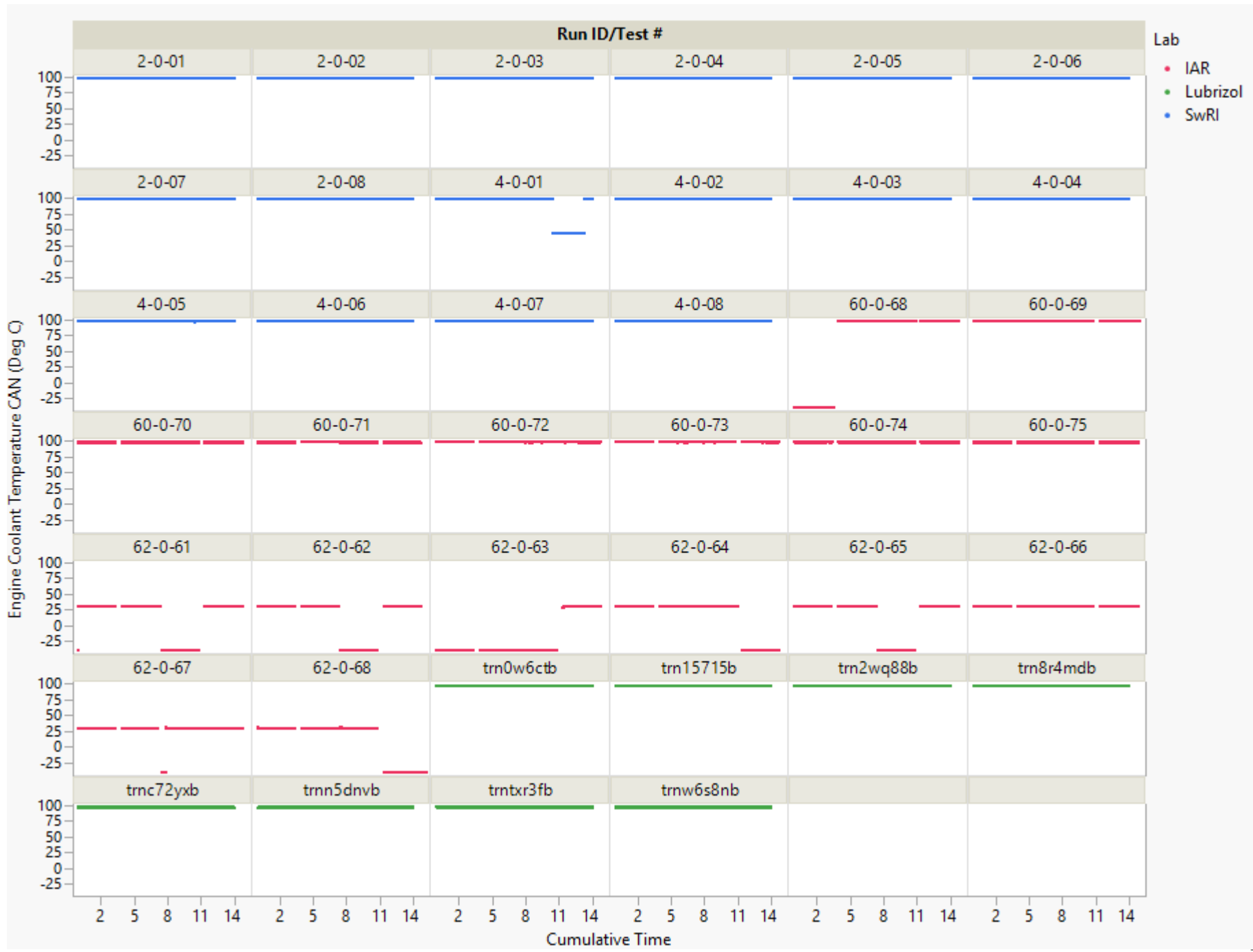
Low Event Oil

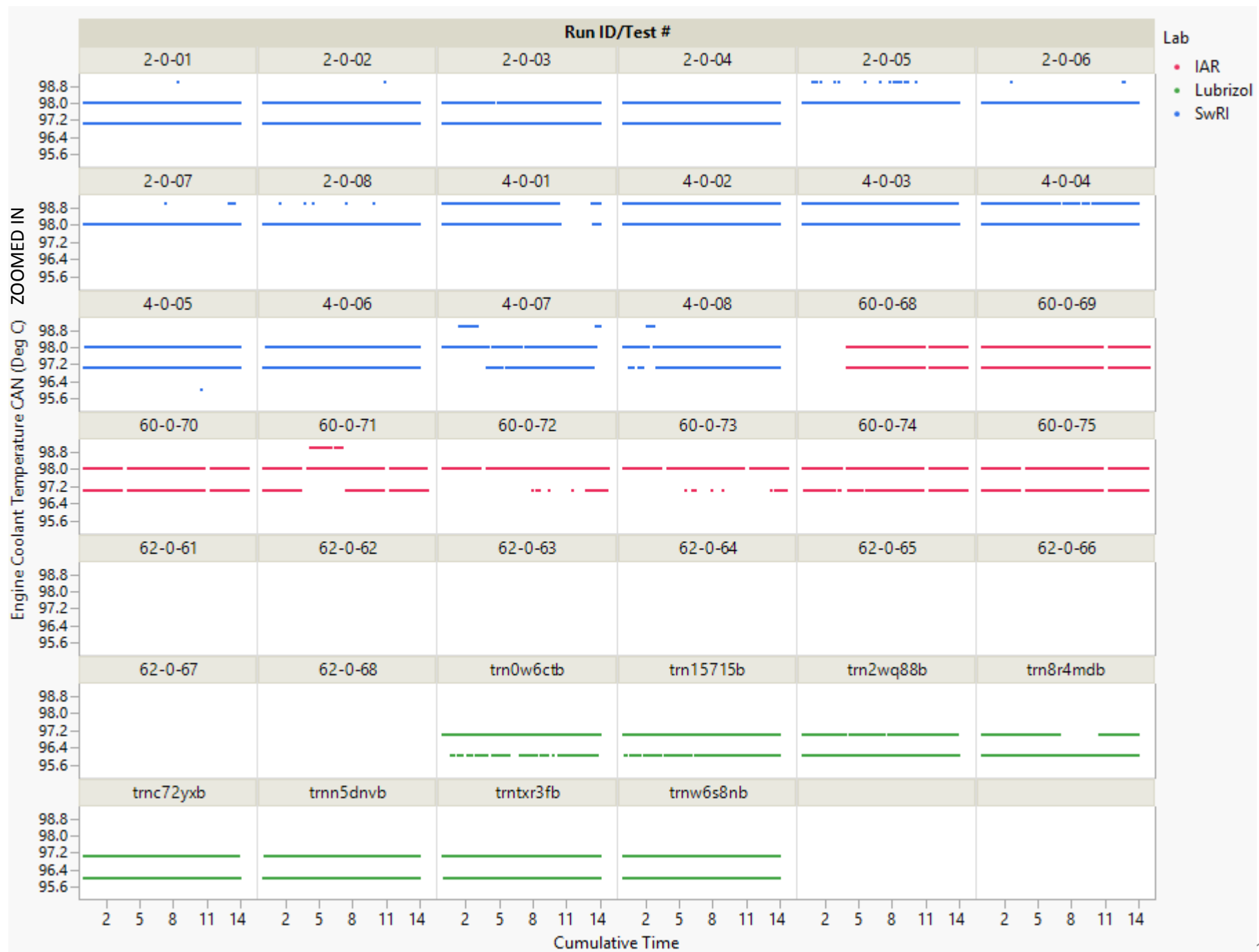


High Event Oil

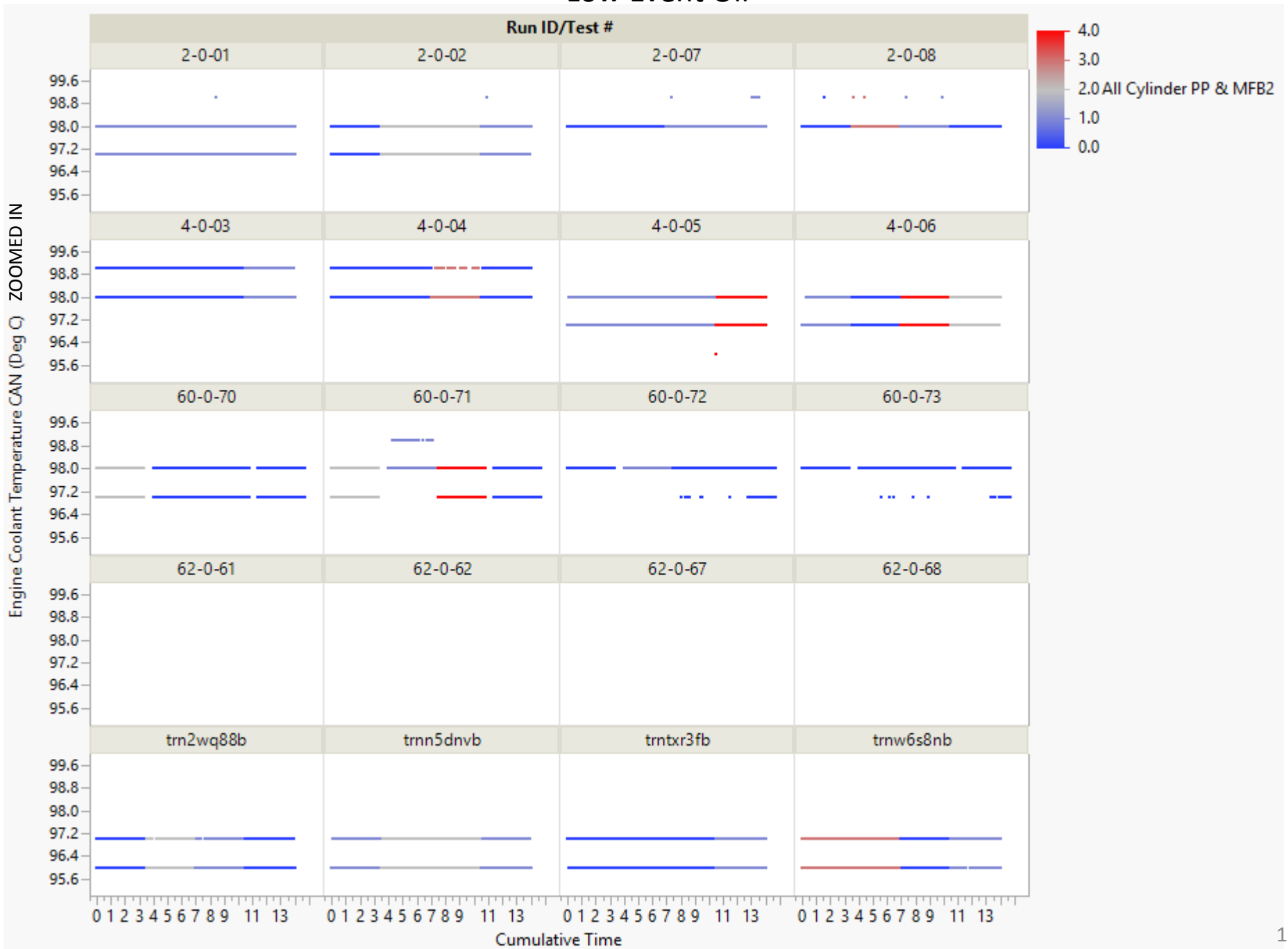


Engine
Coolant
Temperature
CAN

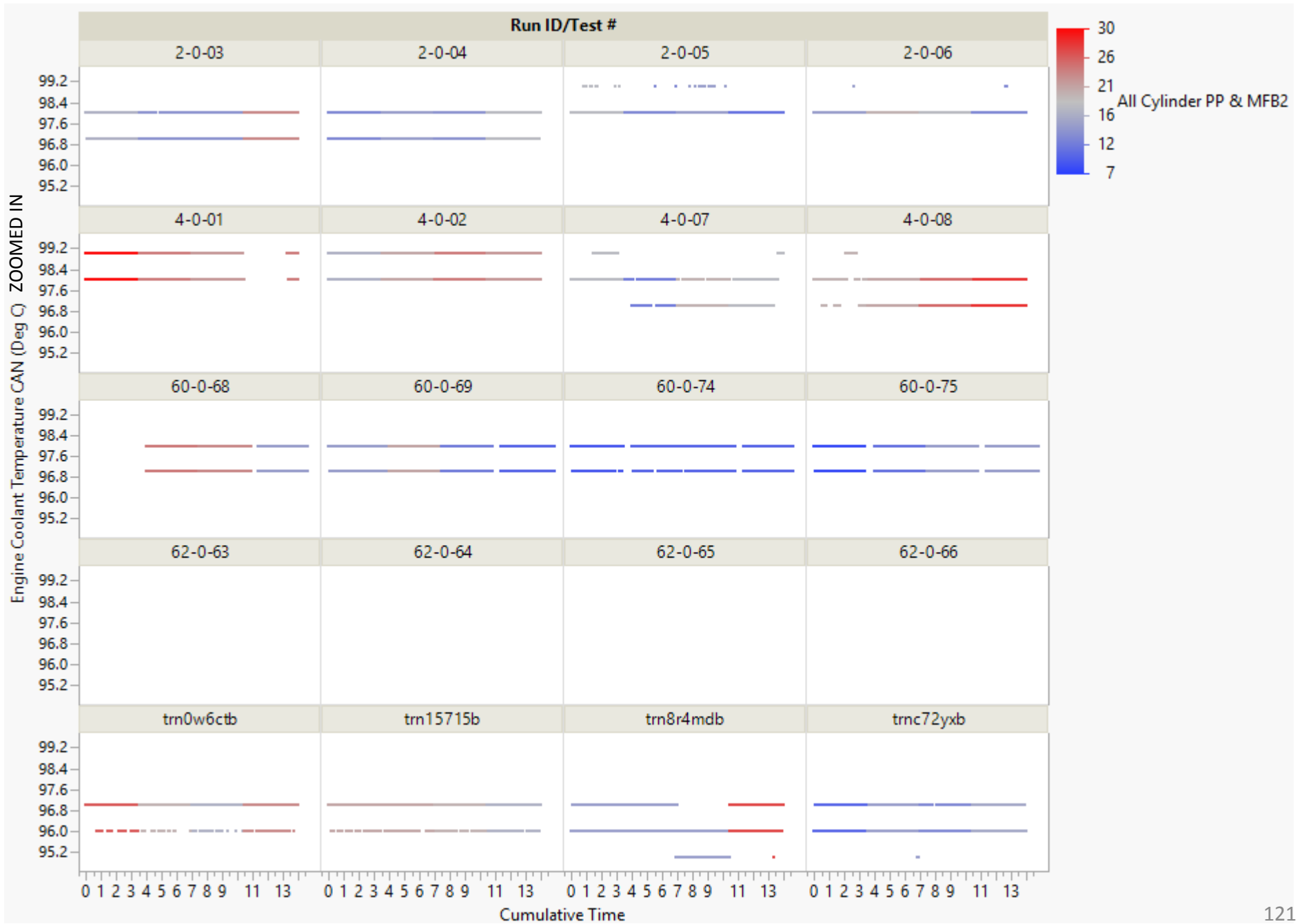




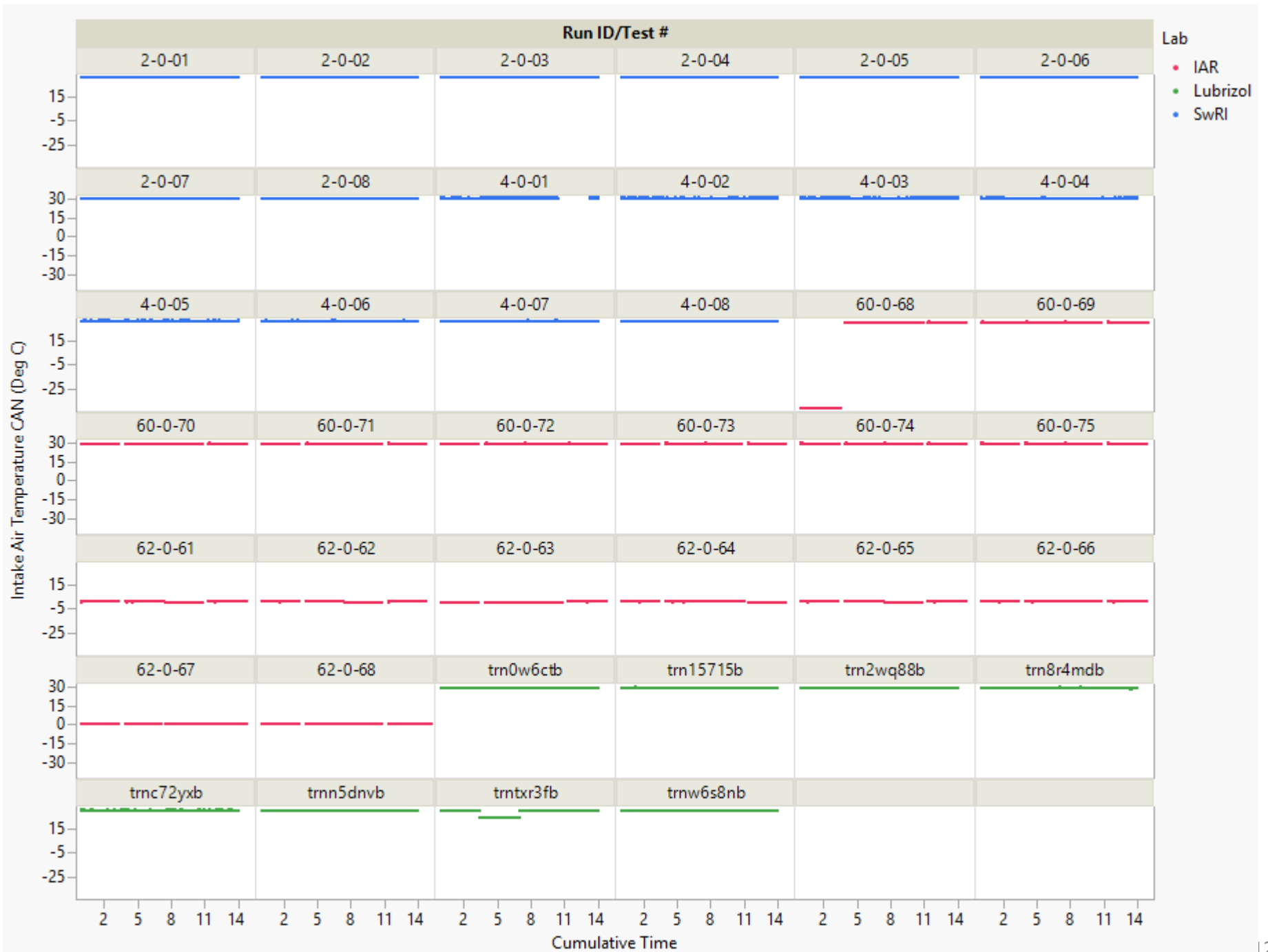
Low Event Oil

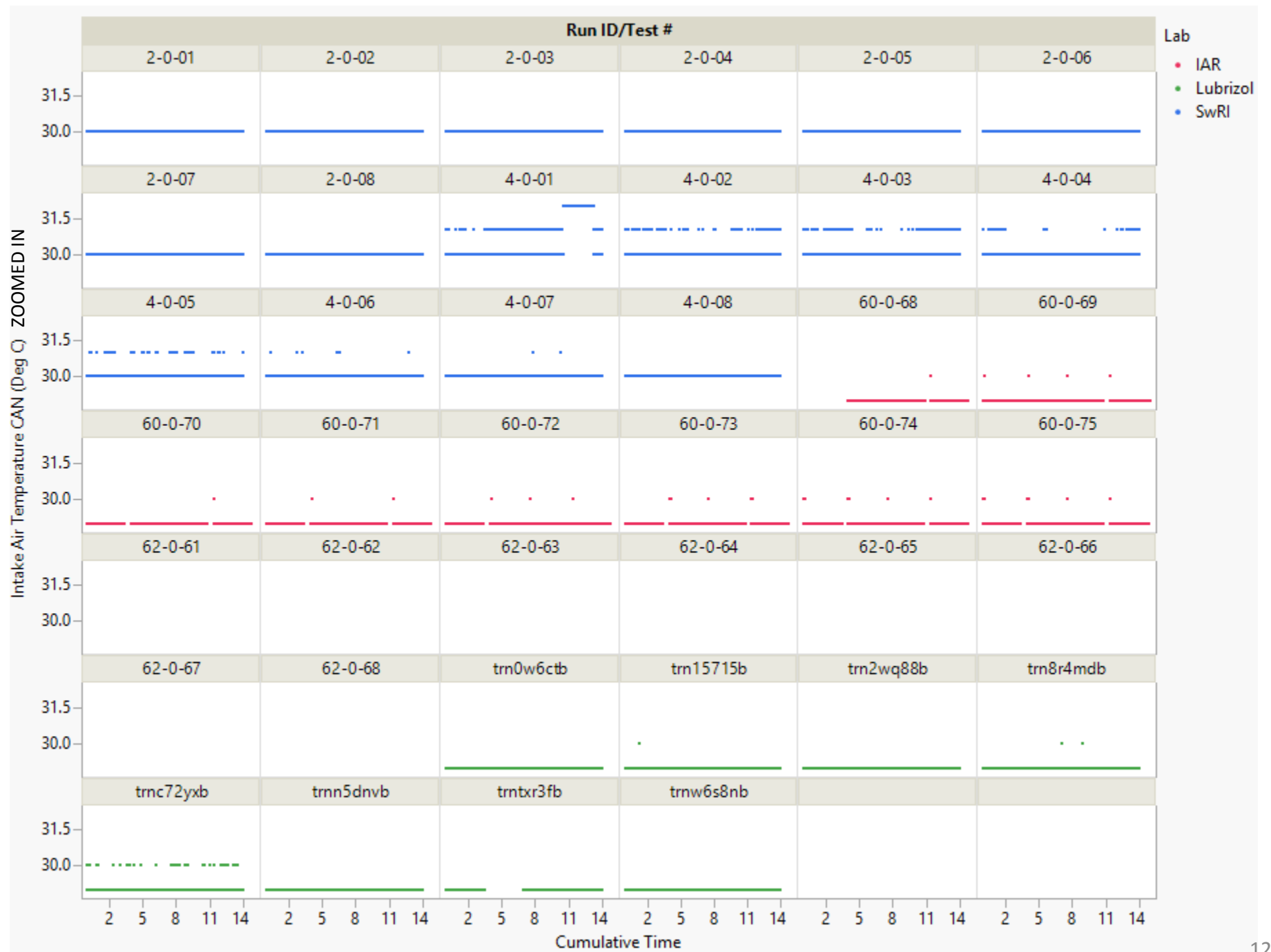


High Event Oil

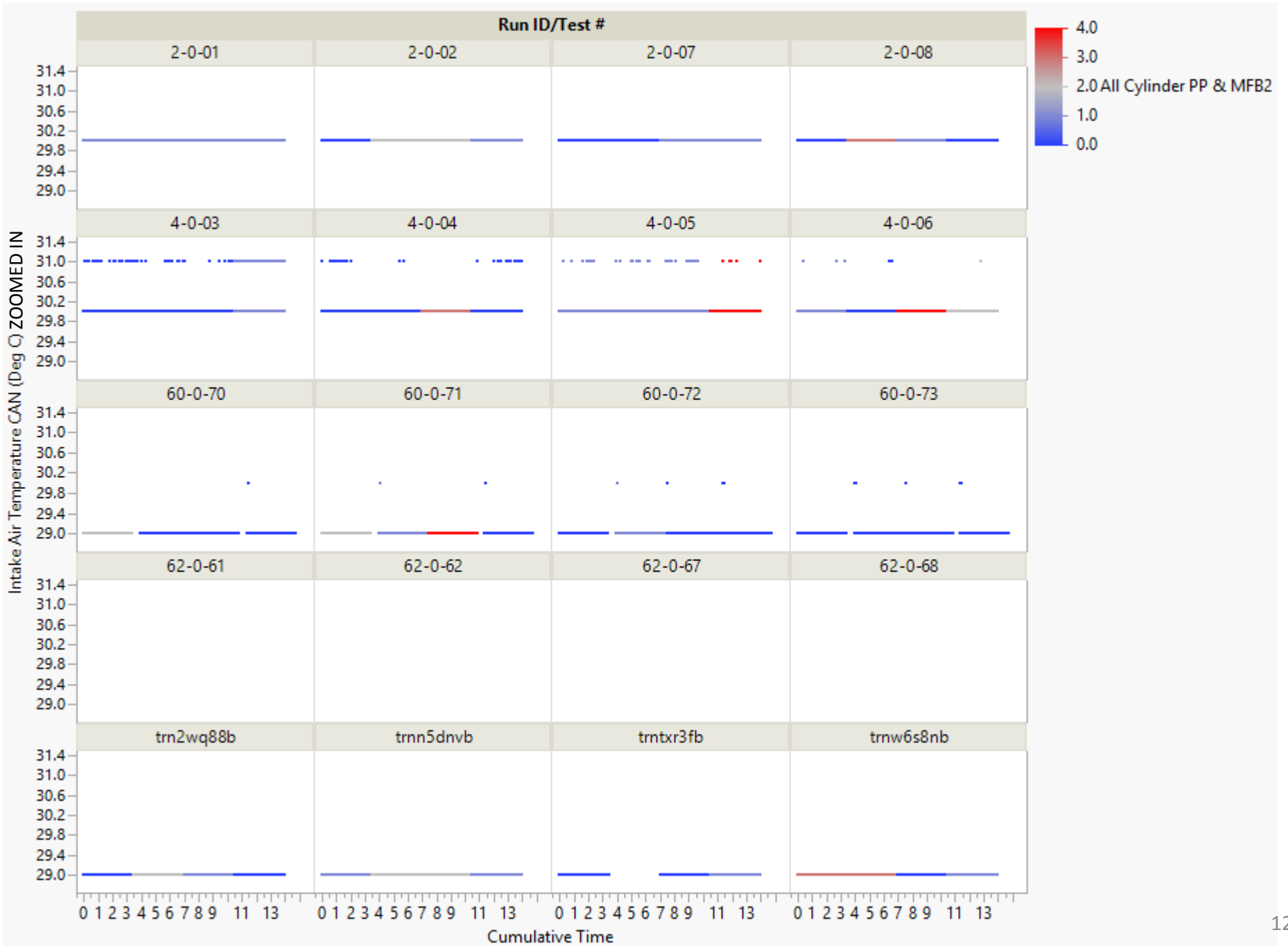


Intake Air Temperature CAN

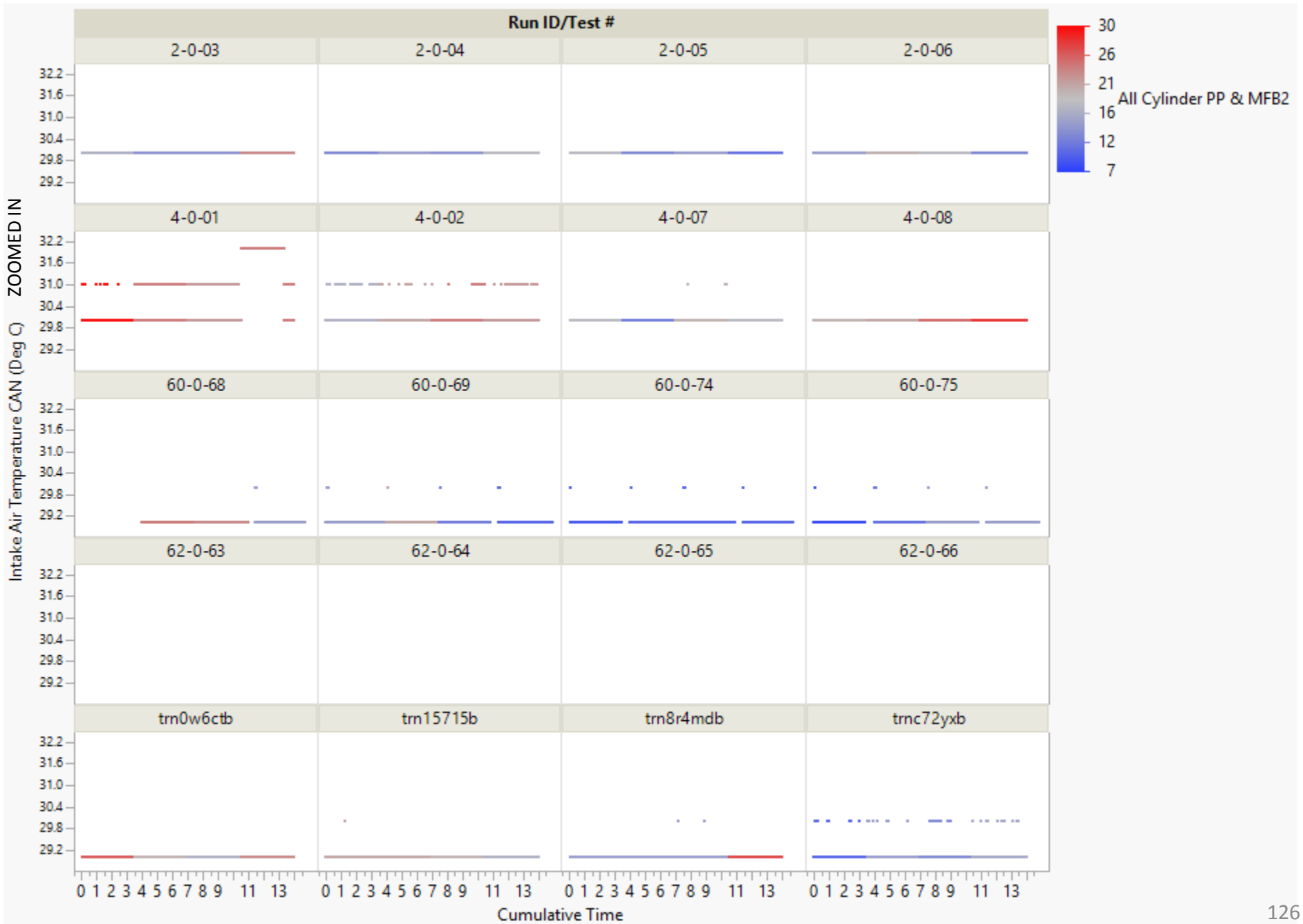




Low Event Oil



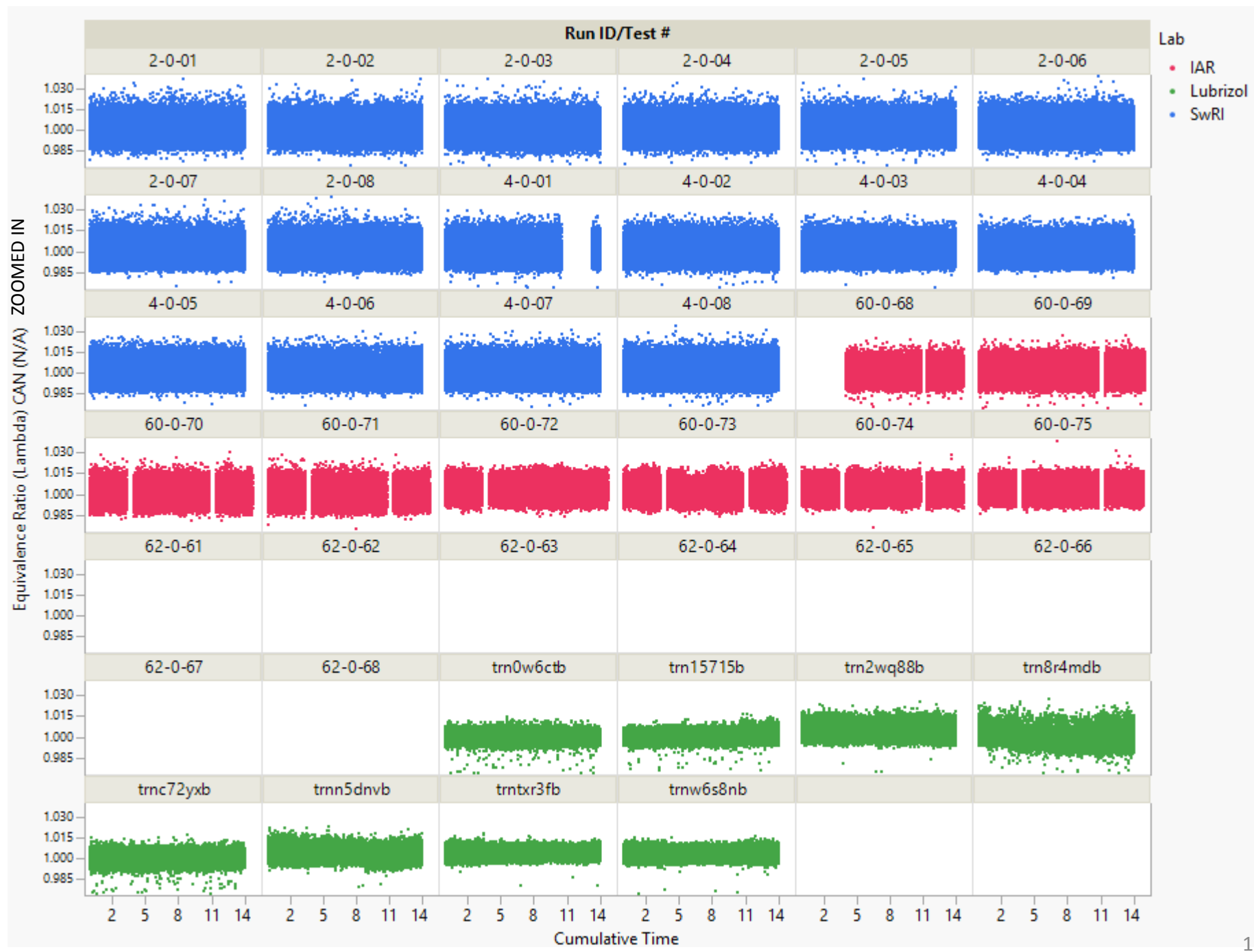
High Event Oil



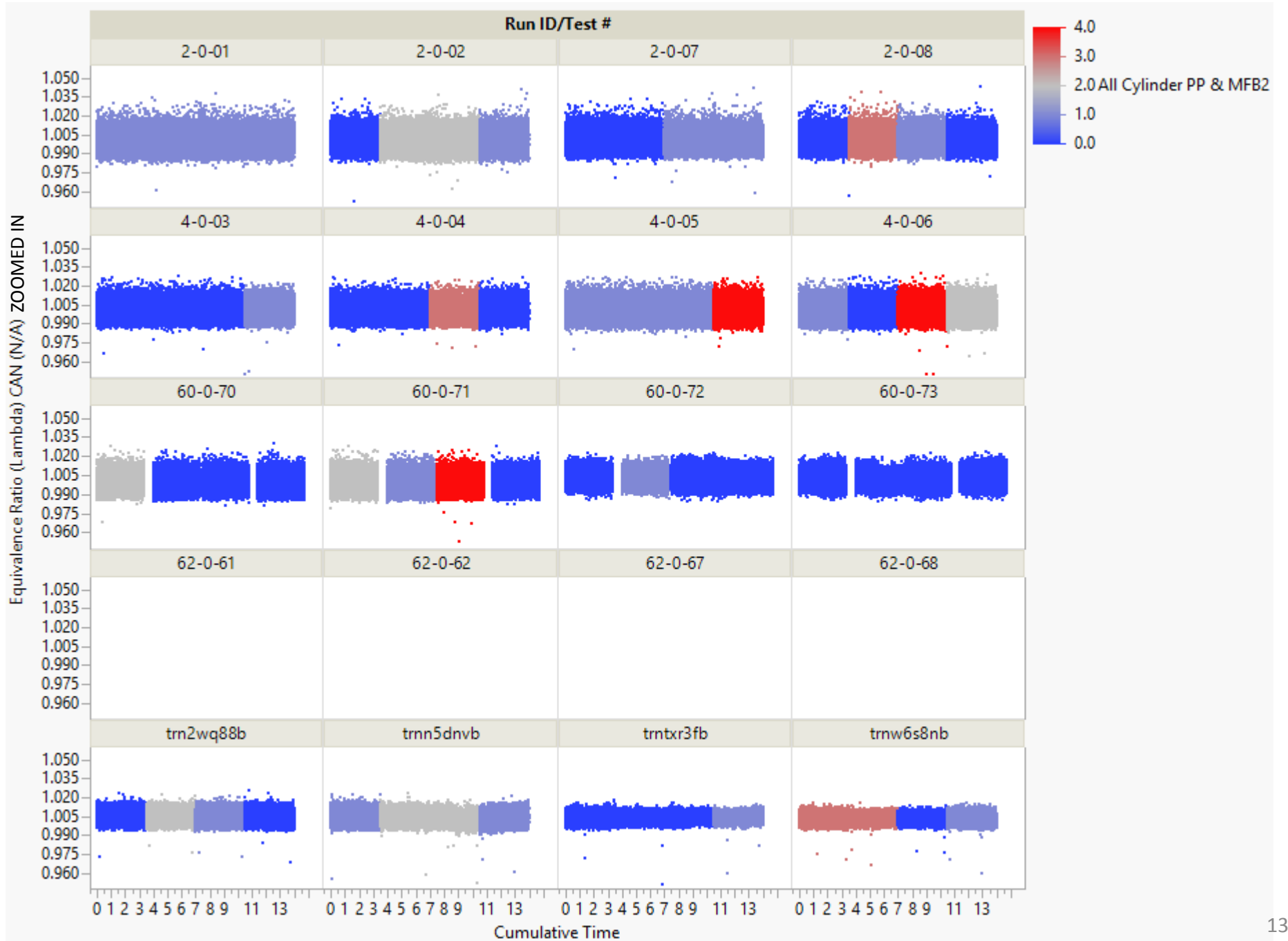
Equivalence Ratio (Lambda) CAN



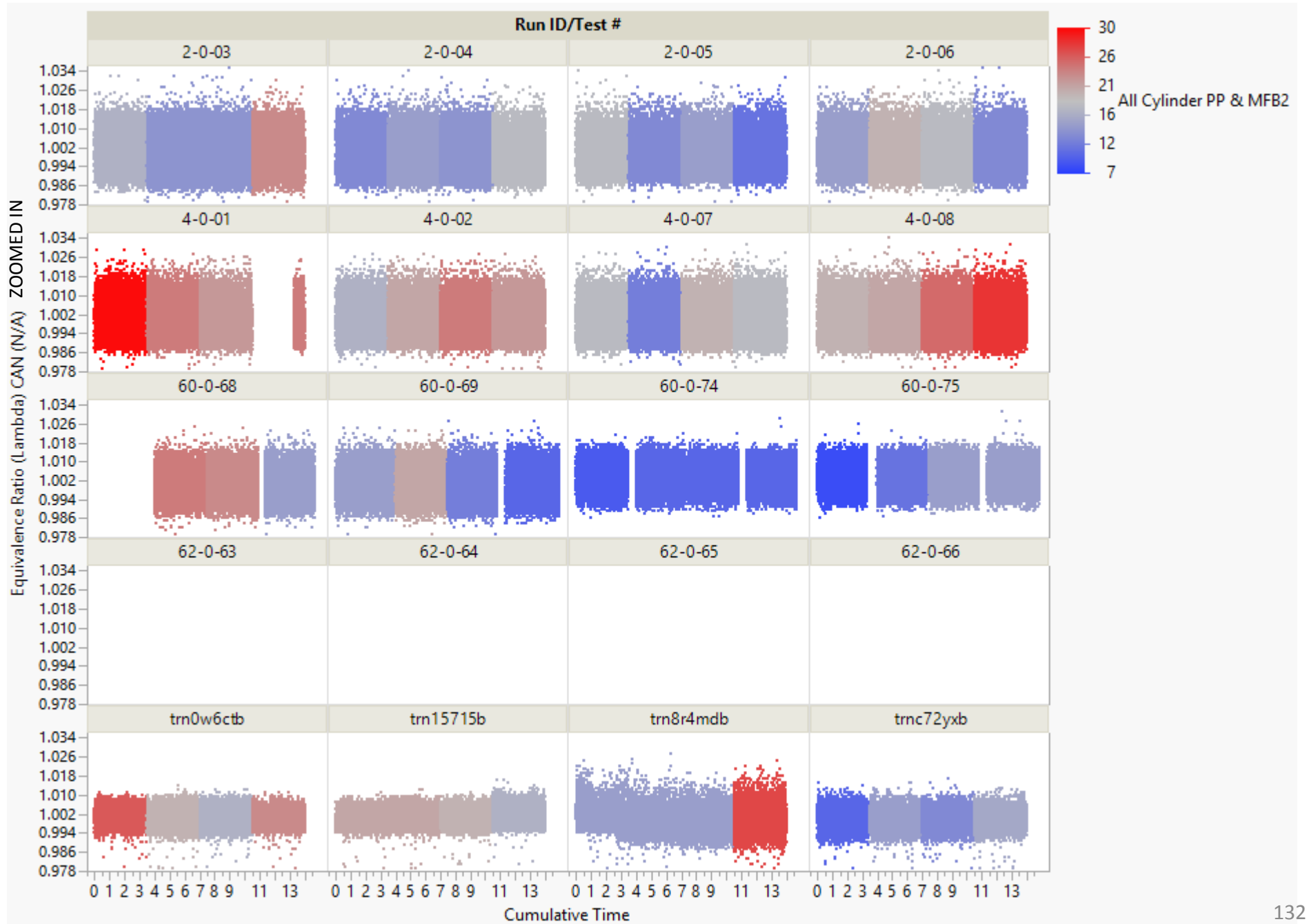




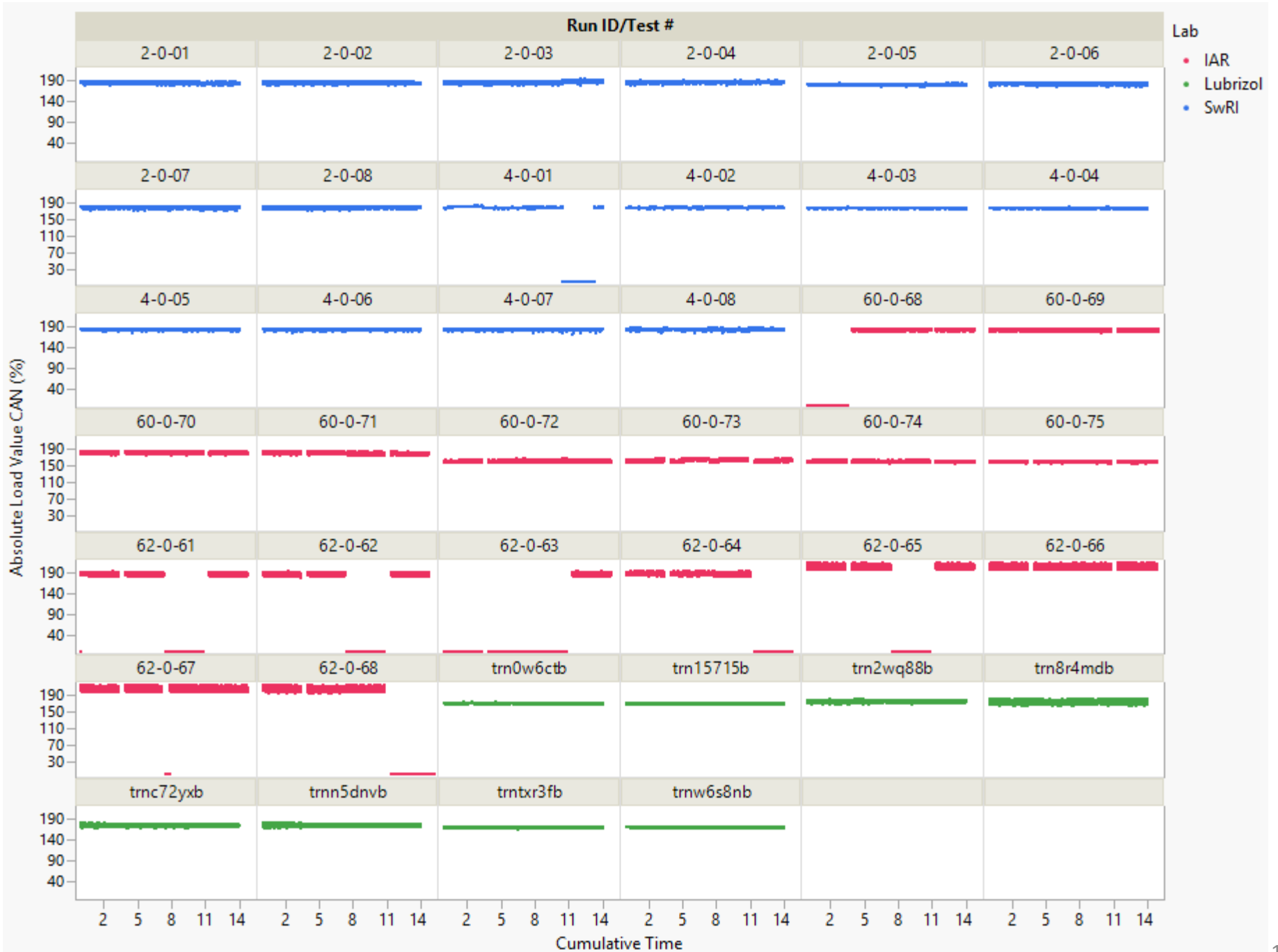
Low Event Oil

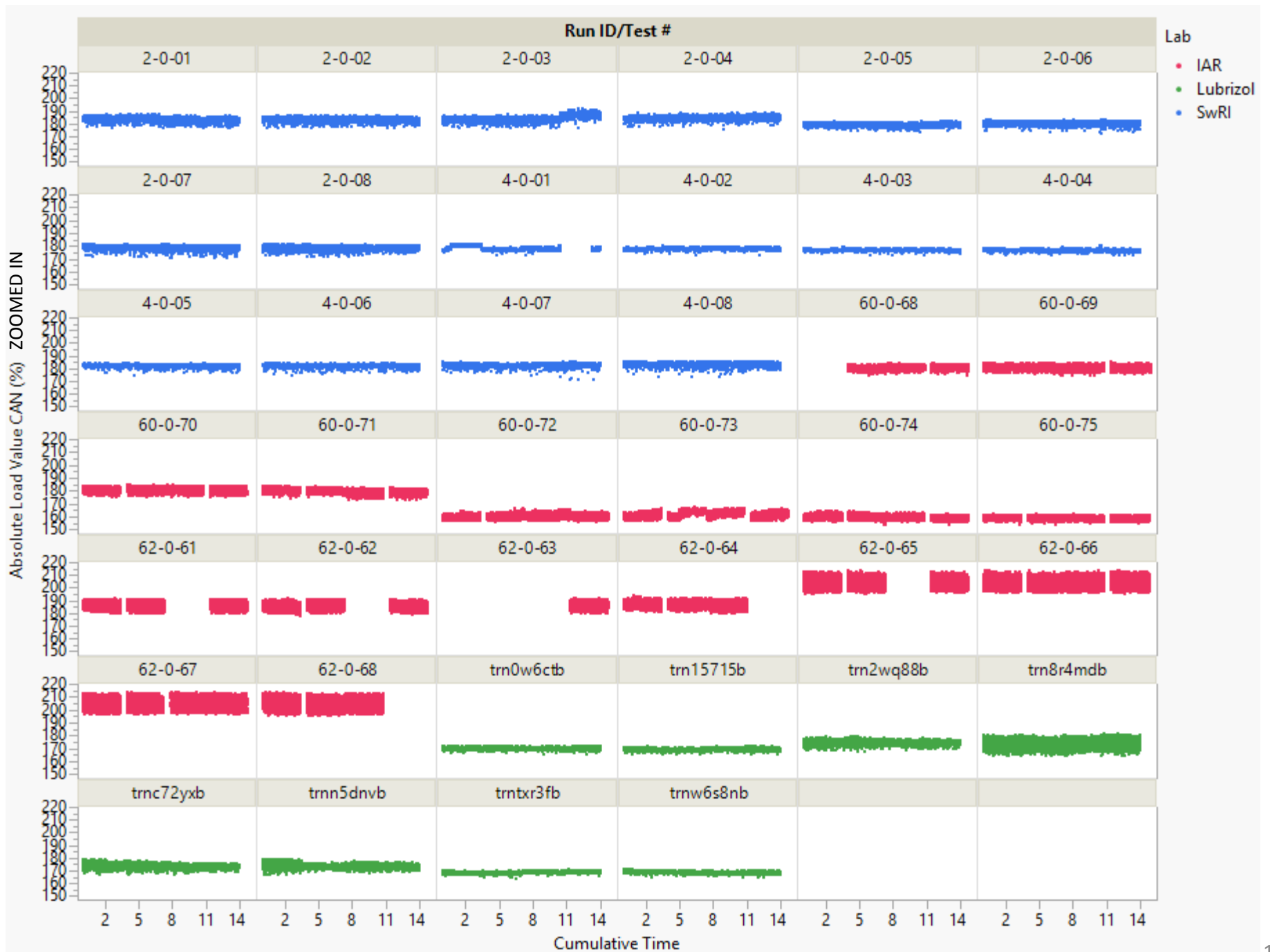


High Event Oil

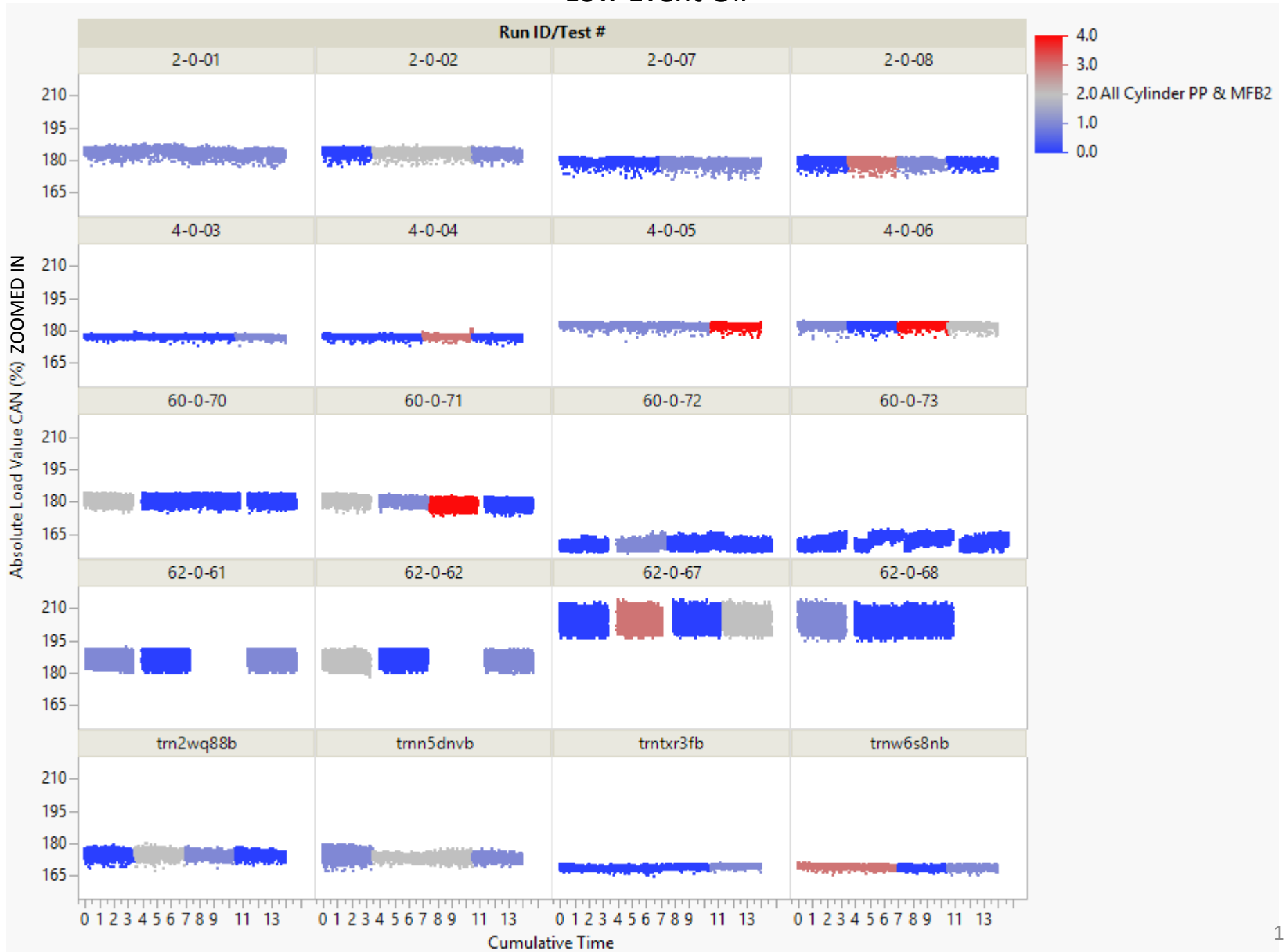


Absolute Load Value CAN

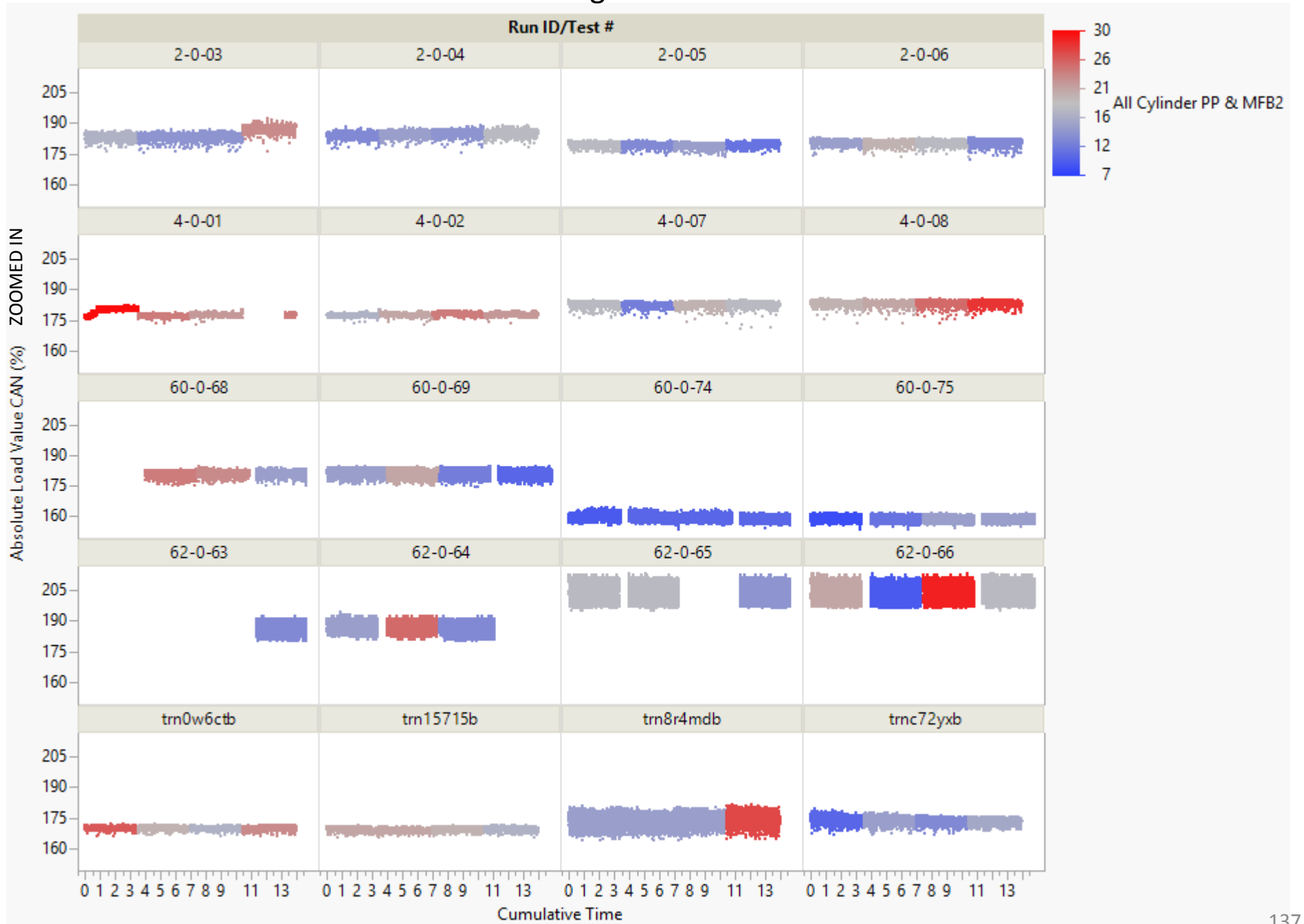




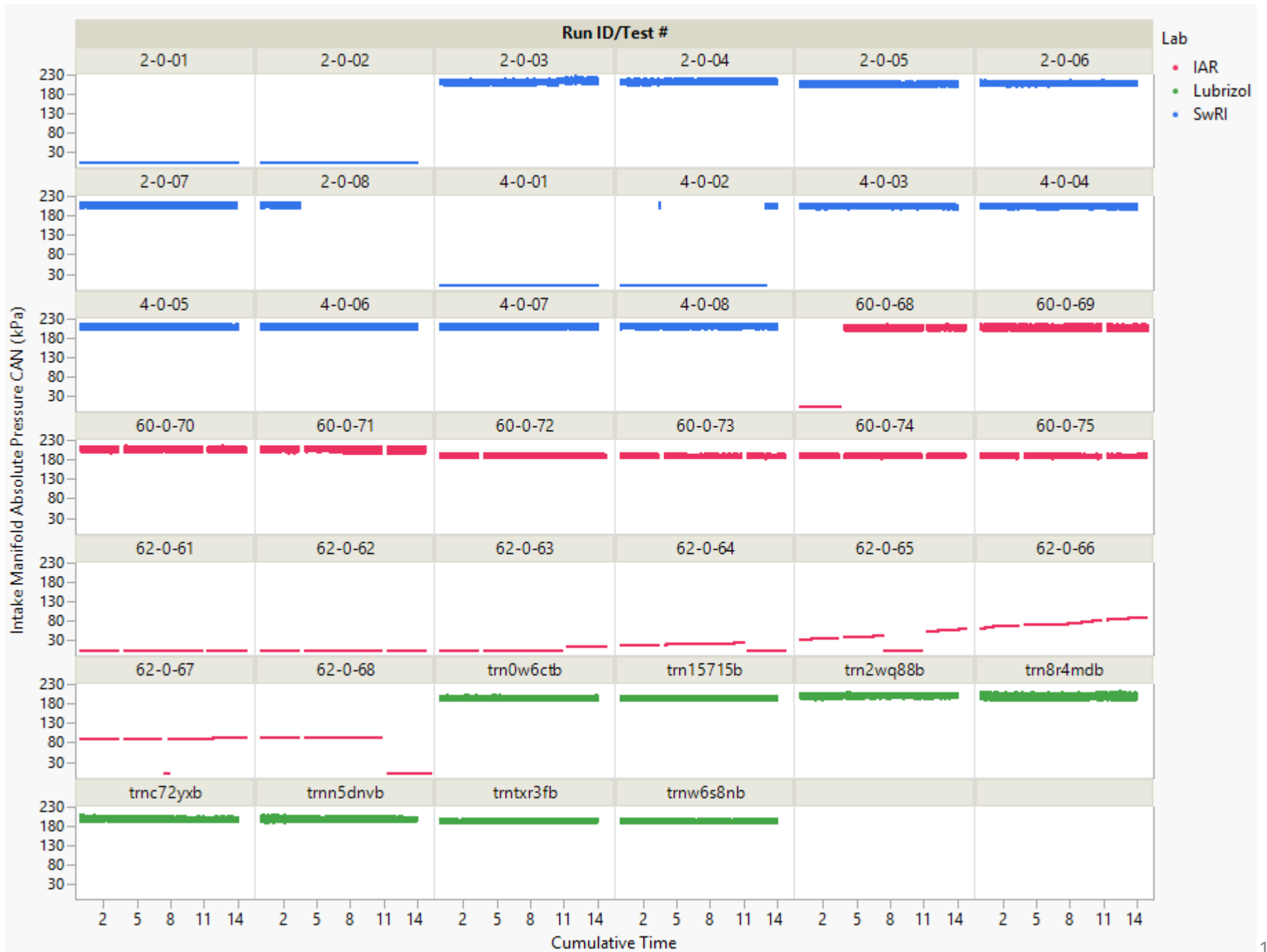
Low Event Oil



High Event Oil

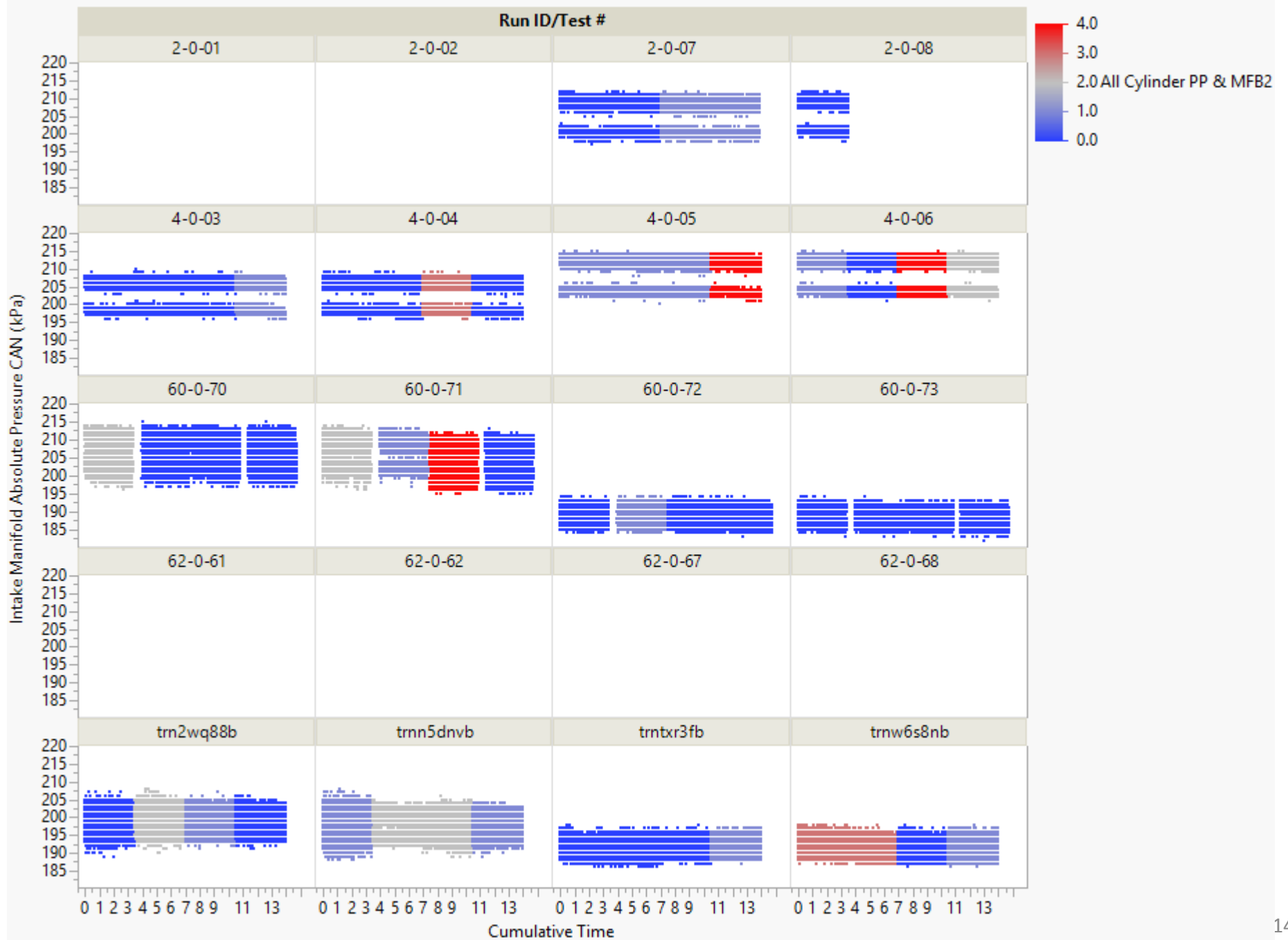


Intake
Manifold
Absolute
Pressure CAN

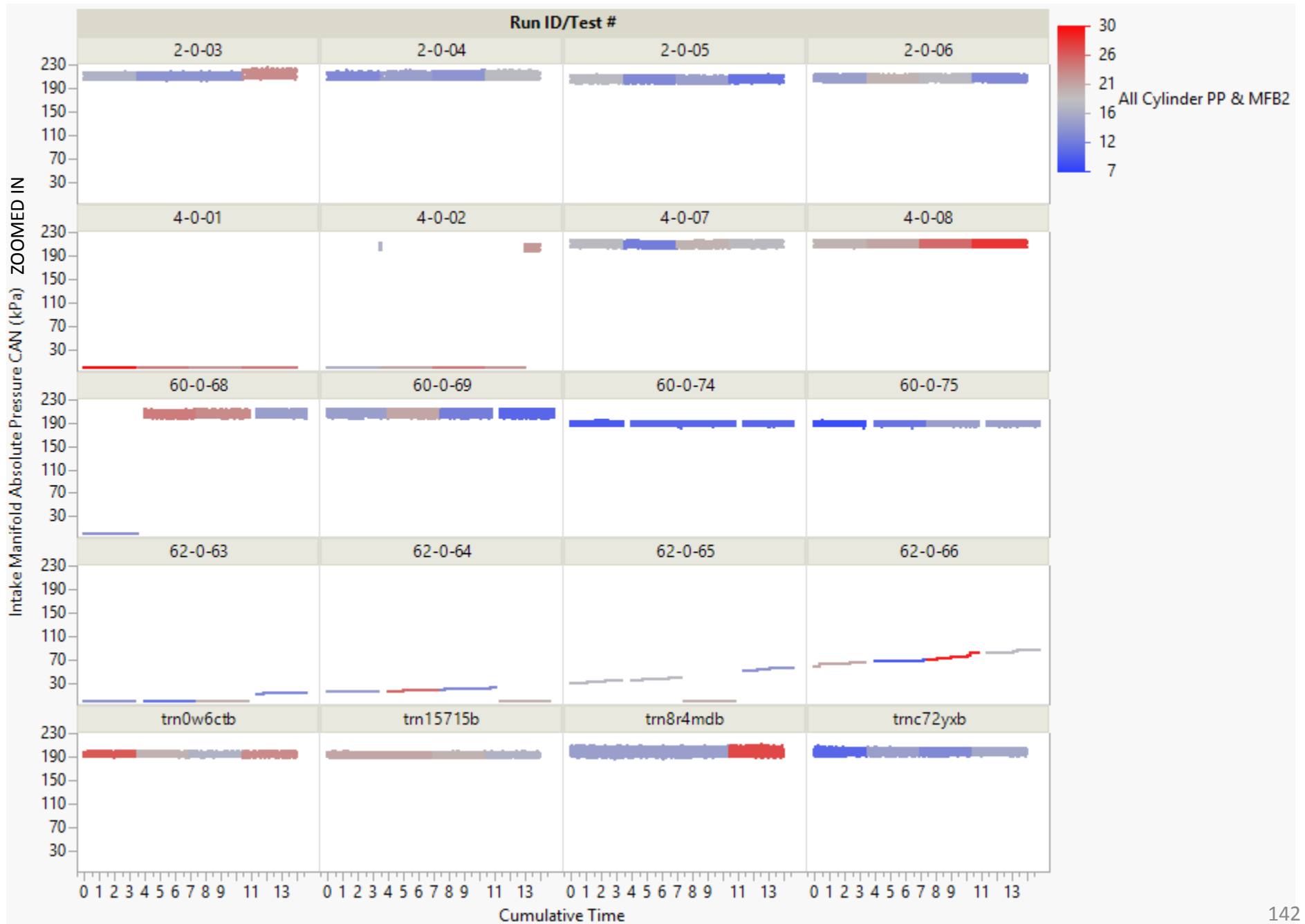




Low Event Oil

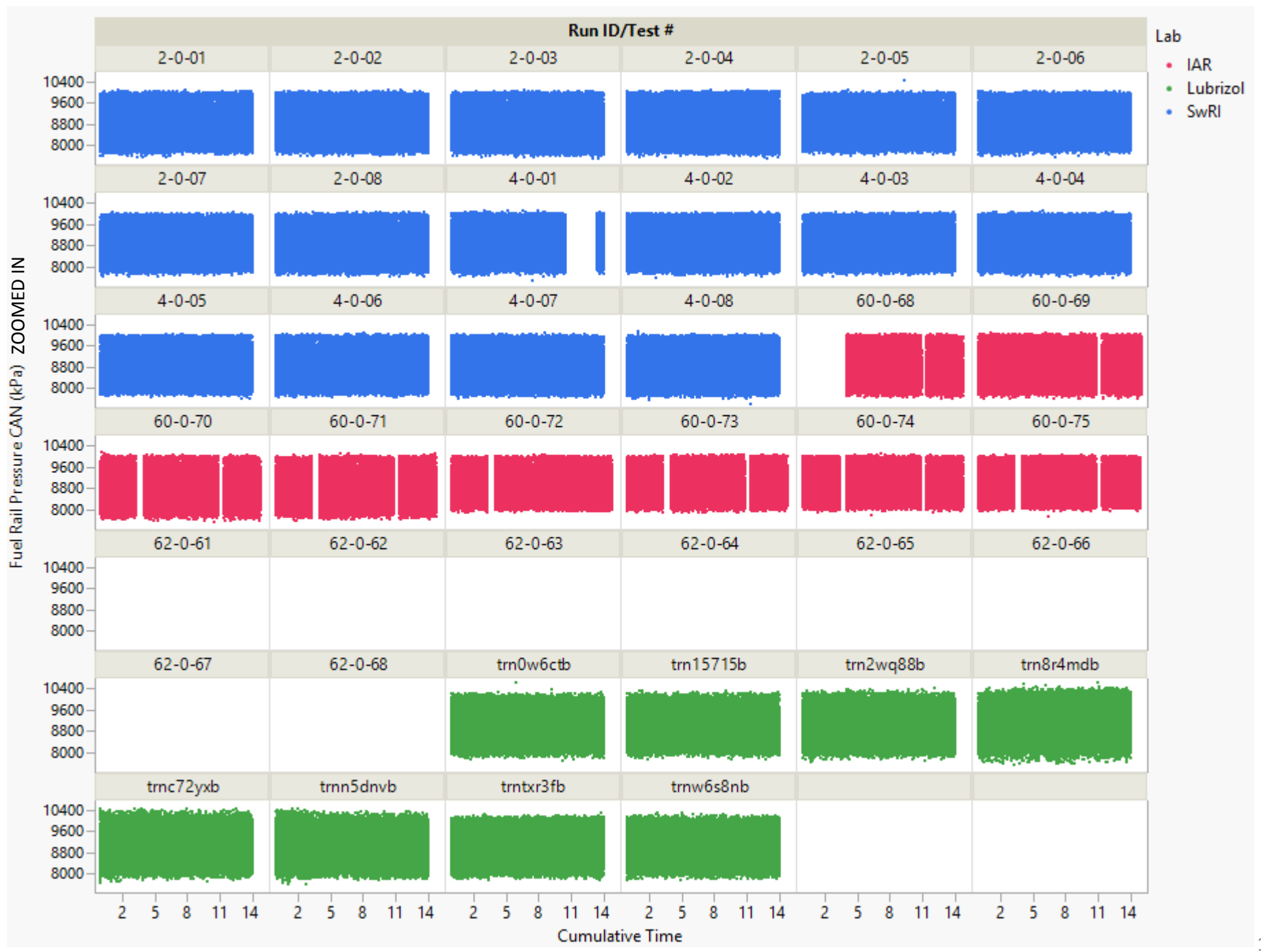


High Event Oil

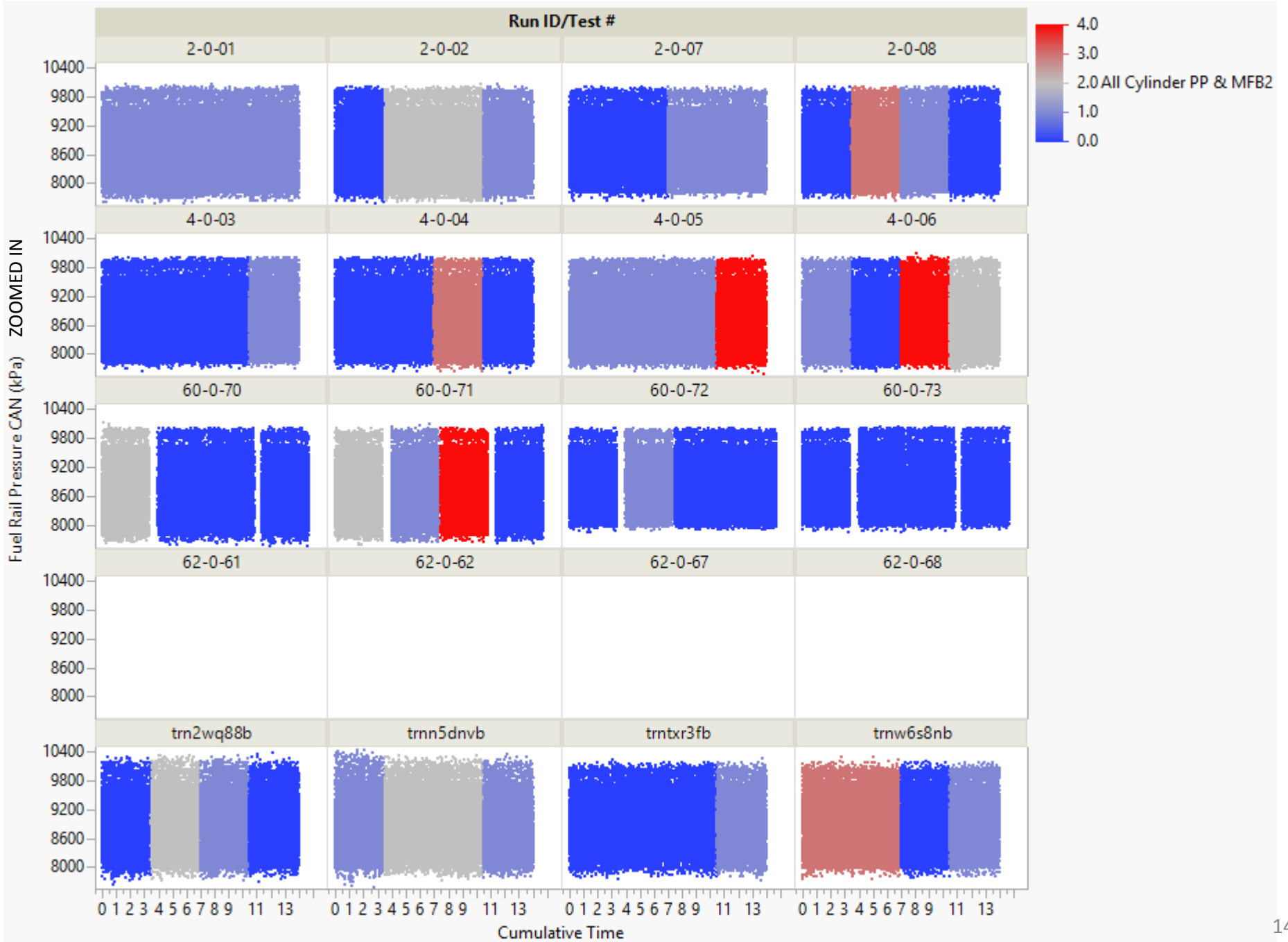


Fuel Rail Pressure CAN

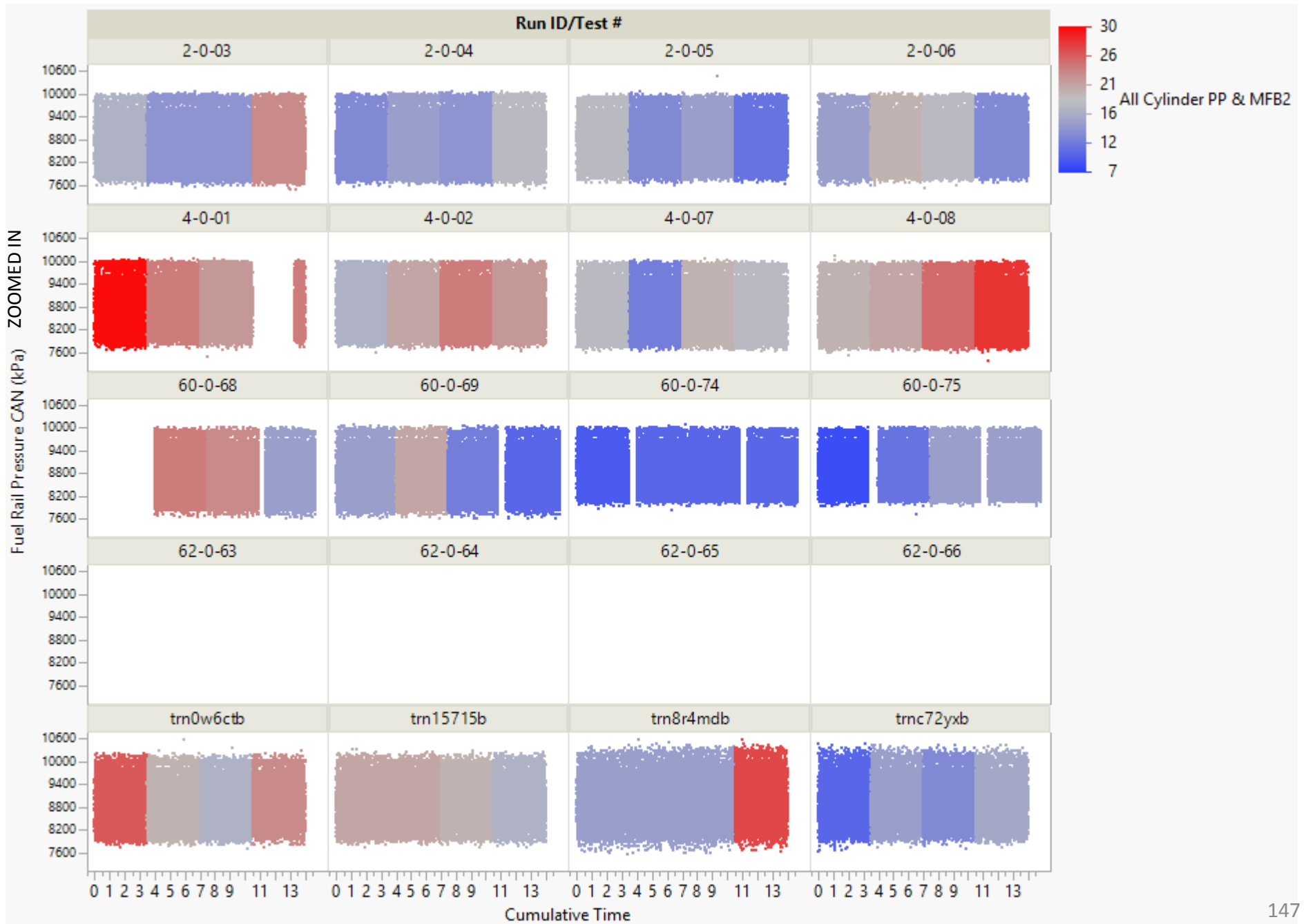




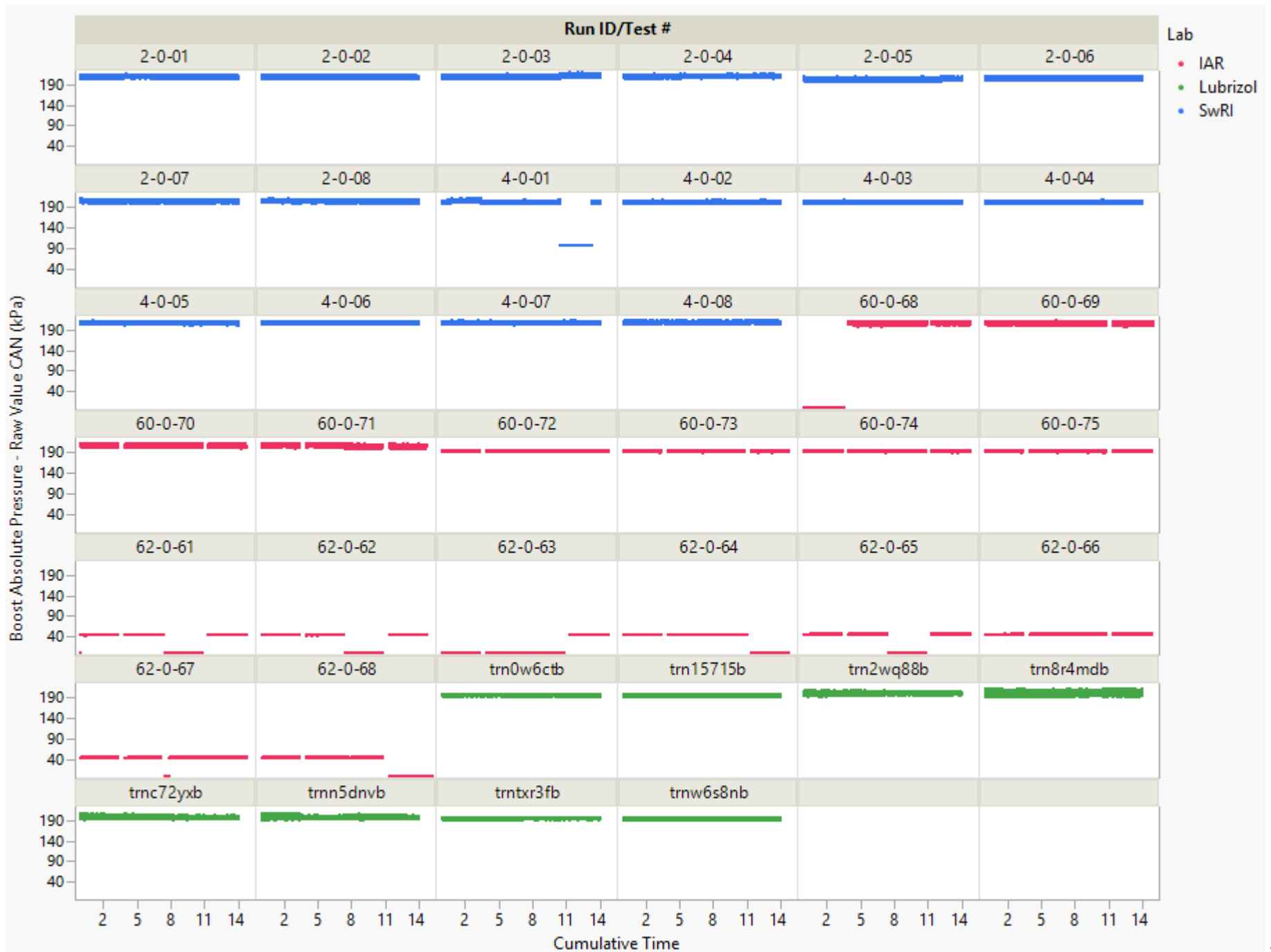
Low Event Oil



High Event Oil

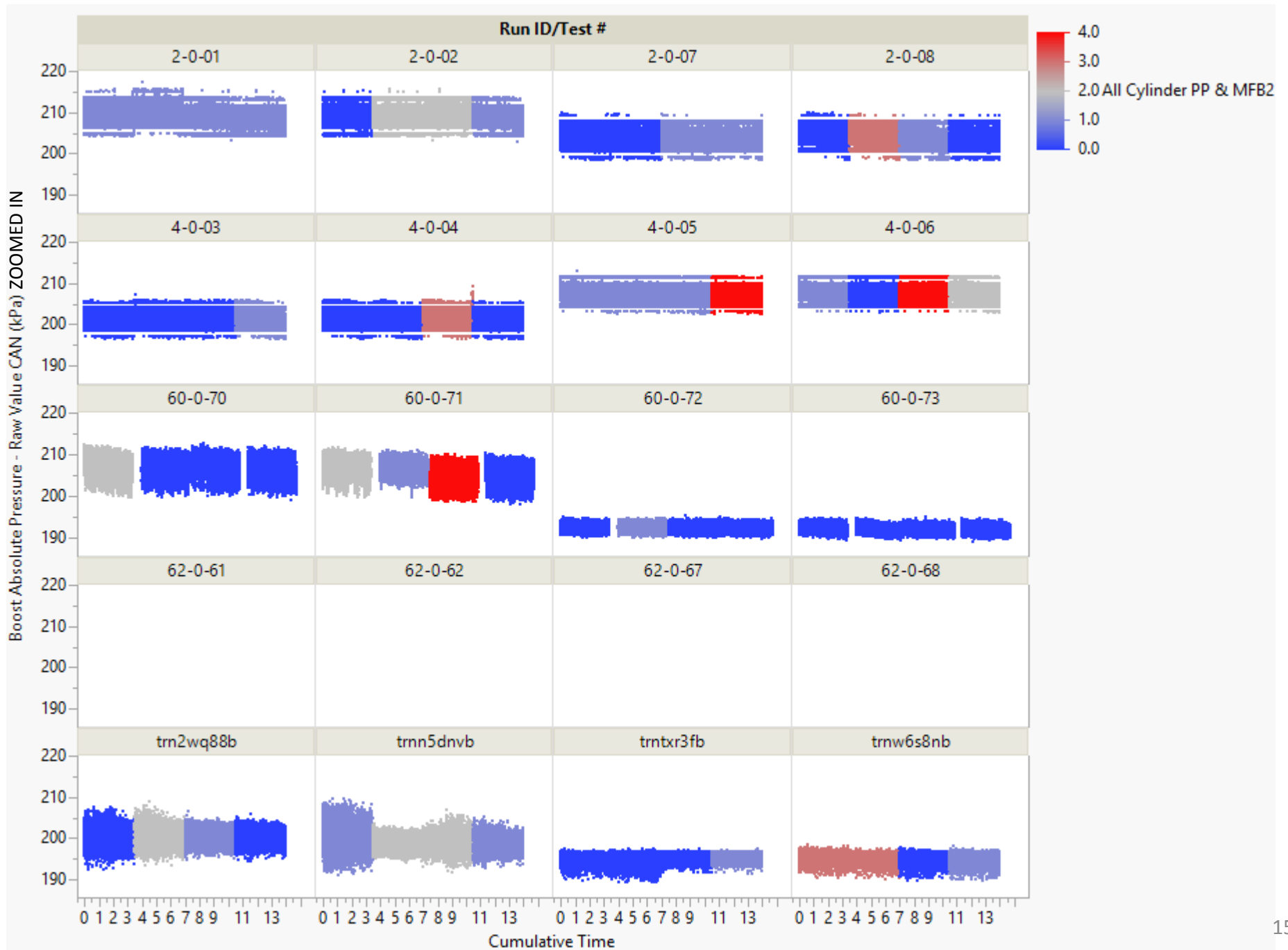


Boost Absolute Pressure - Raw Value CAN

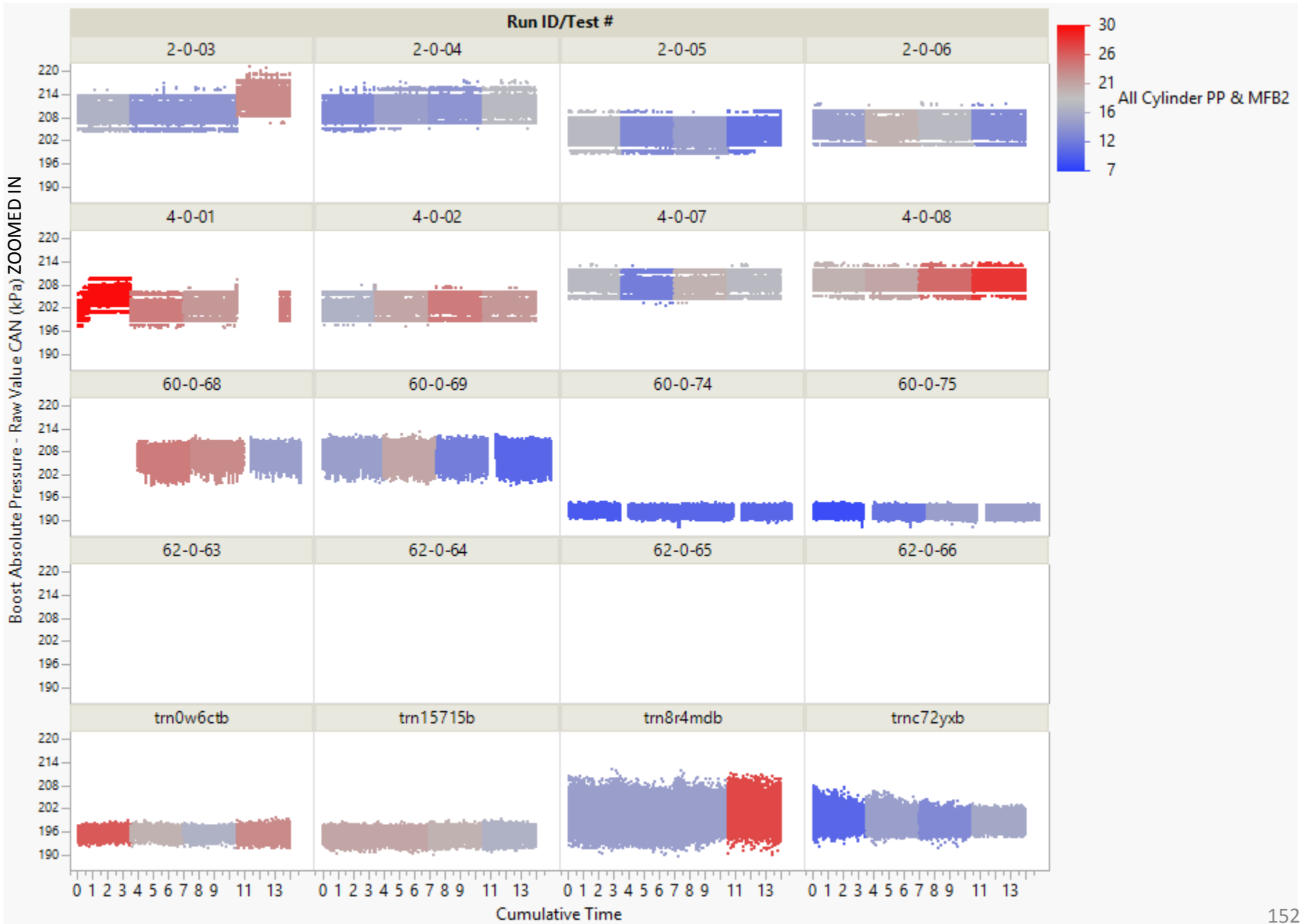




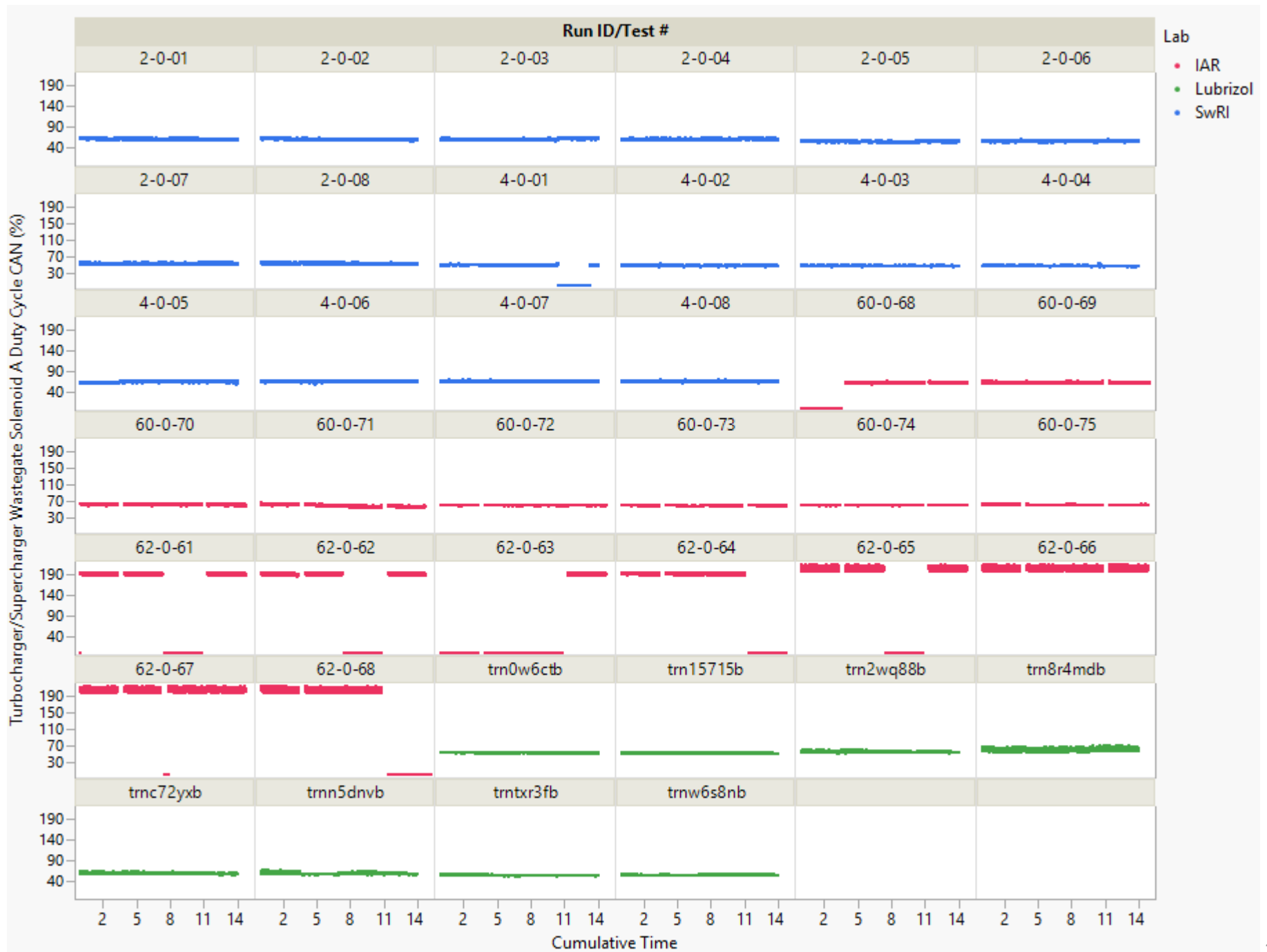
Low Event Oil

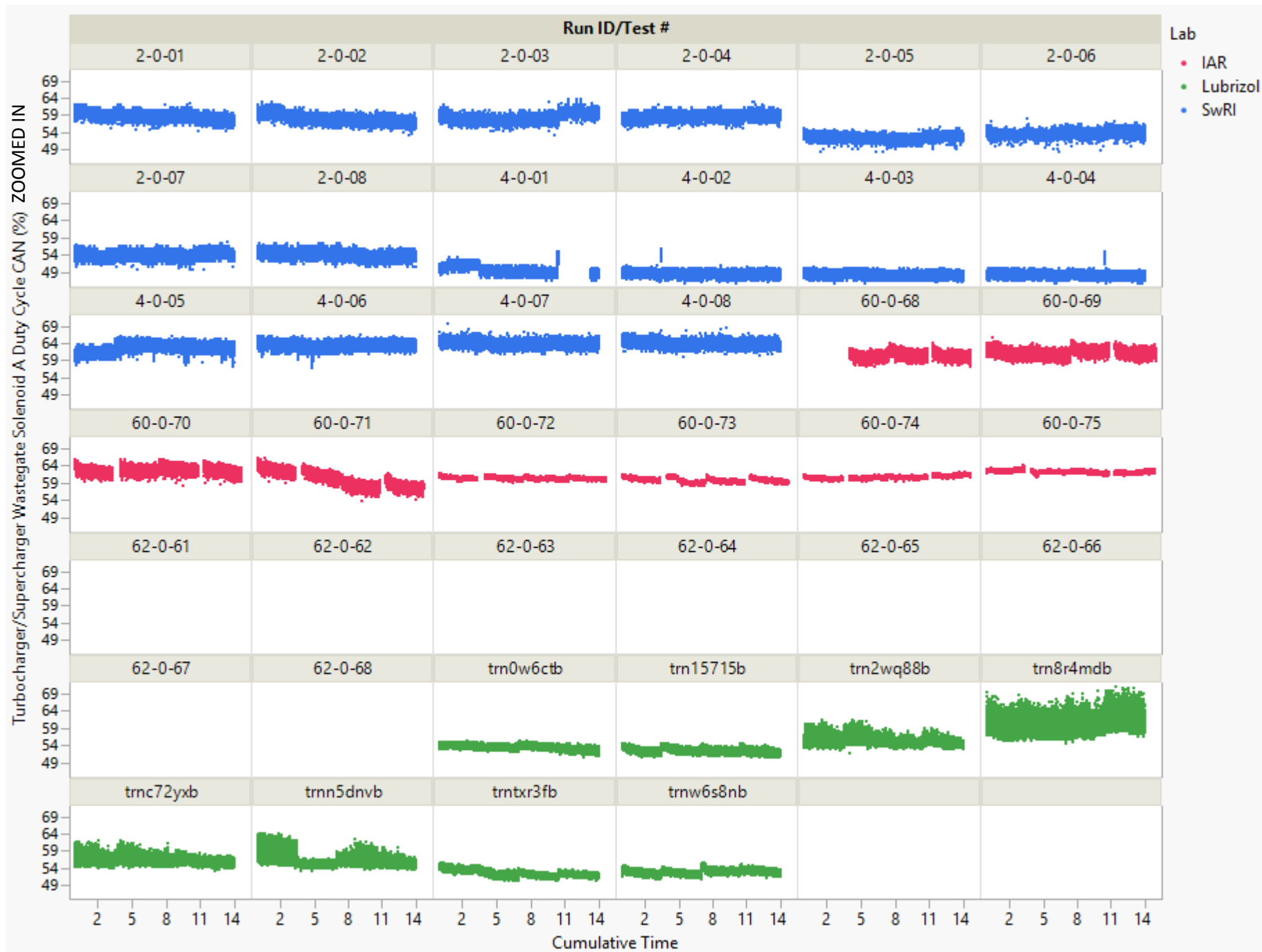


High Event Oil

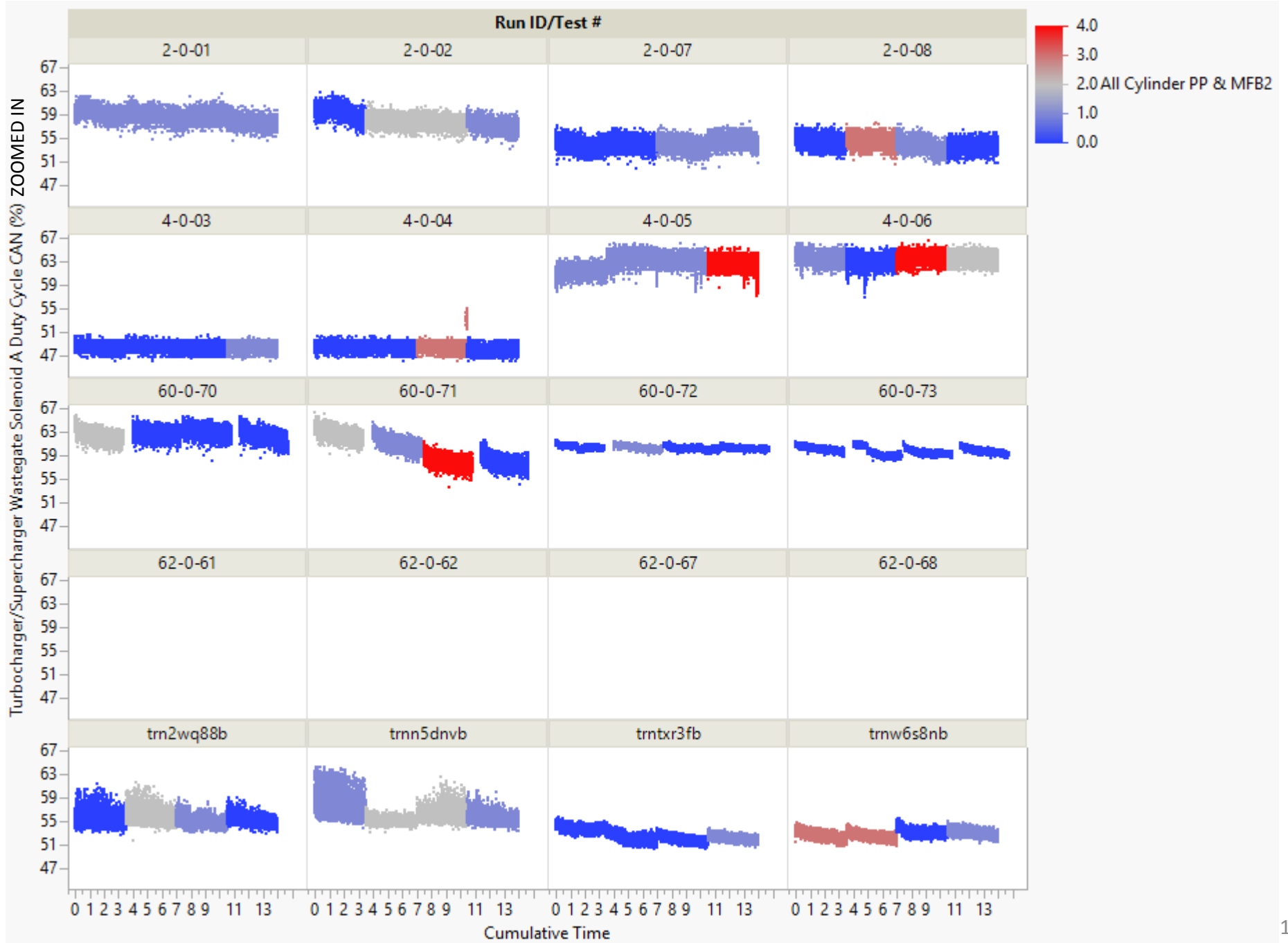


Turbocharger/Supercharger
Wastegate Solenoid A Duty
Cycle CAN

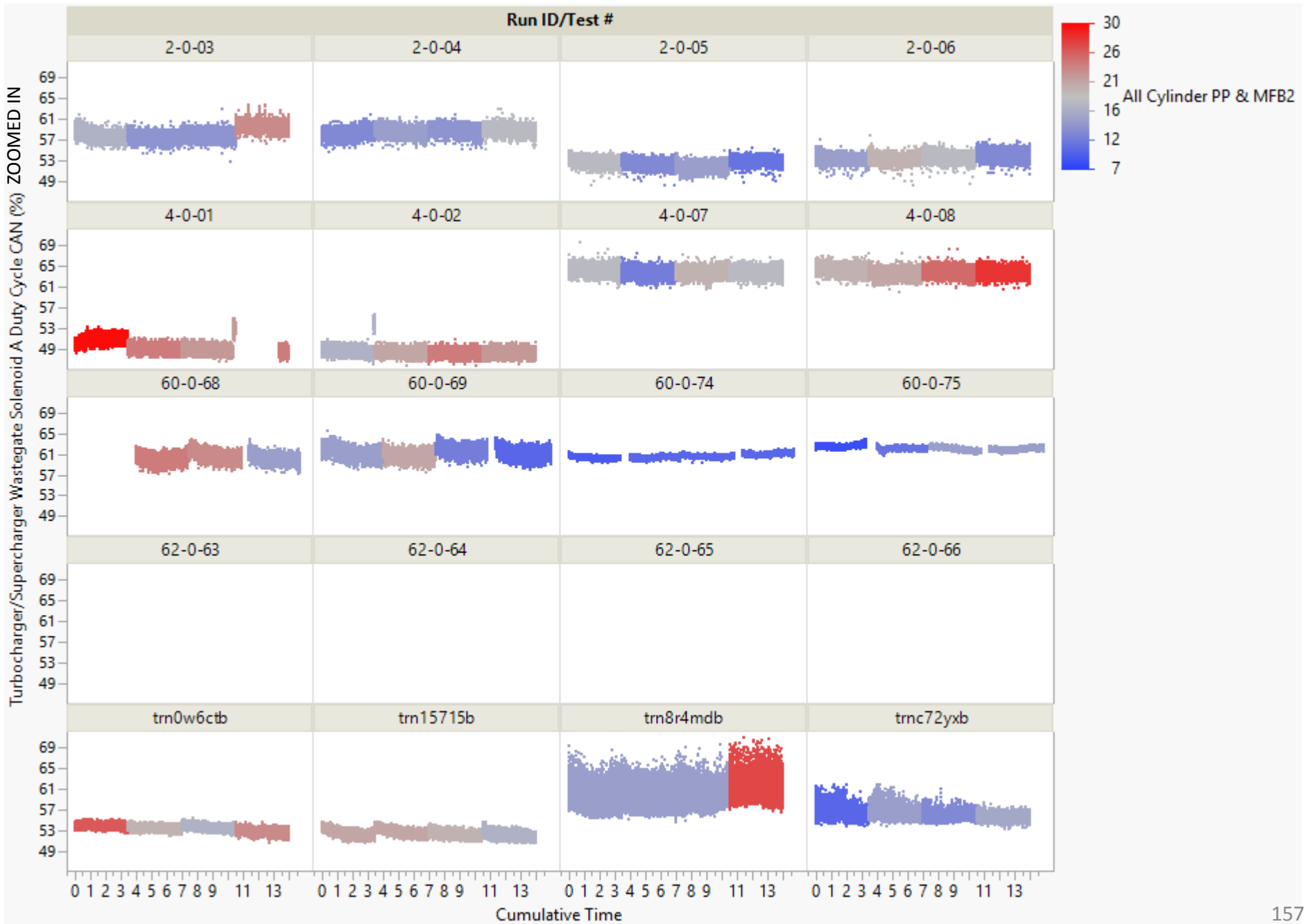




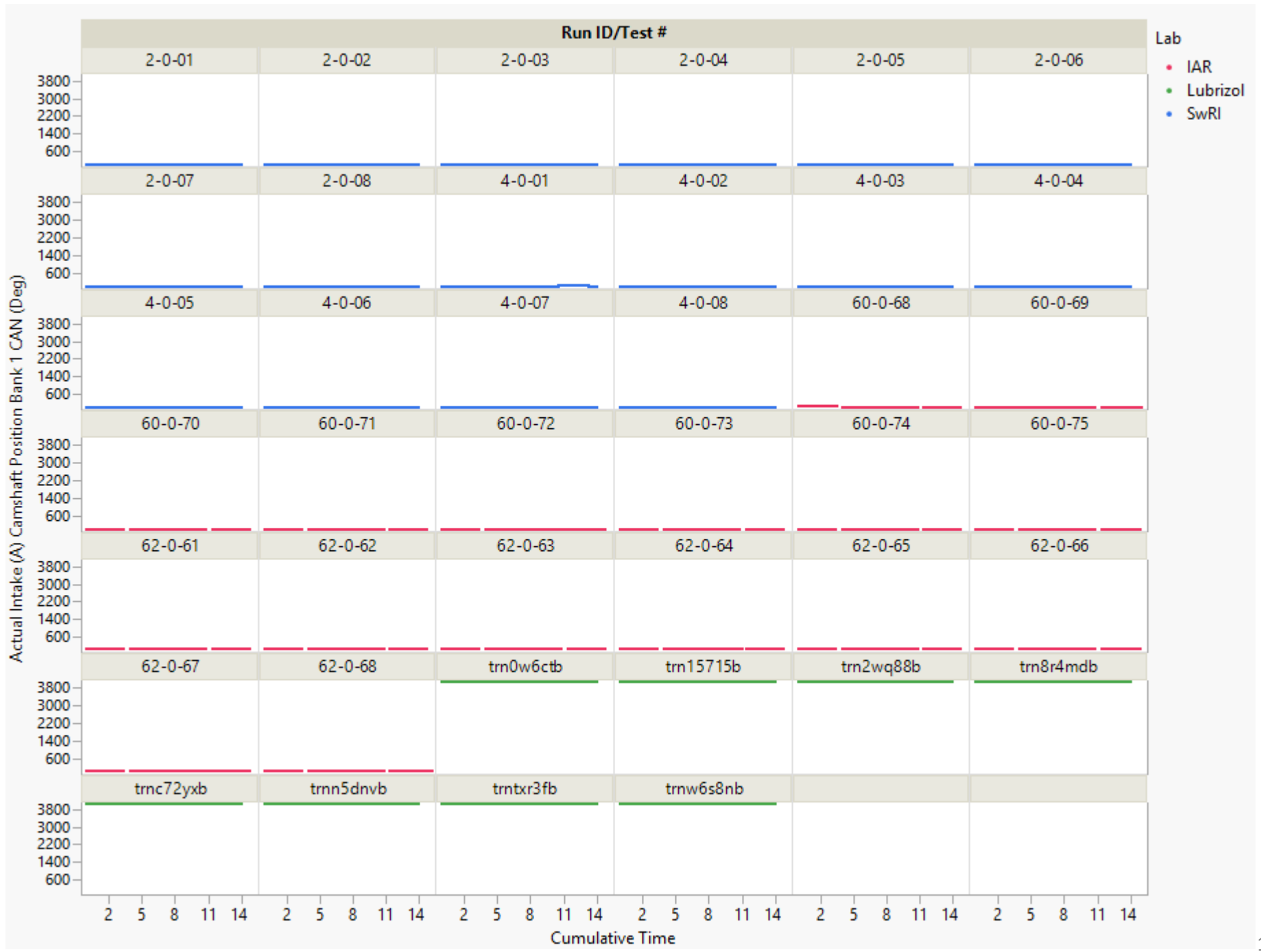
Low Event Oil

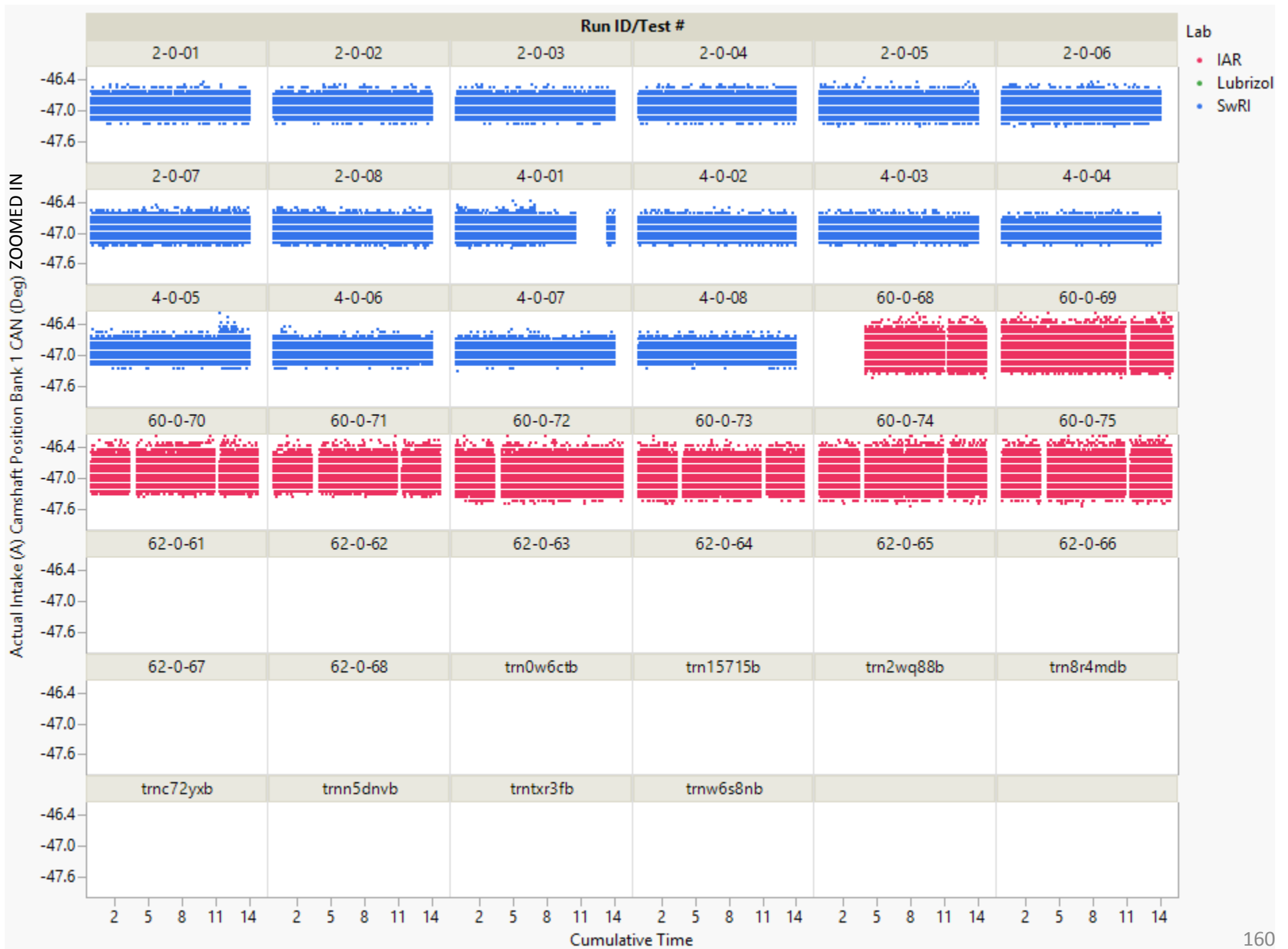


High Event Oil



Actual Intake (A)
Camshaft Position
Bank 1 CAN



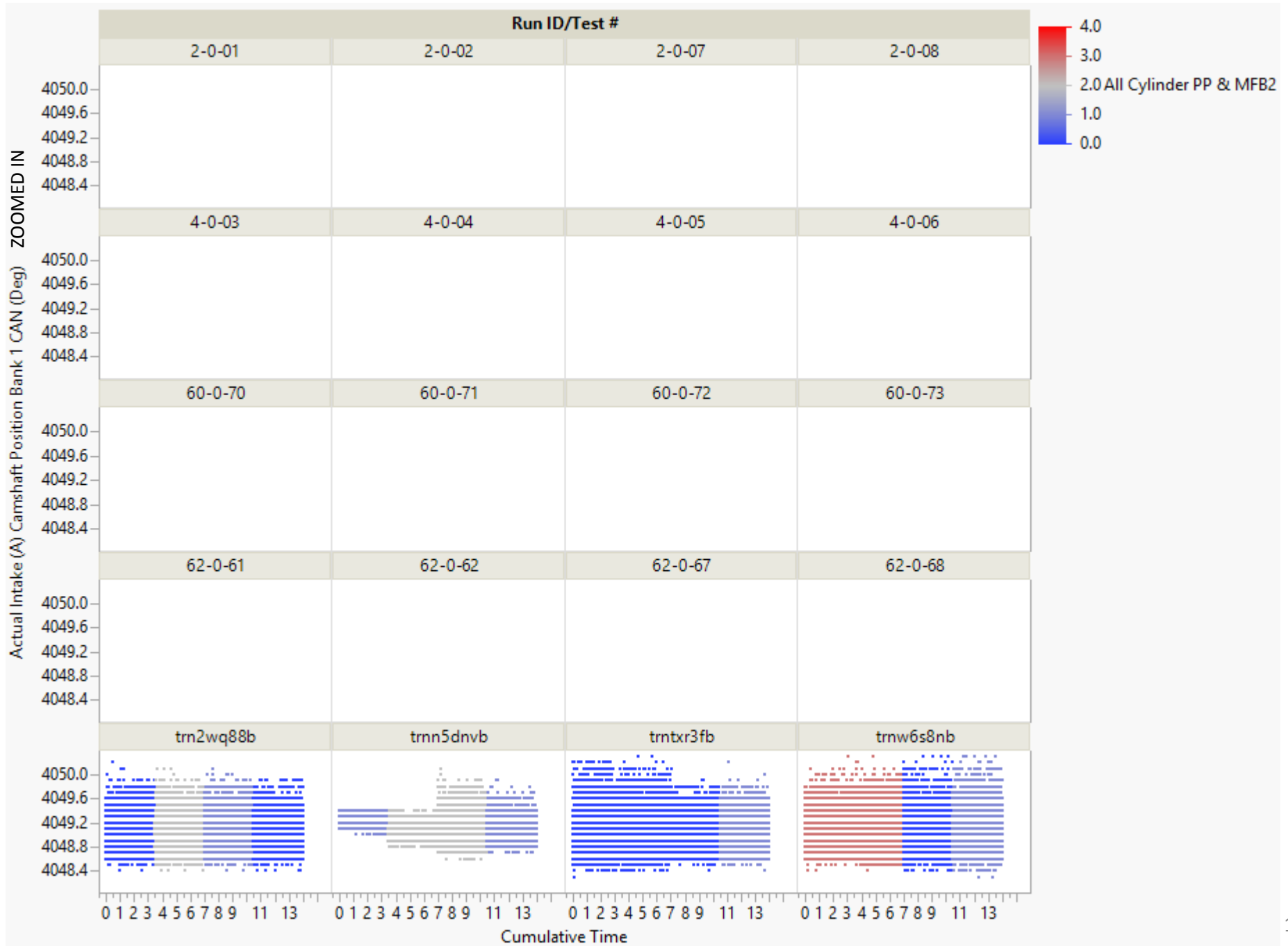




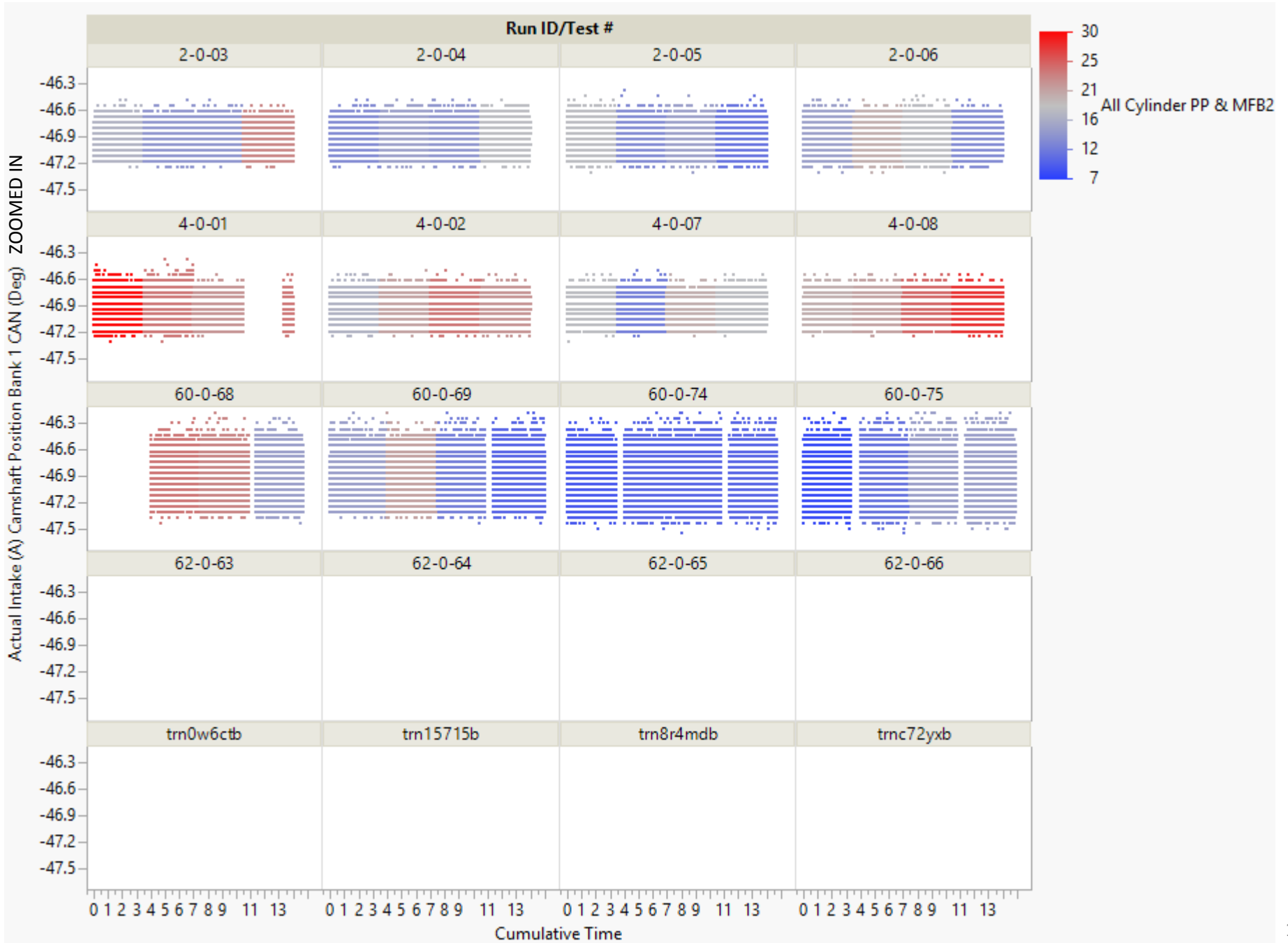
Low Event Oil



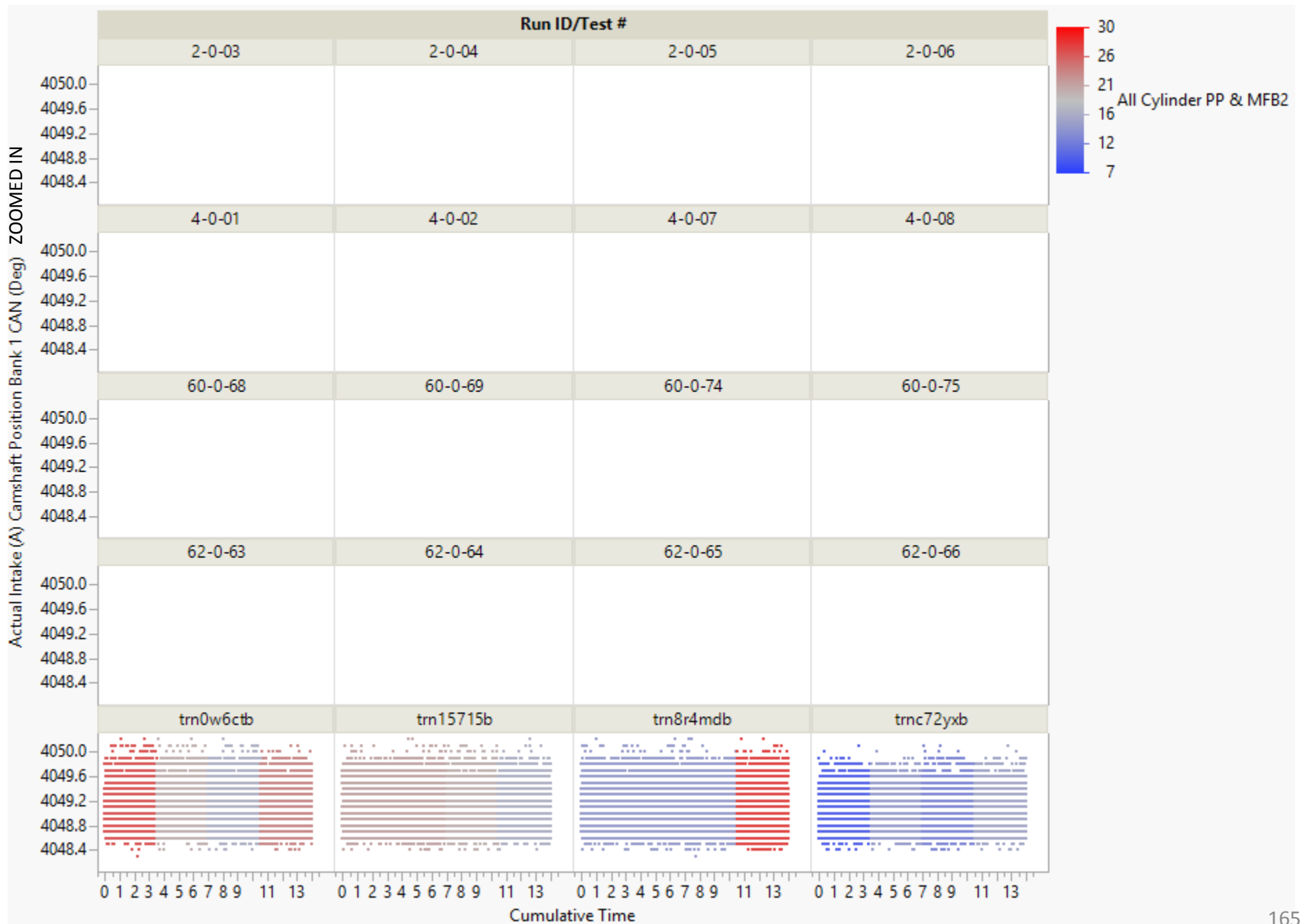
Low Event Oil



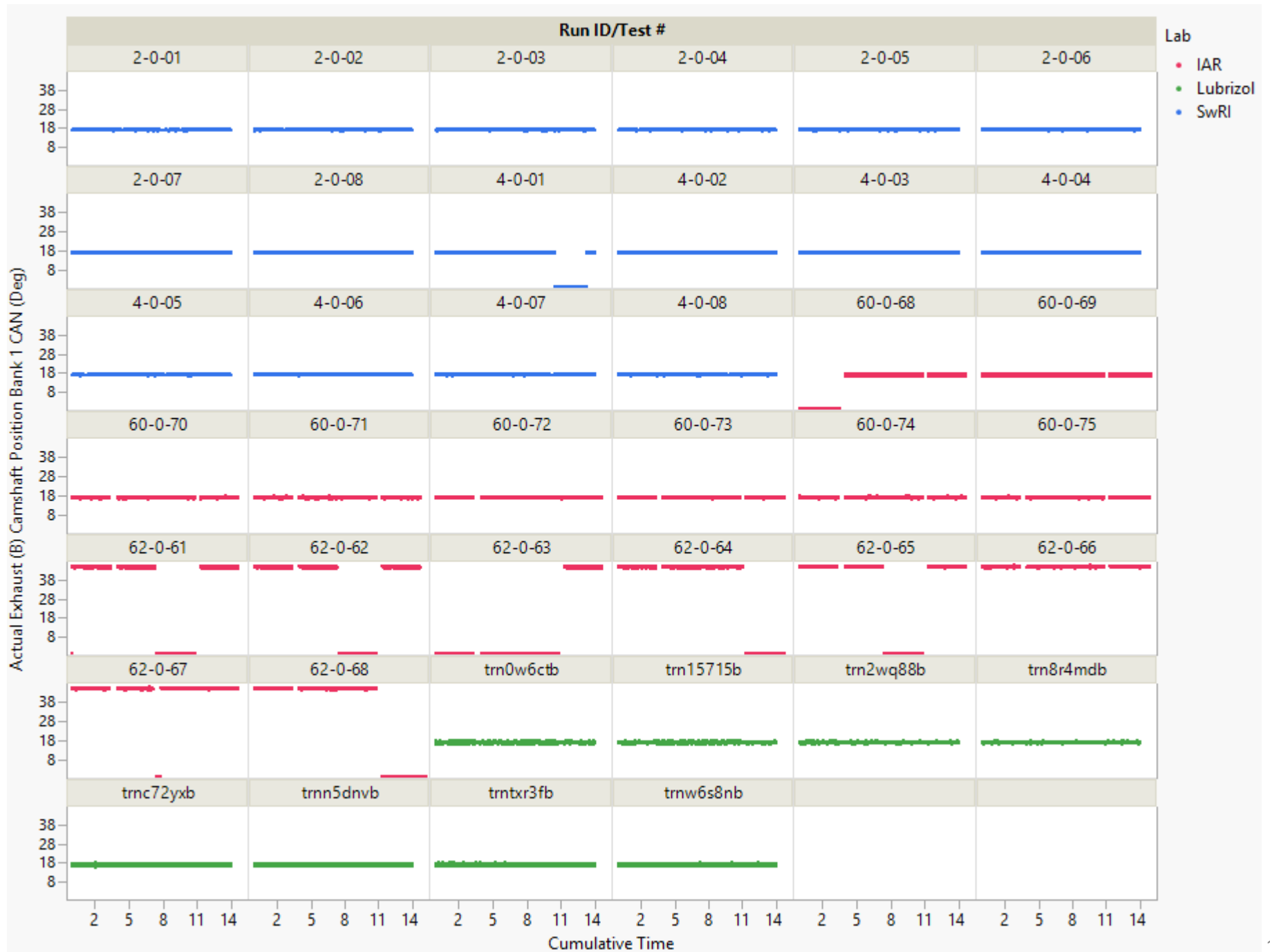
High Event Oil

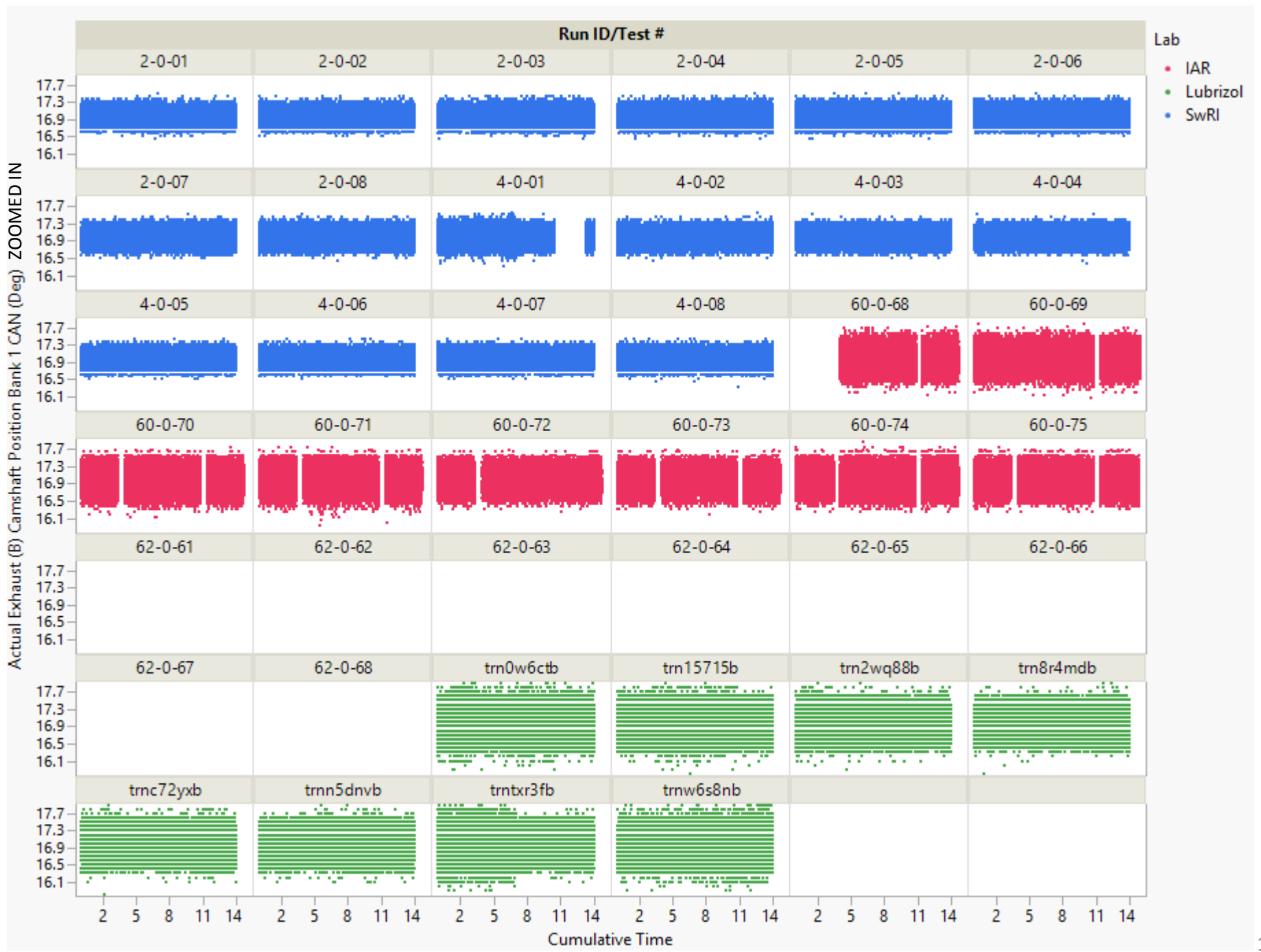


High Event Oil

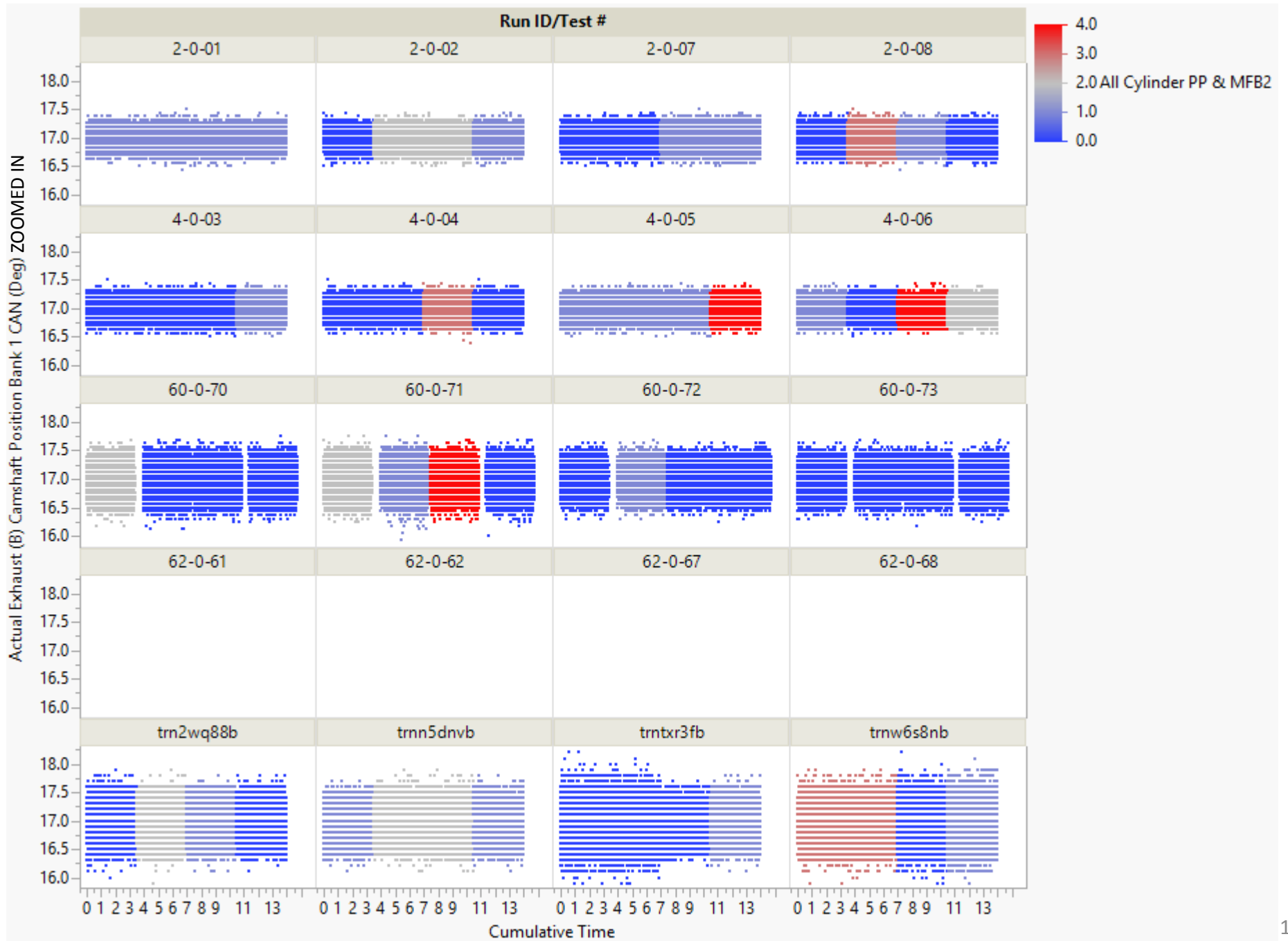


Actual Exhaust
(B) Camshaft
Position Bank 1
CAN

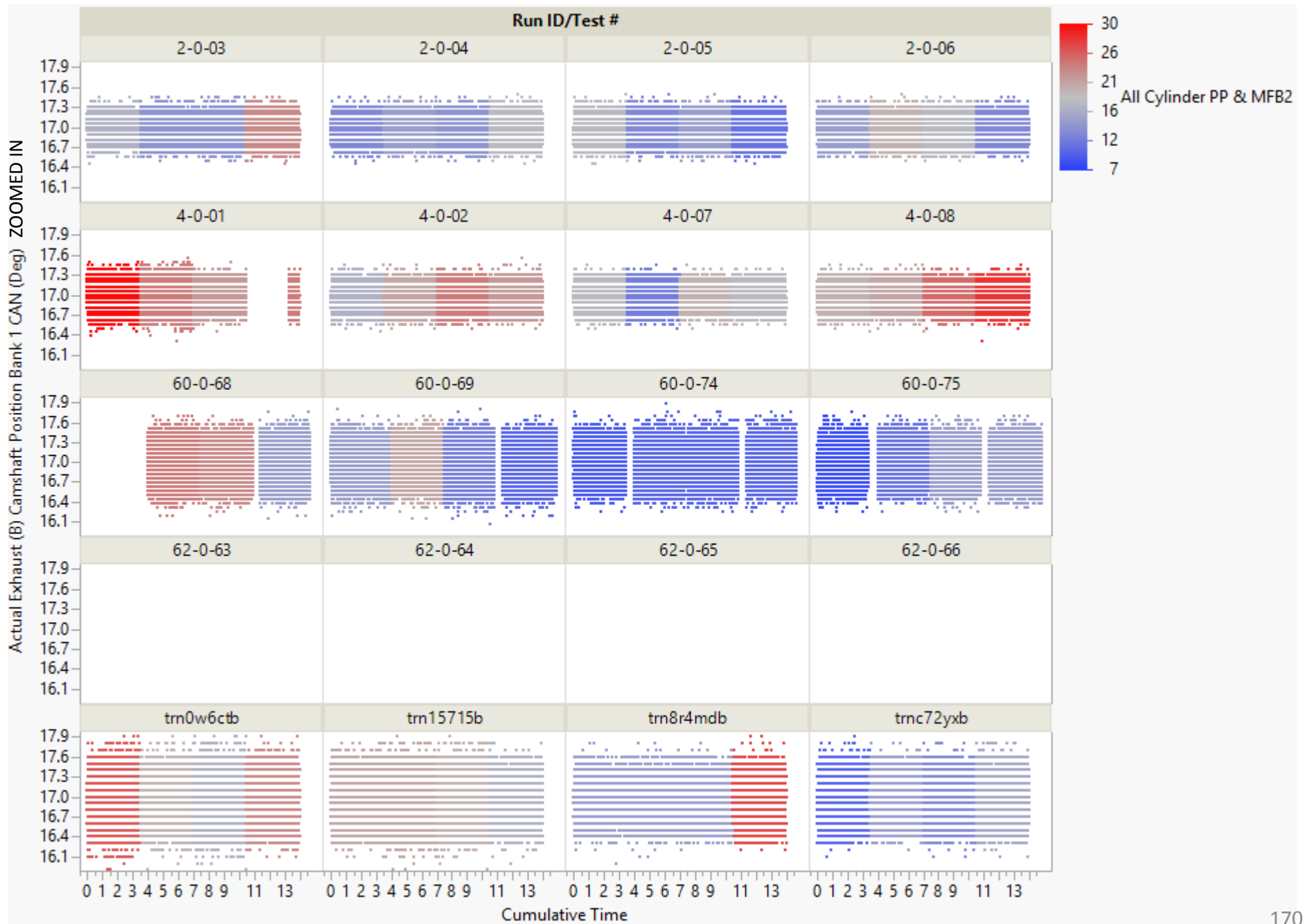




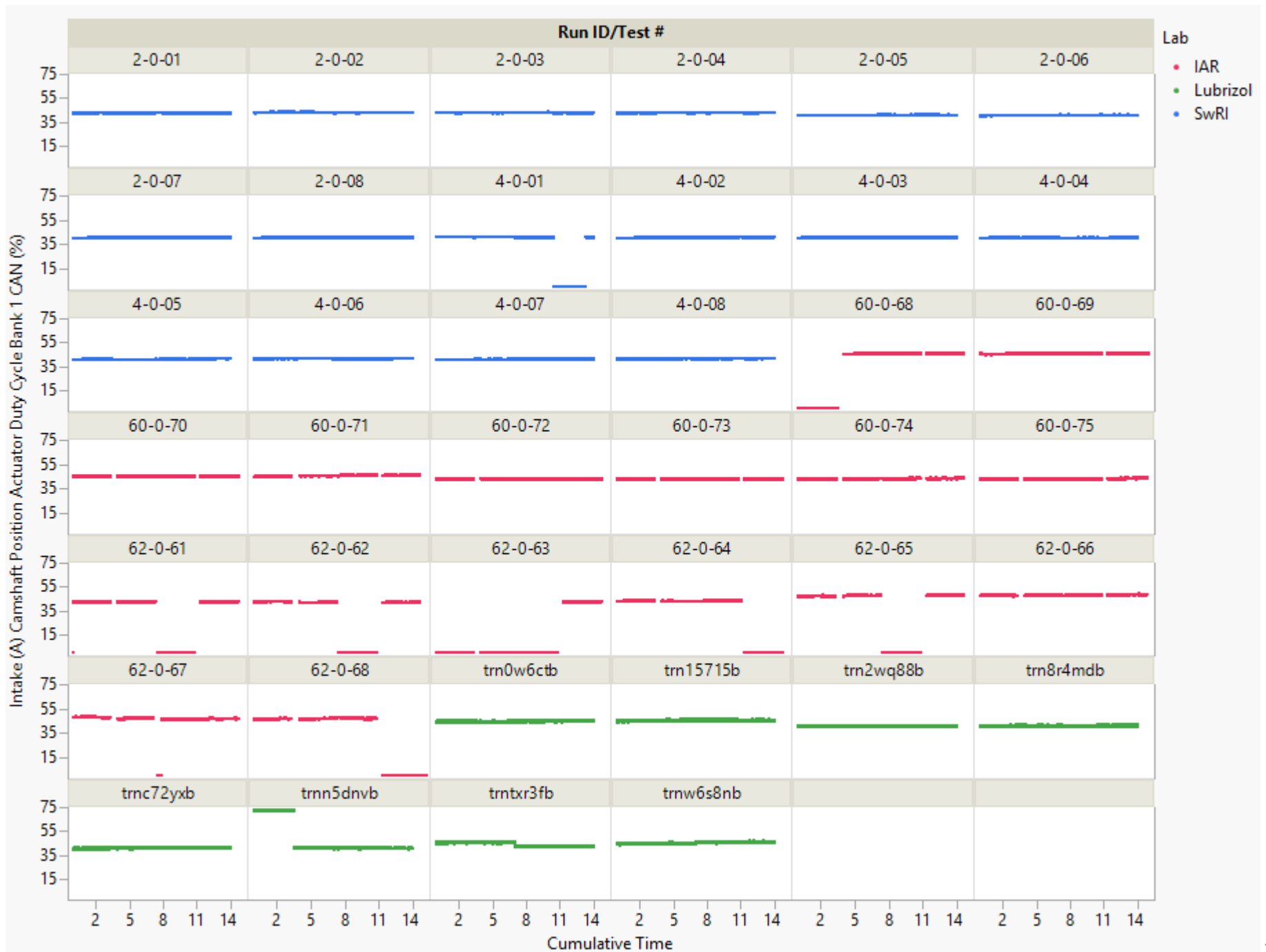
Low Event Oil

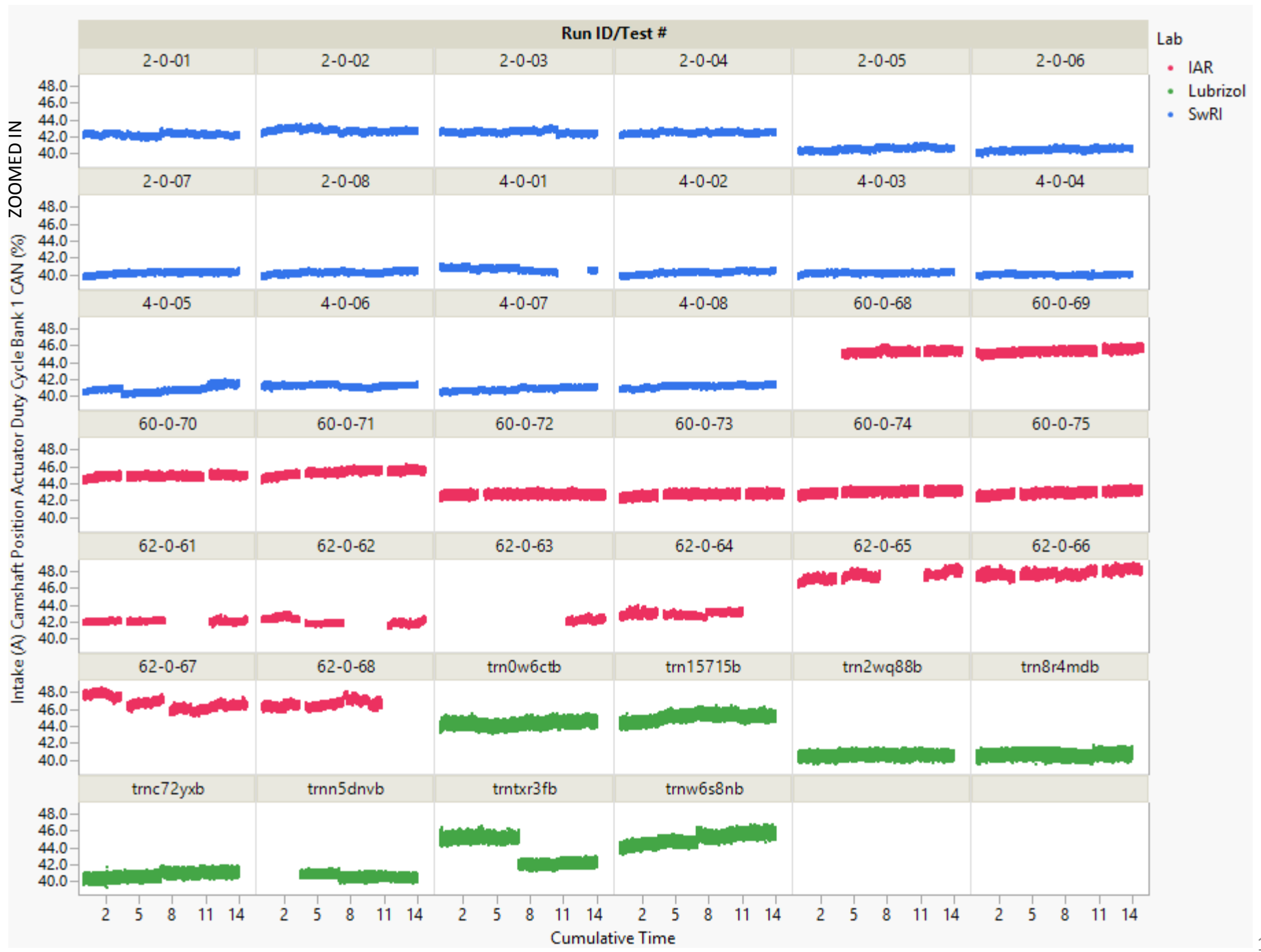


High Event Oil

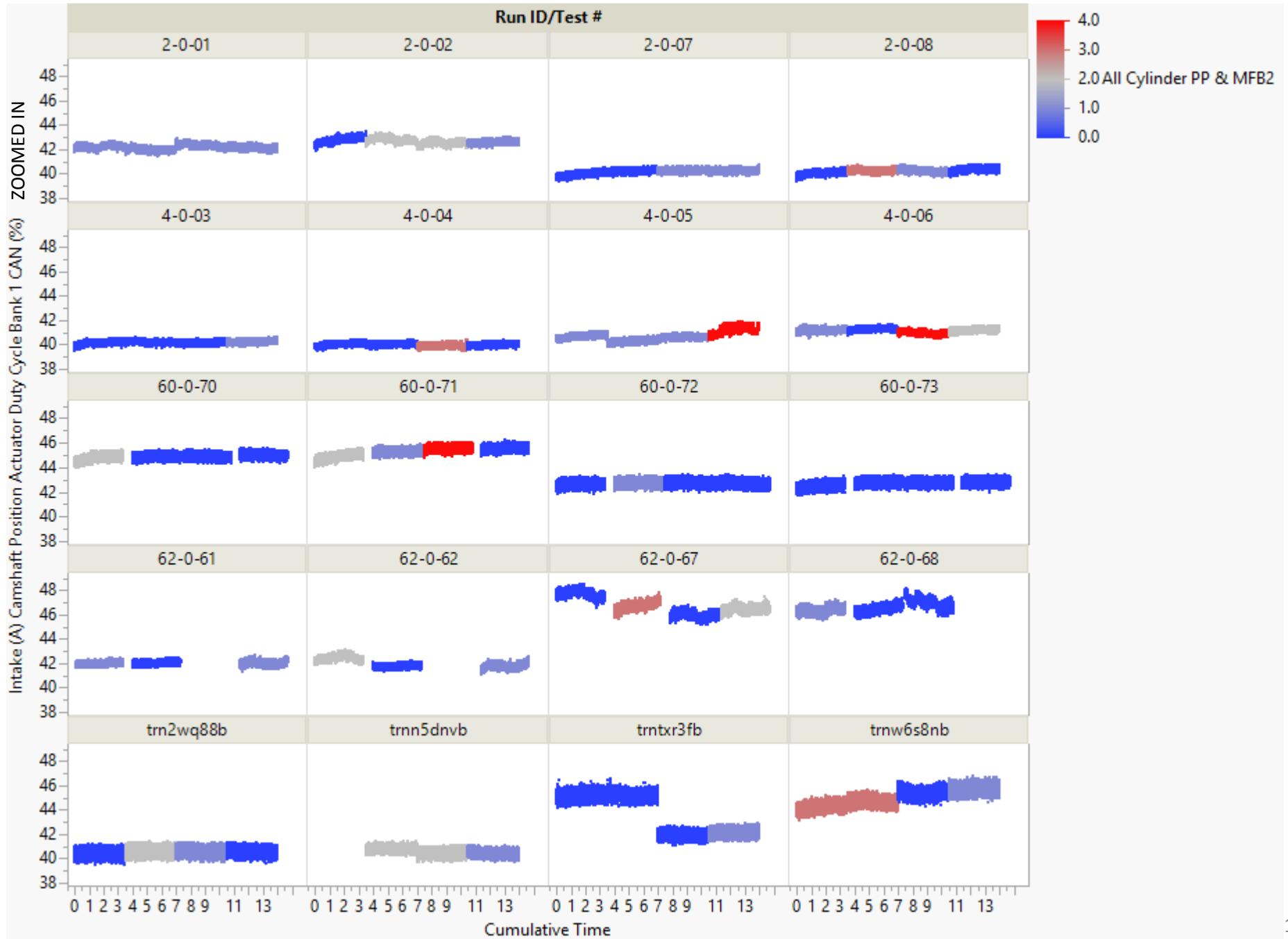


Intake (A) Camshaft
Position Actuator
Duty Cycle Bank 1
CAN

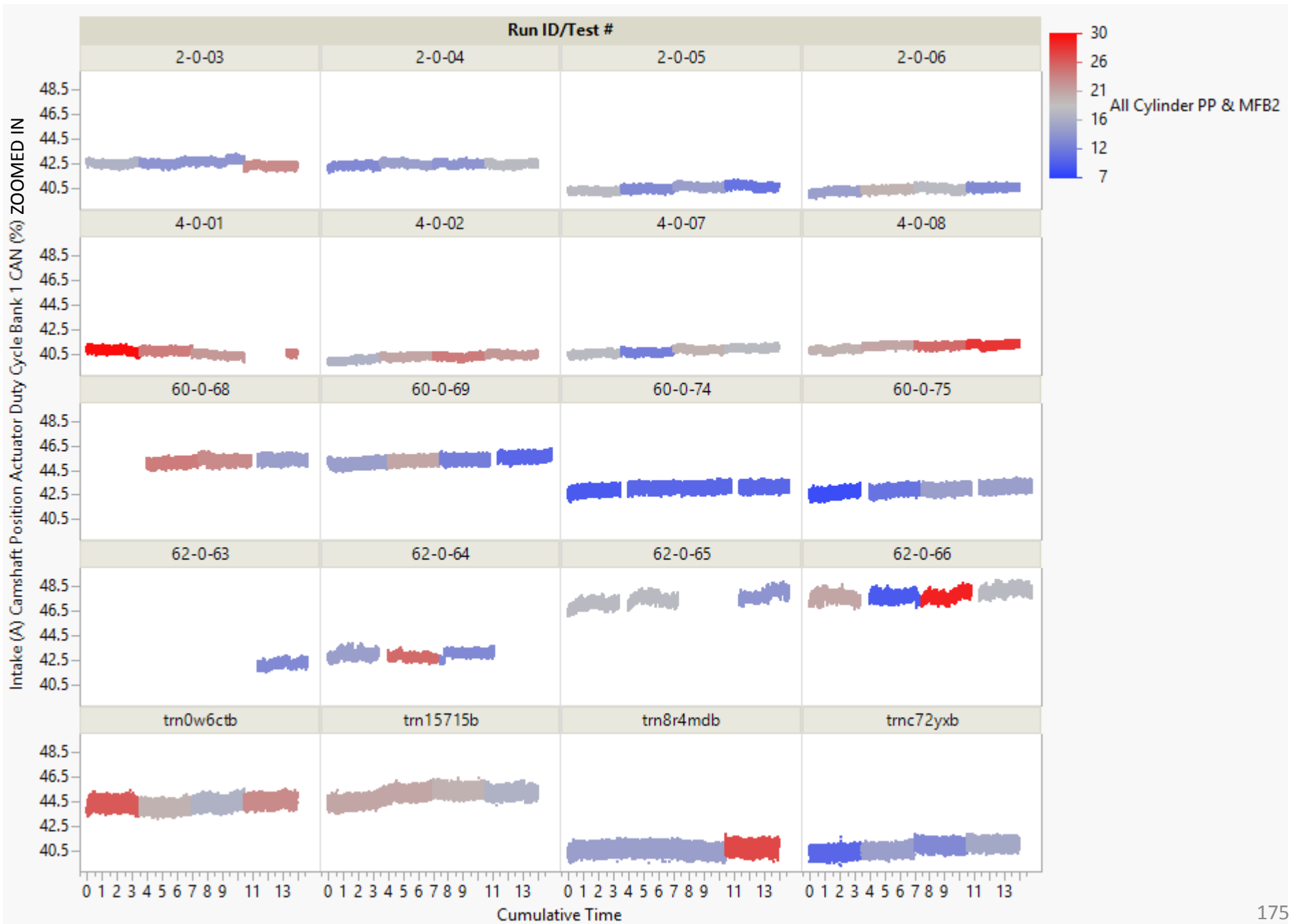




Low Event Oil

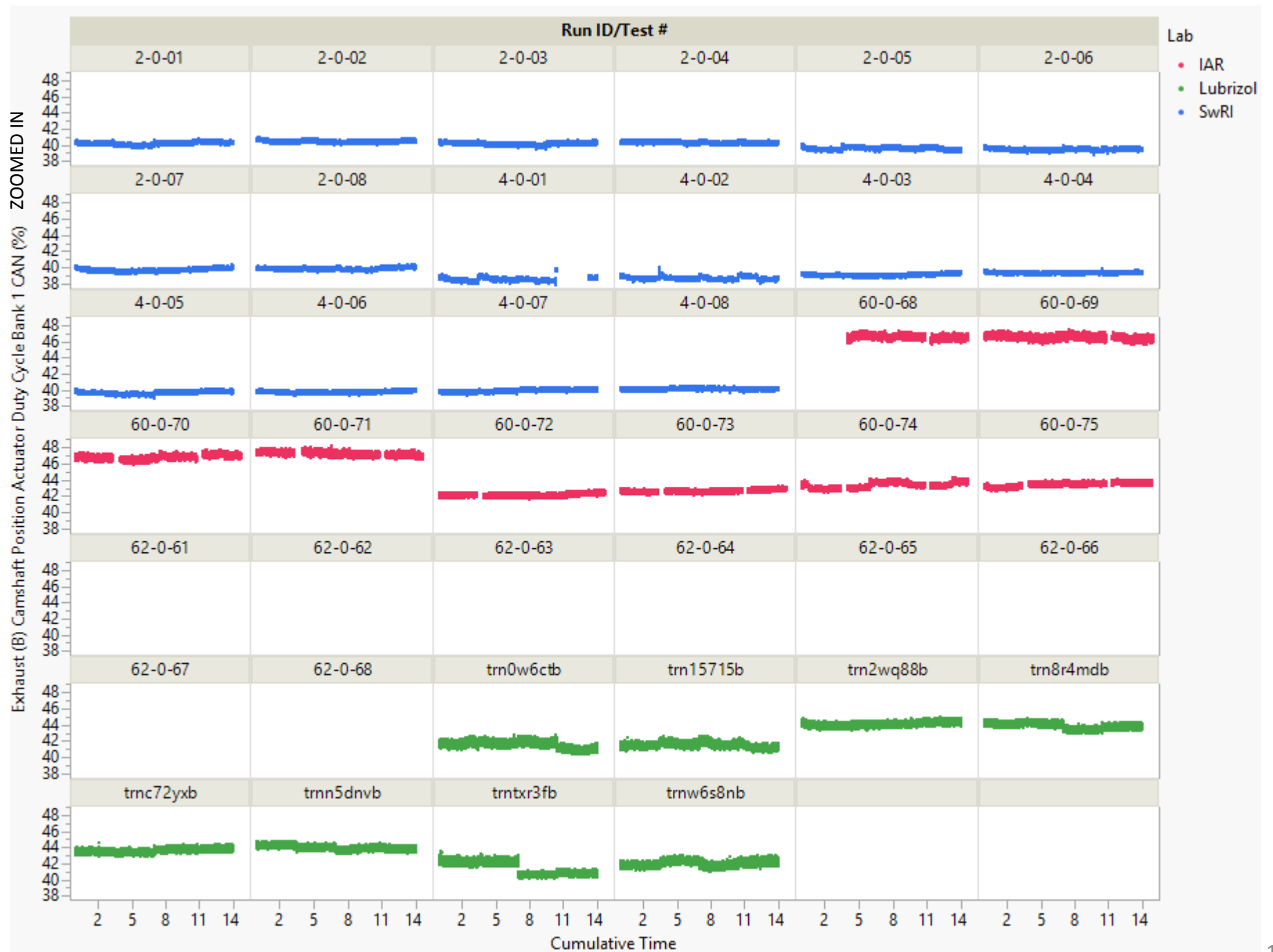


High Event Oil

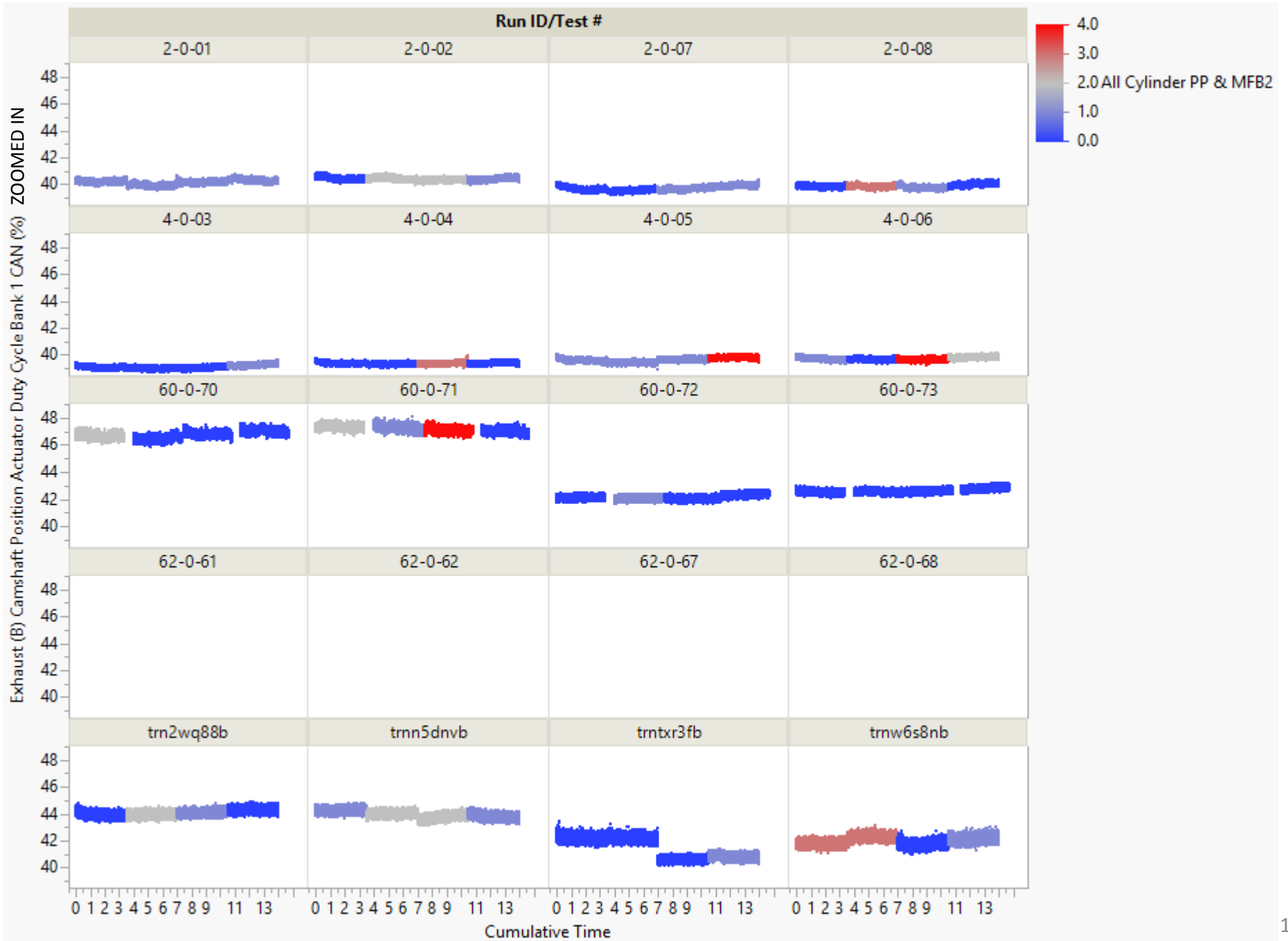


Exhaust (B) Camshaft
Position Actuator
Duty Cycle Bank 1
CAN

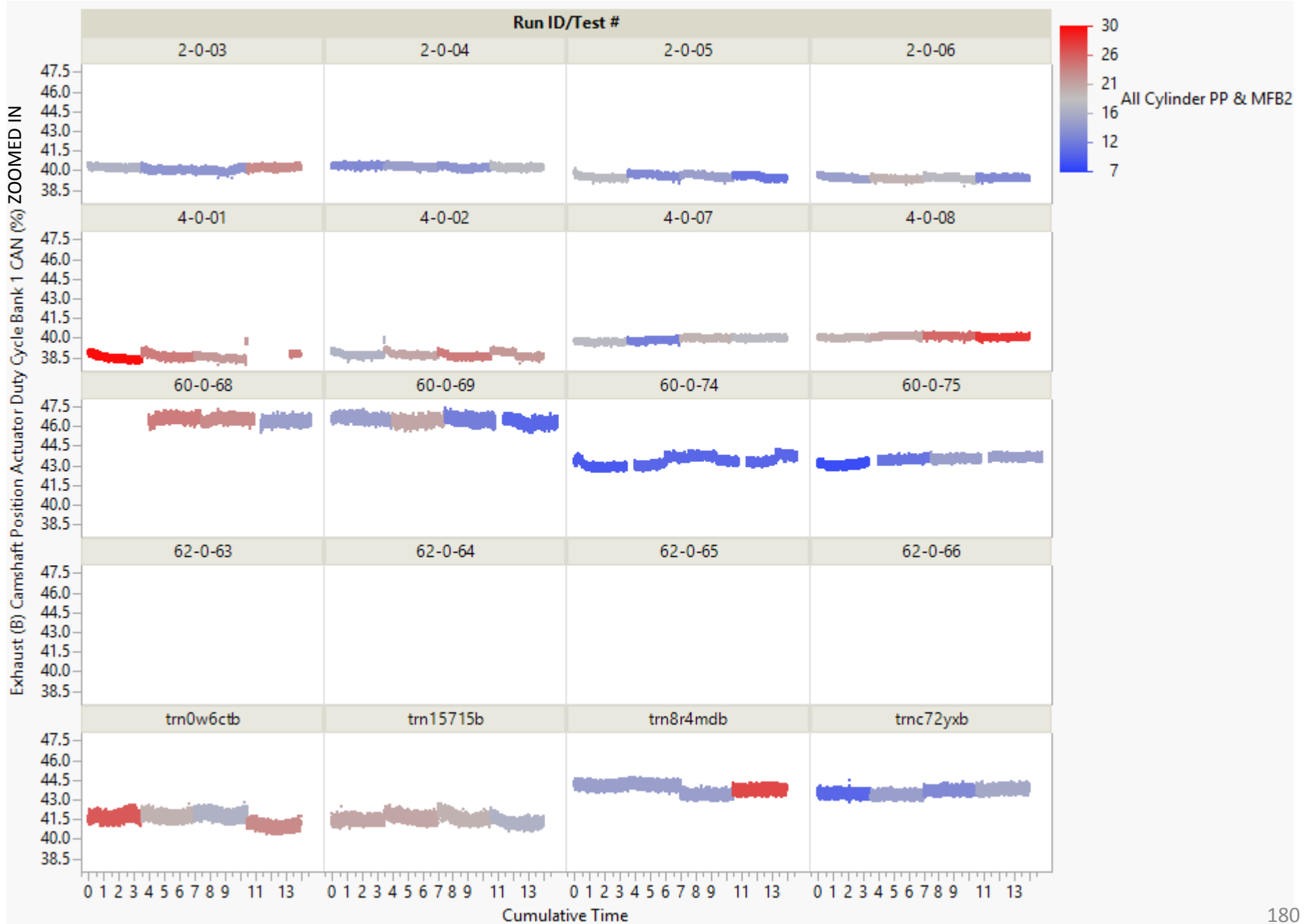




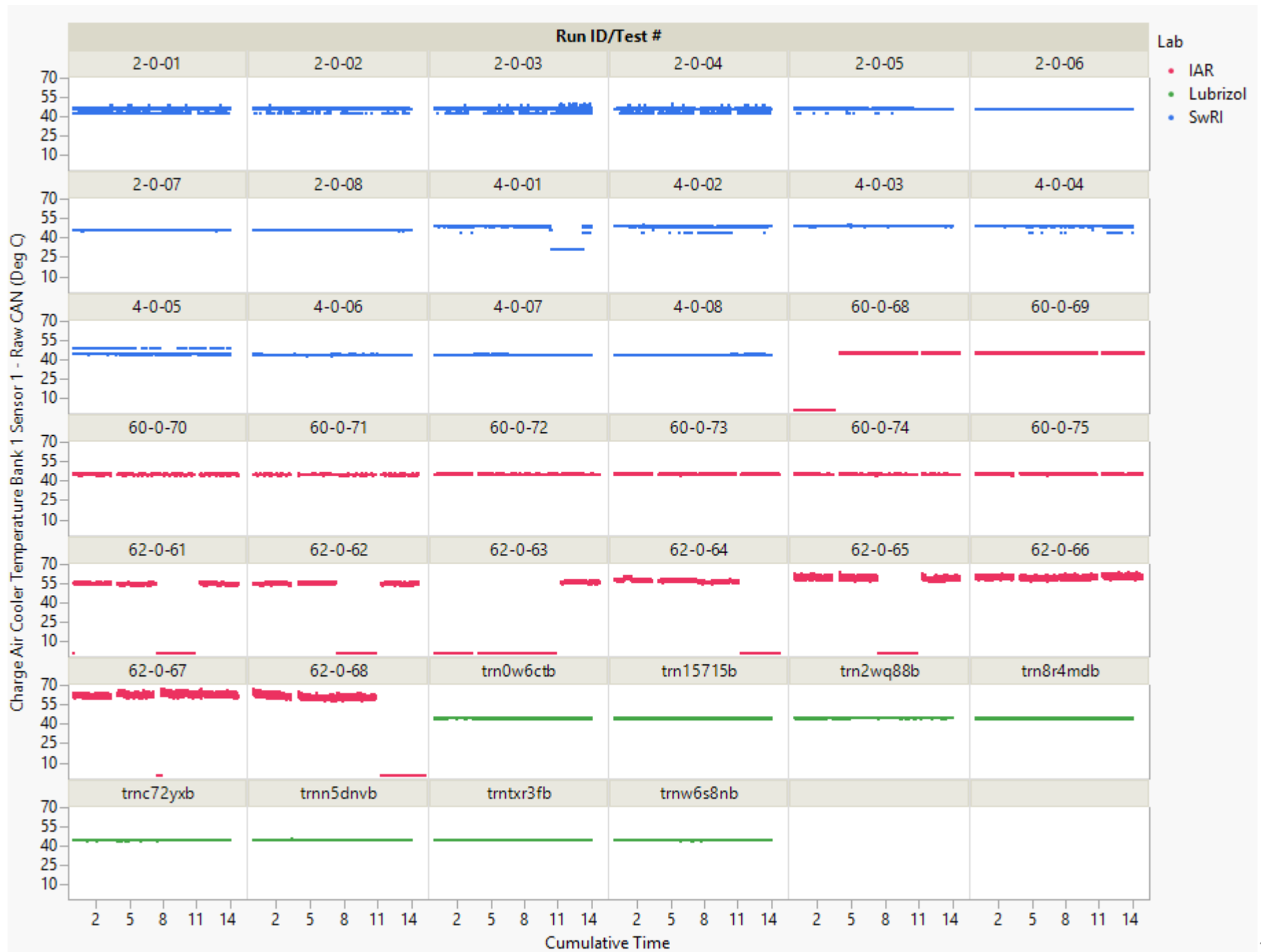
Low Event Oil

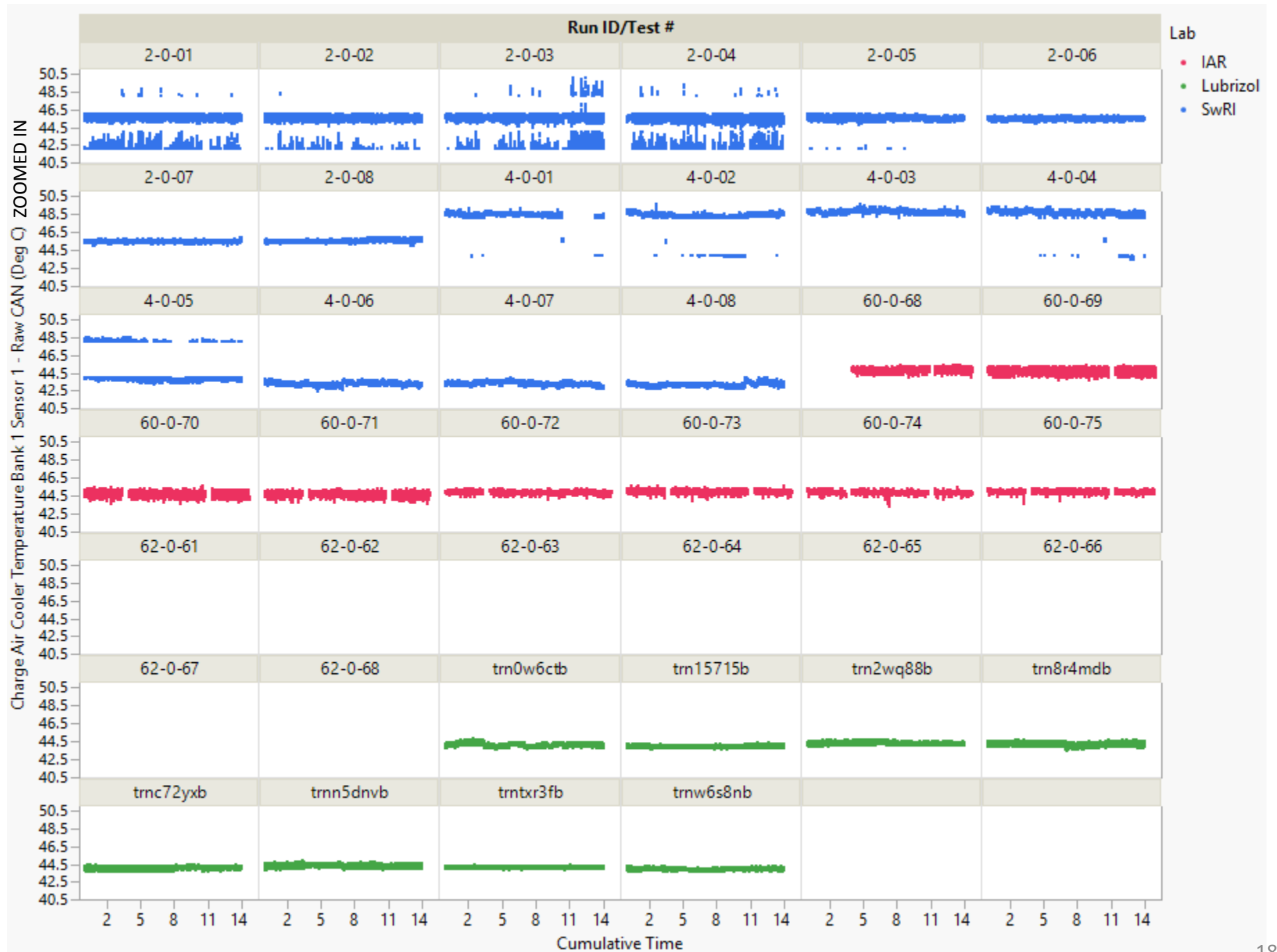


High Event Oil

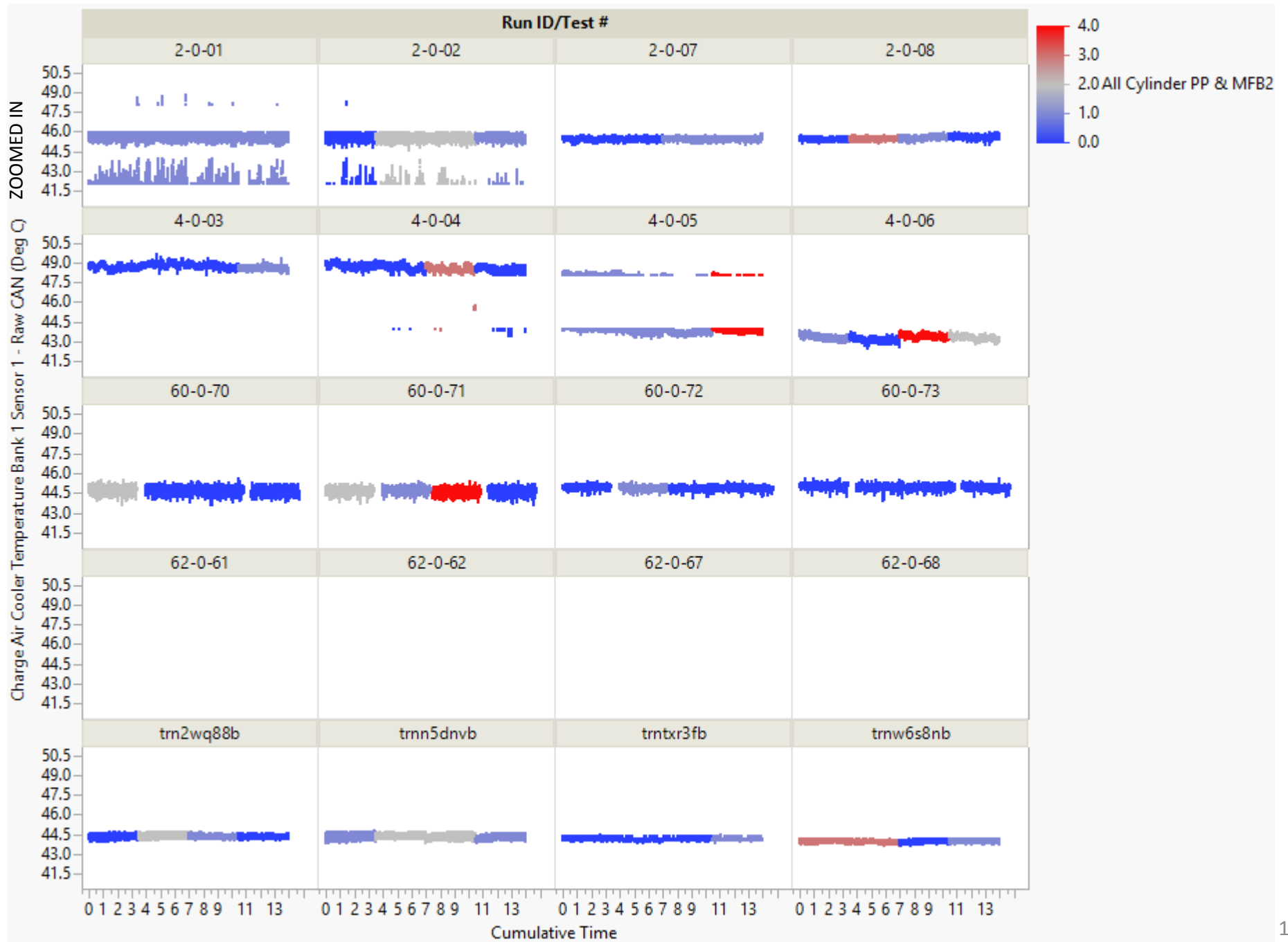


Charge Air Cooler
Temperature Bank
1 Sensor 1 - Raw
CAN

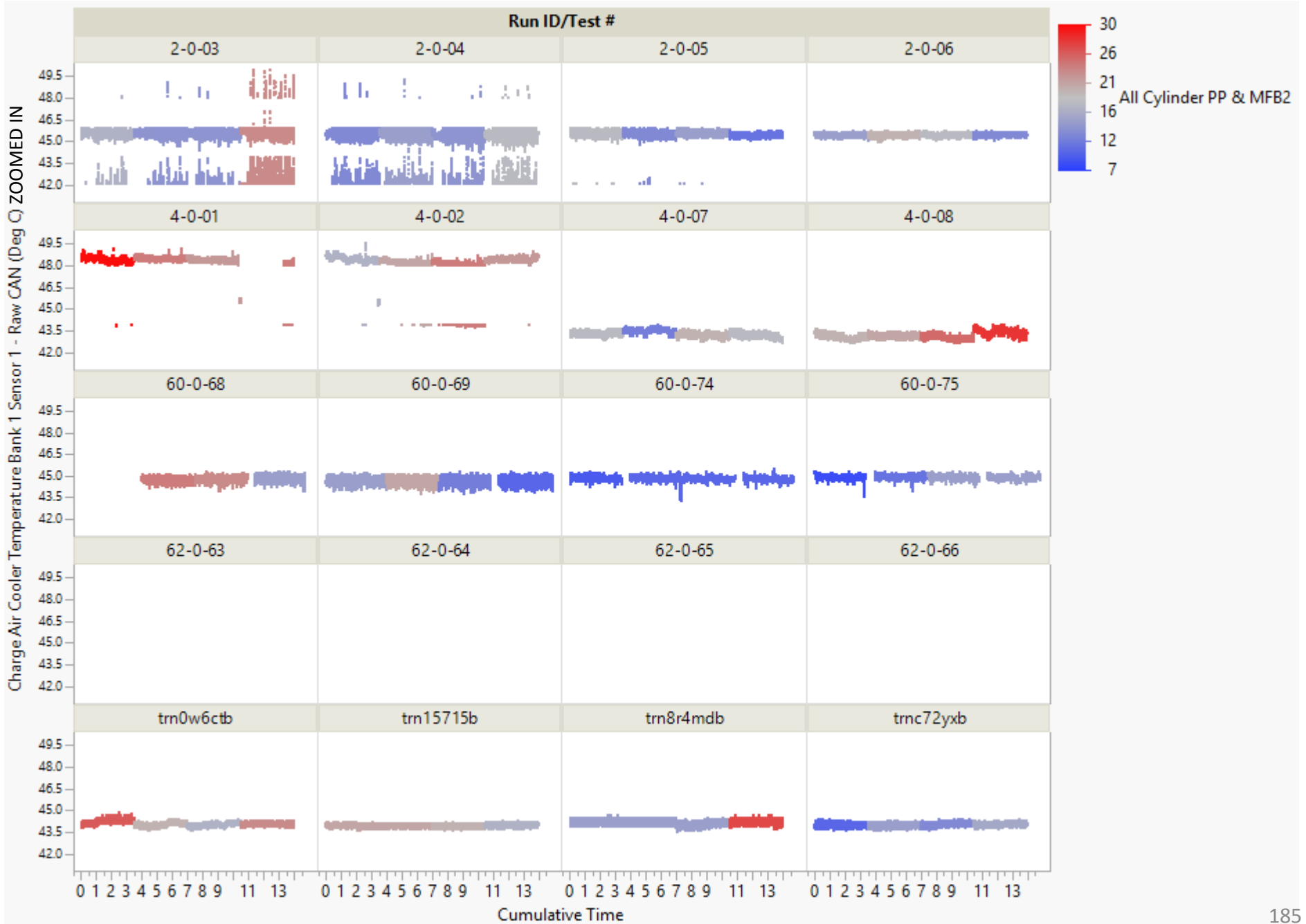




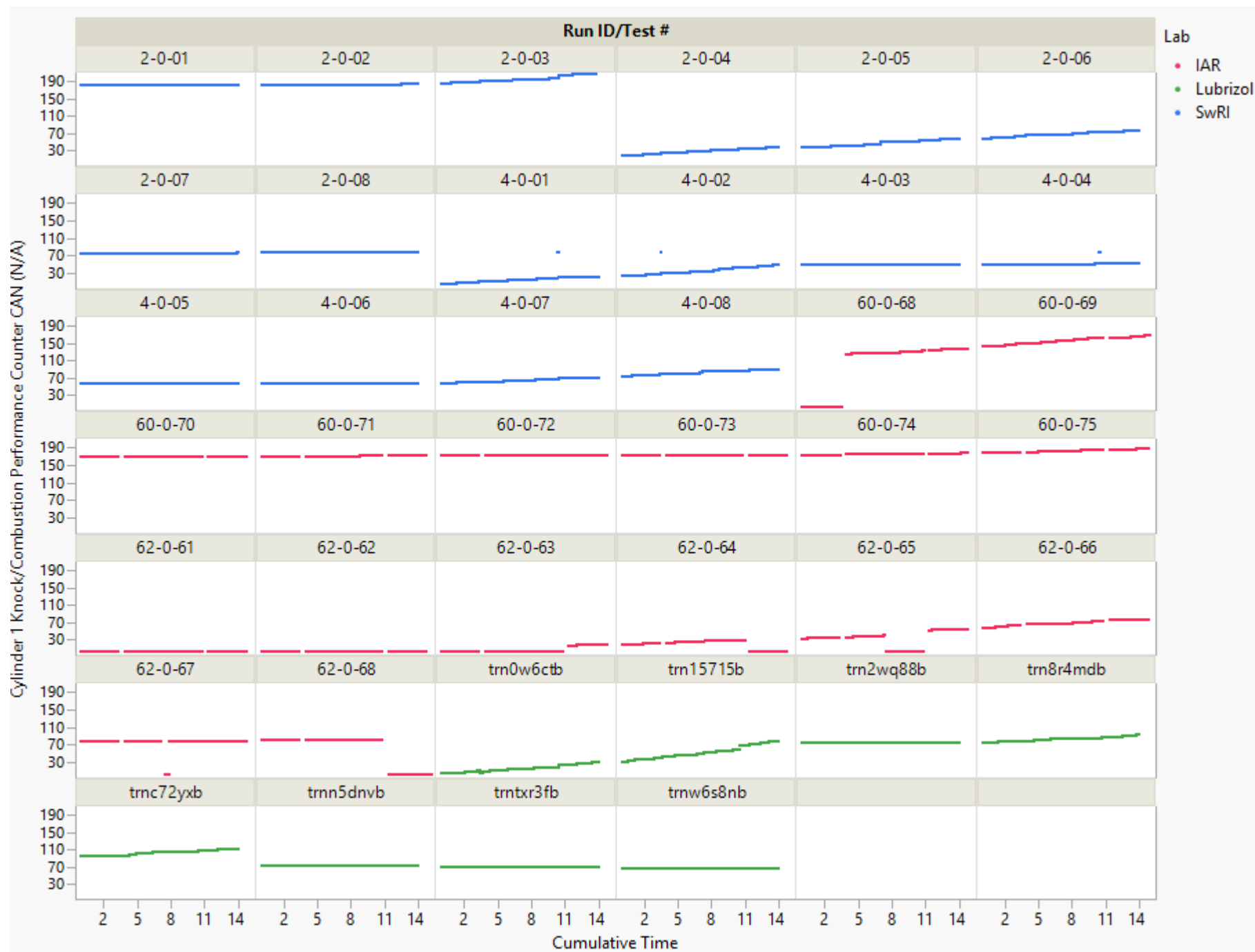
Low Event Oil



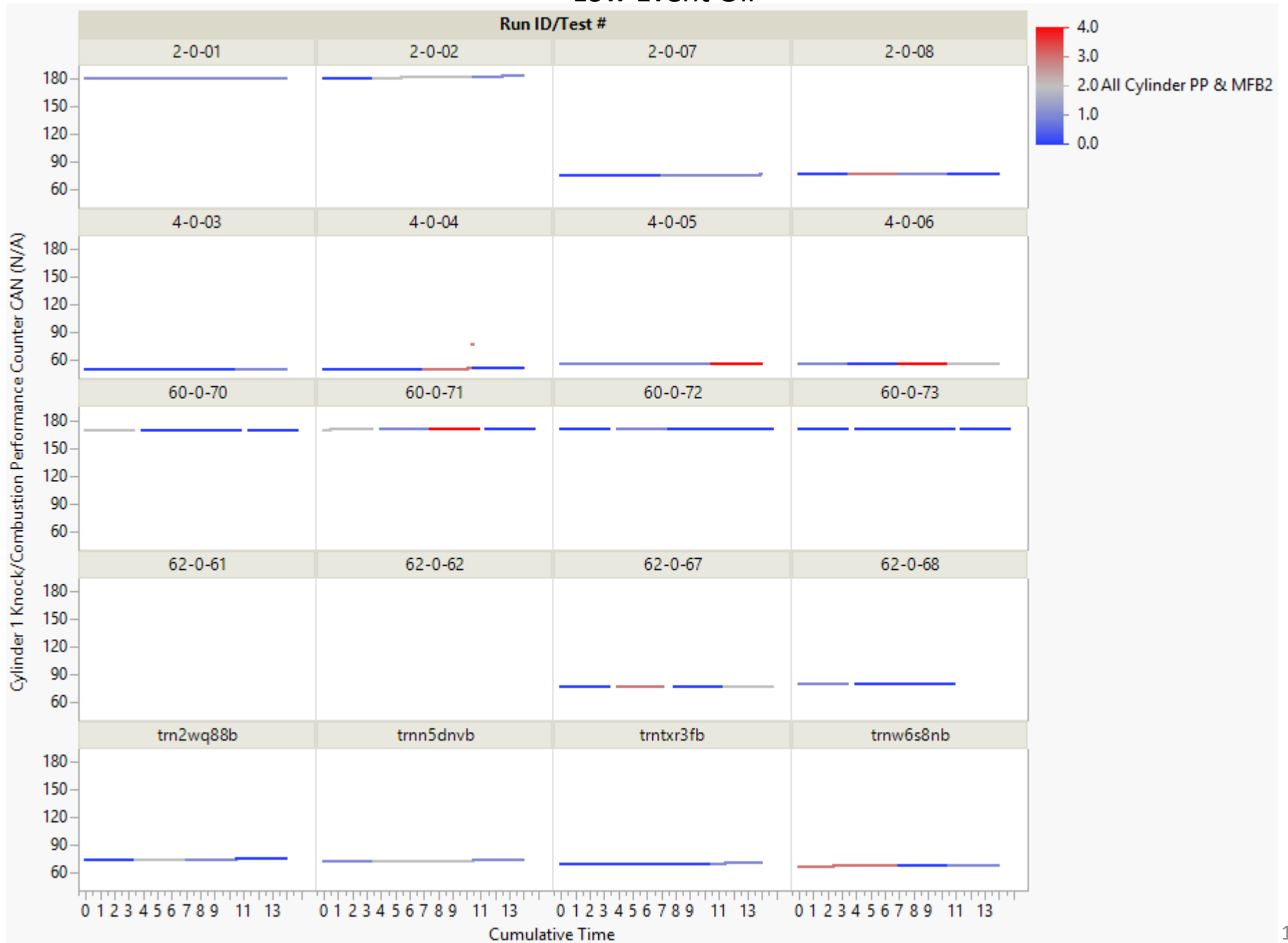
High Event Oil



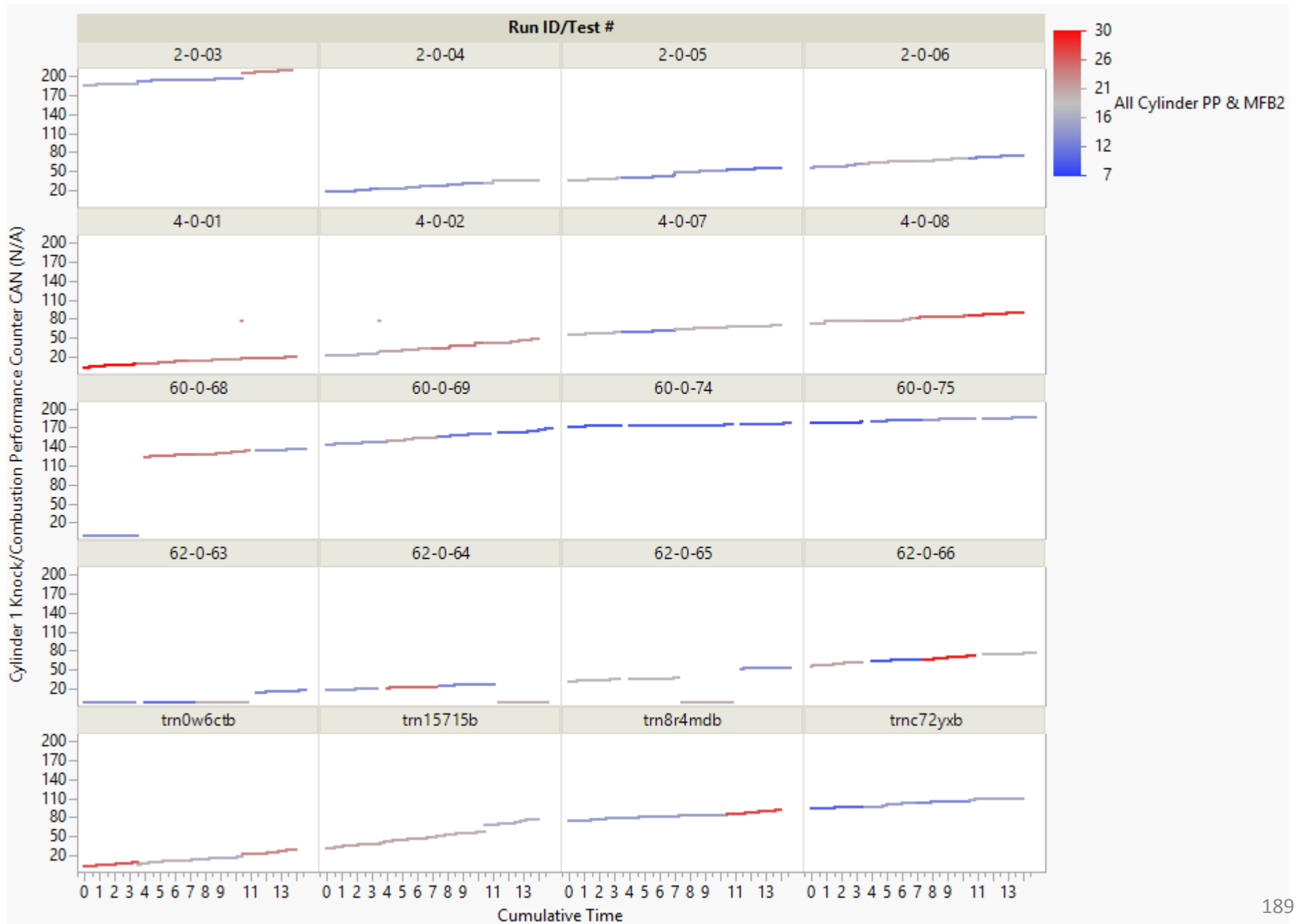
Cylinder 1
Knock/Combustion
Performance
Counter CAN



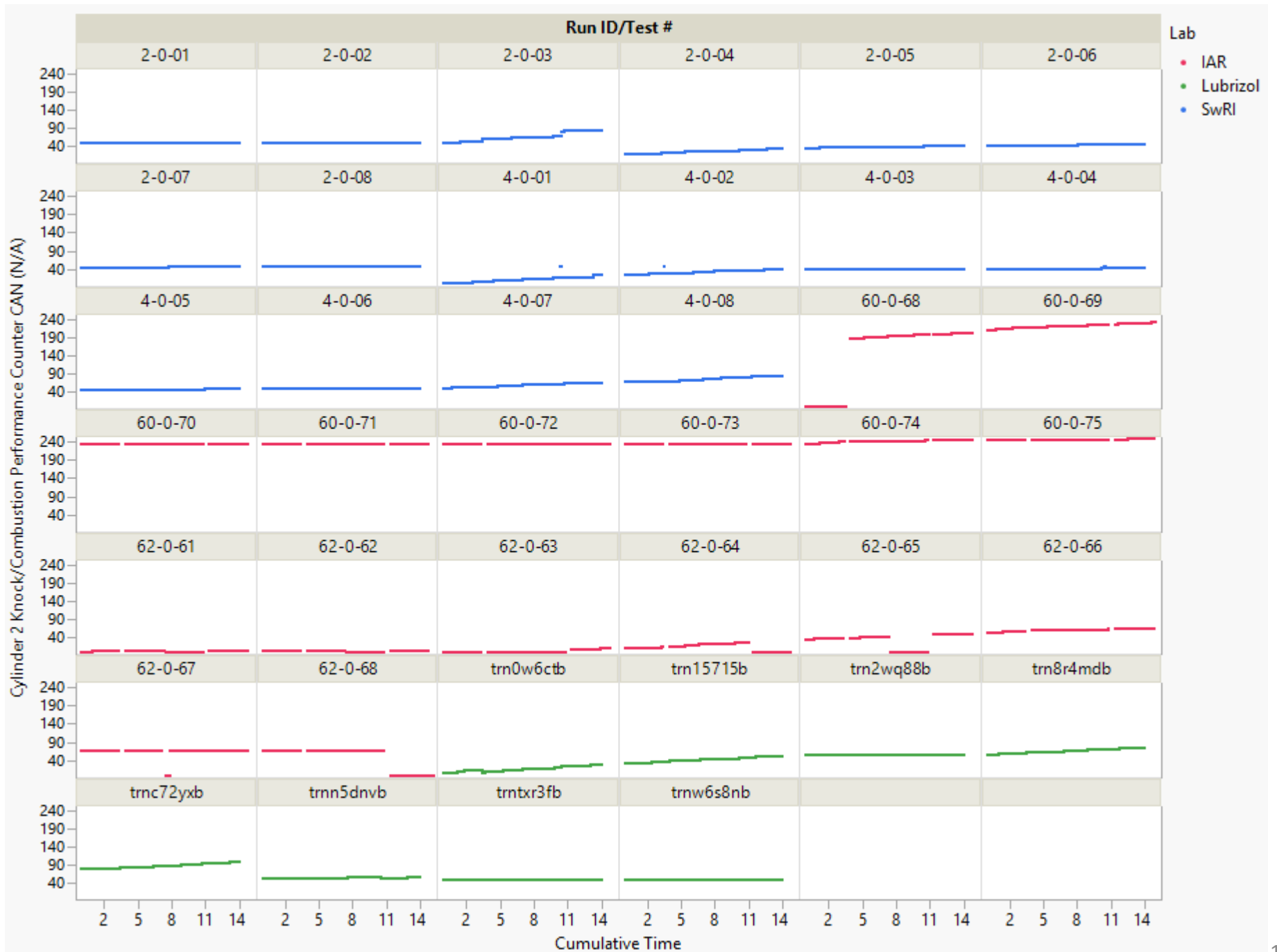
Low Event Oil



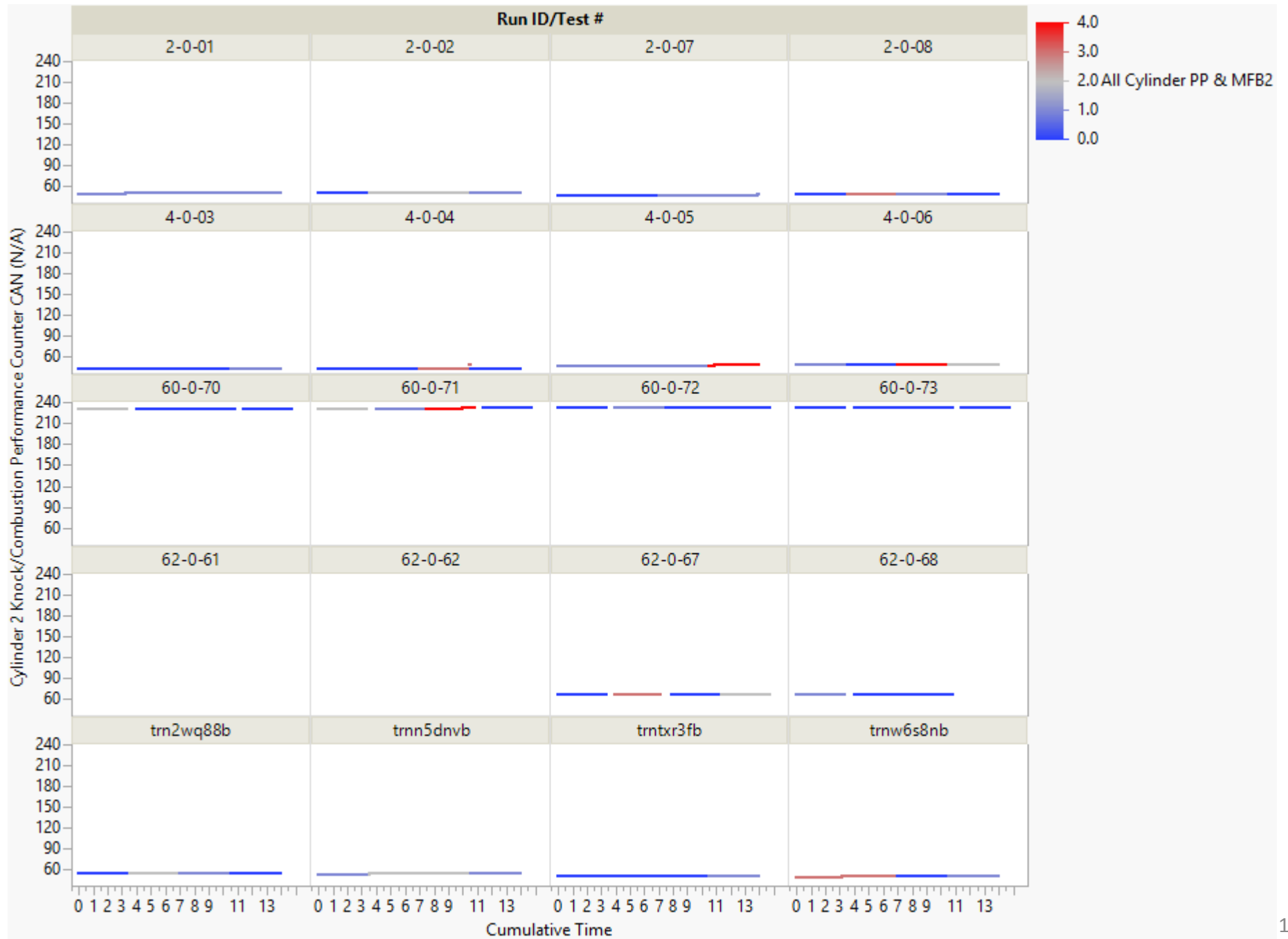
High Event Oil



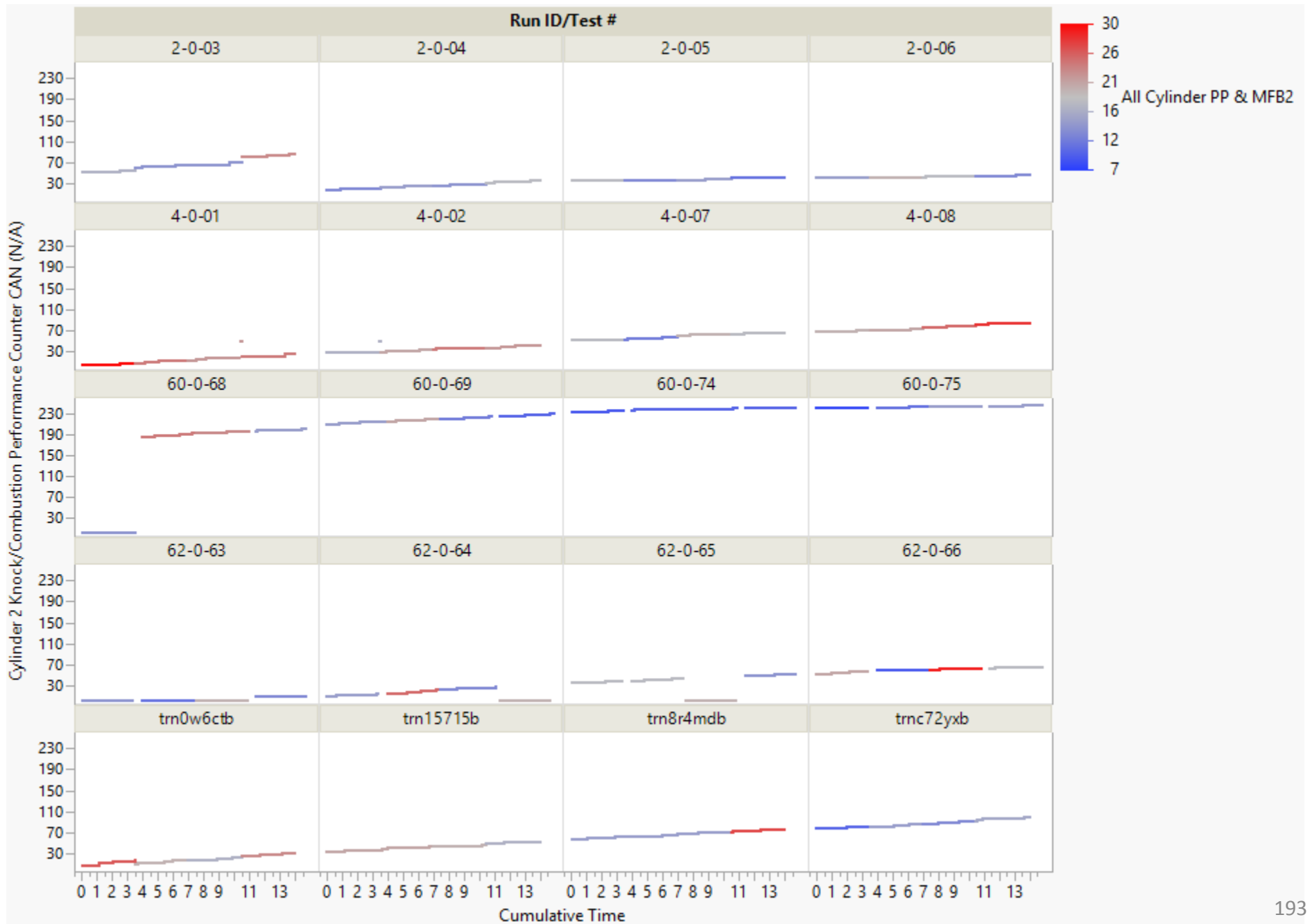
Cylinder 2 Knock/Combustion Performance Counter CAN



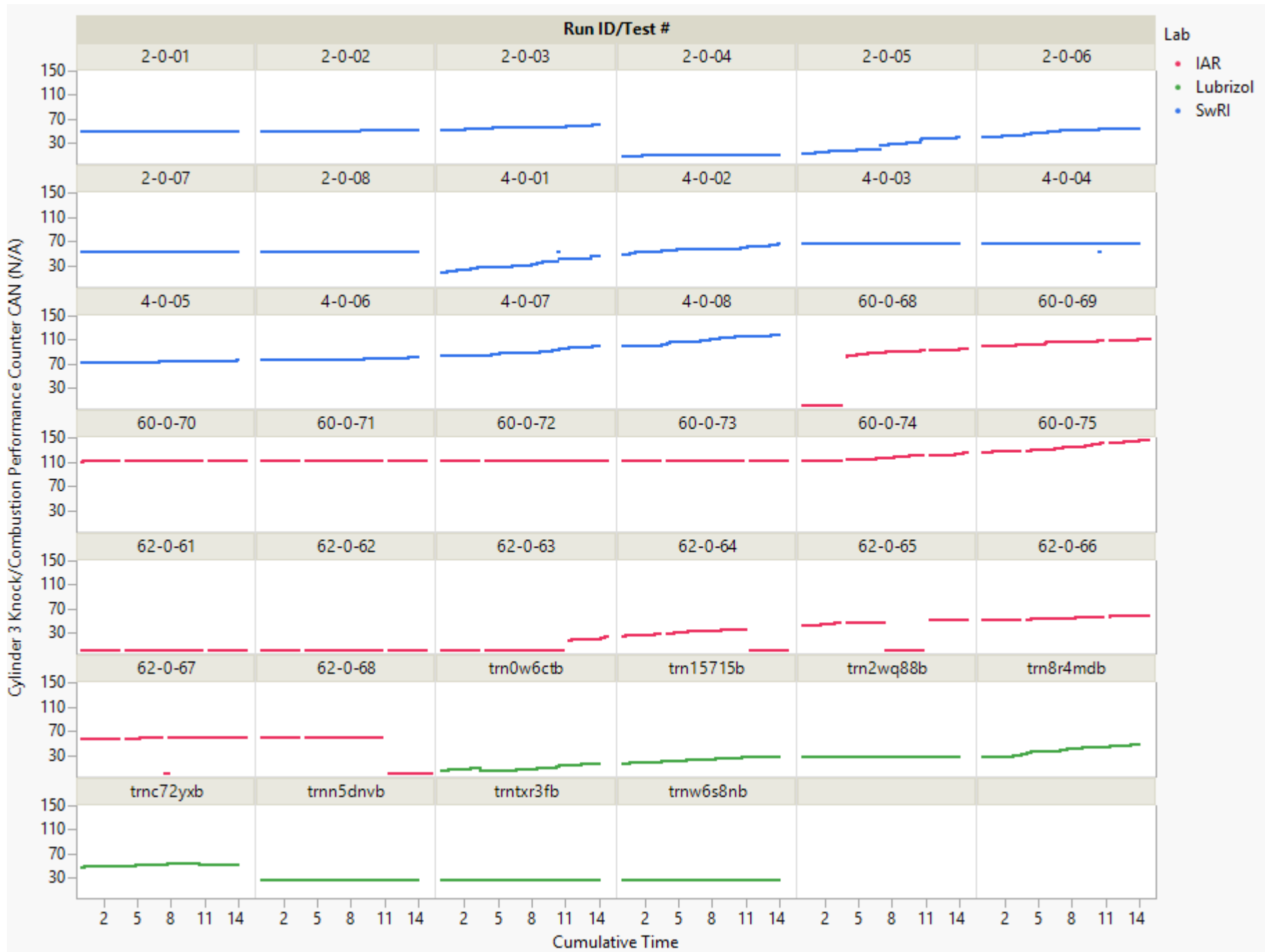
Low Event Oil



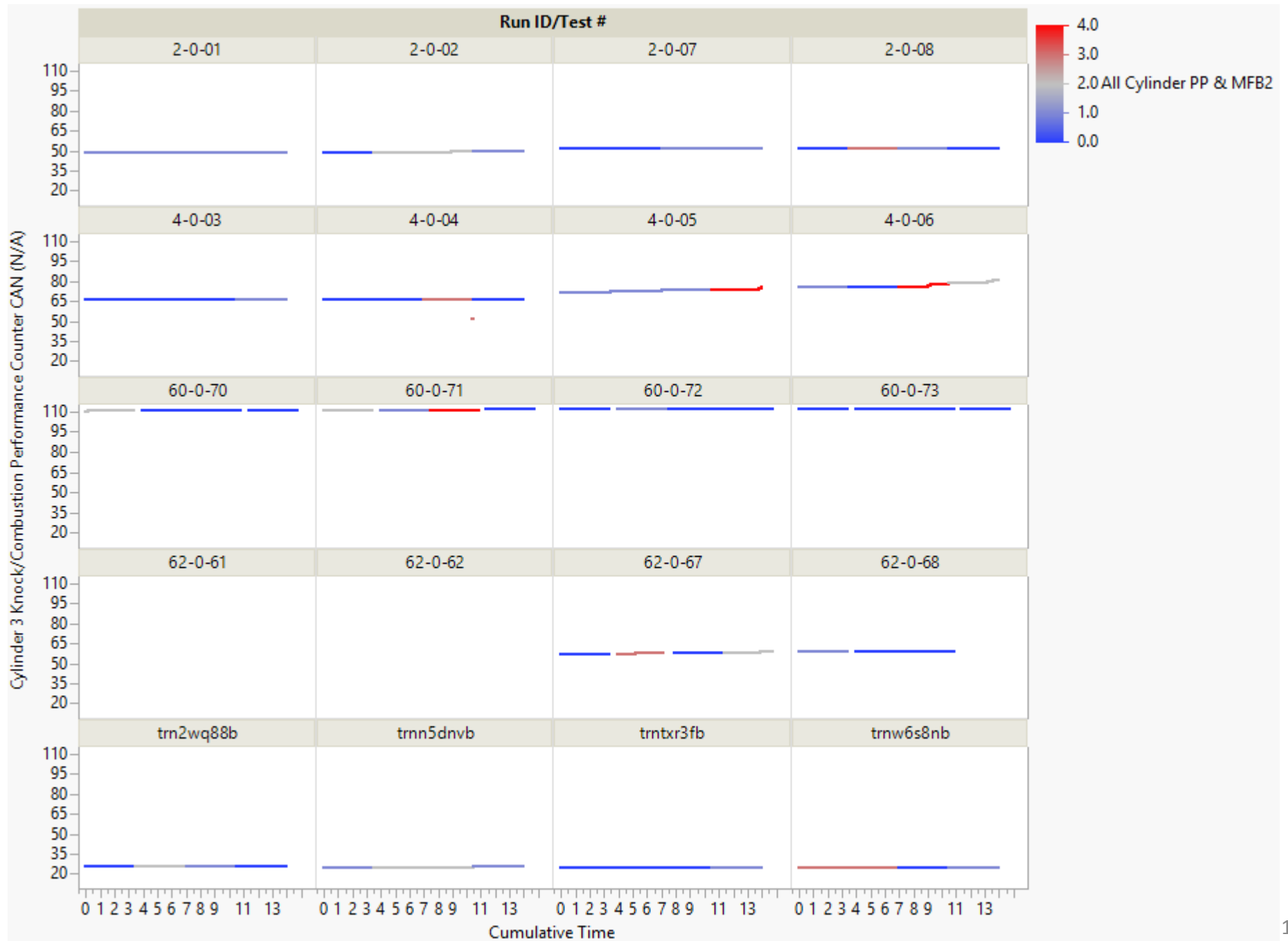
High Event Oil



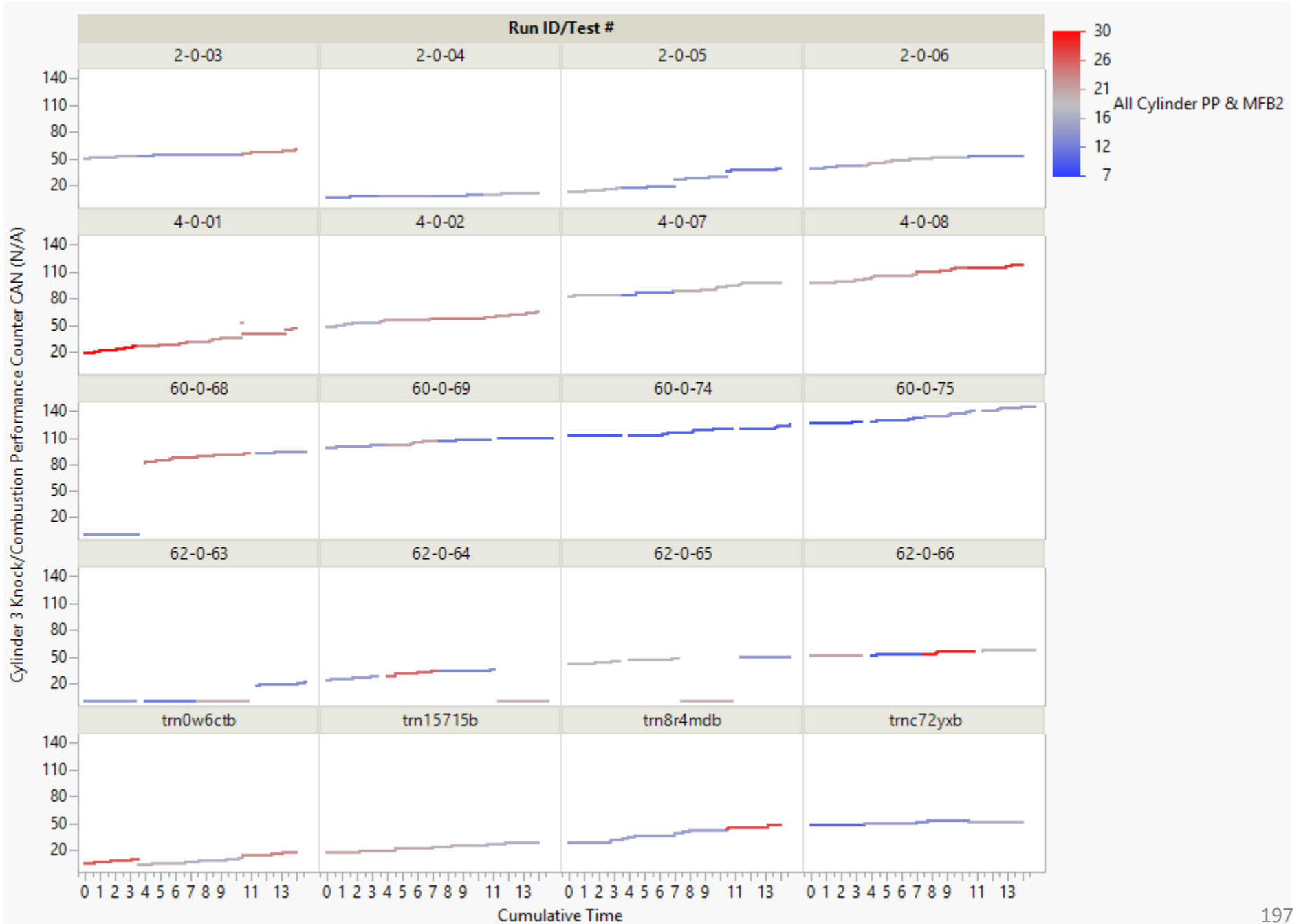
Cylinder 3 Knock/Combustion Performance Counter CAN



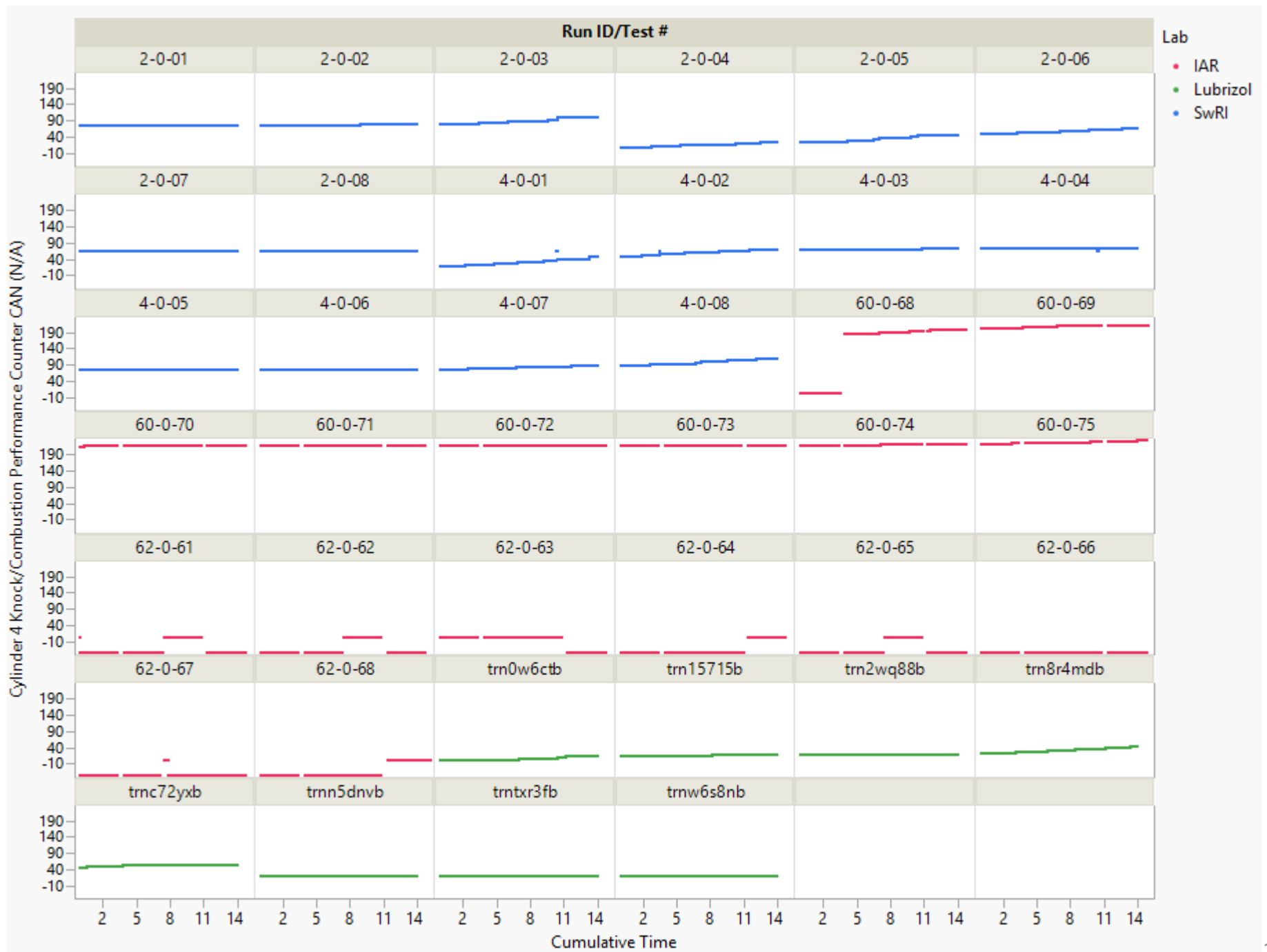
Low Event Oil



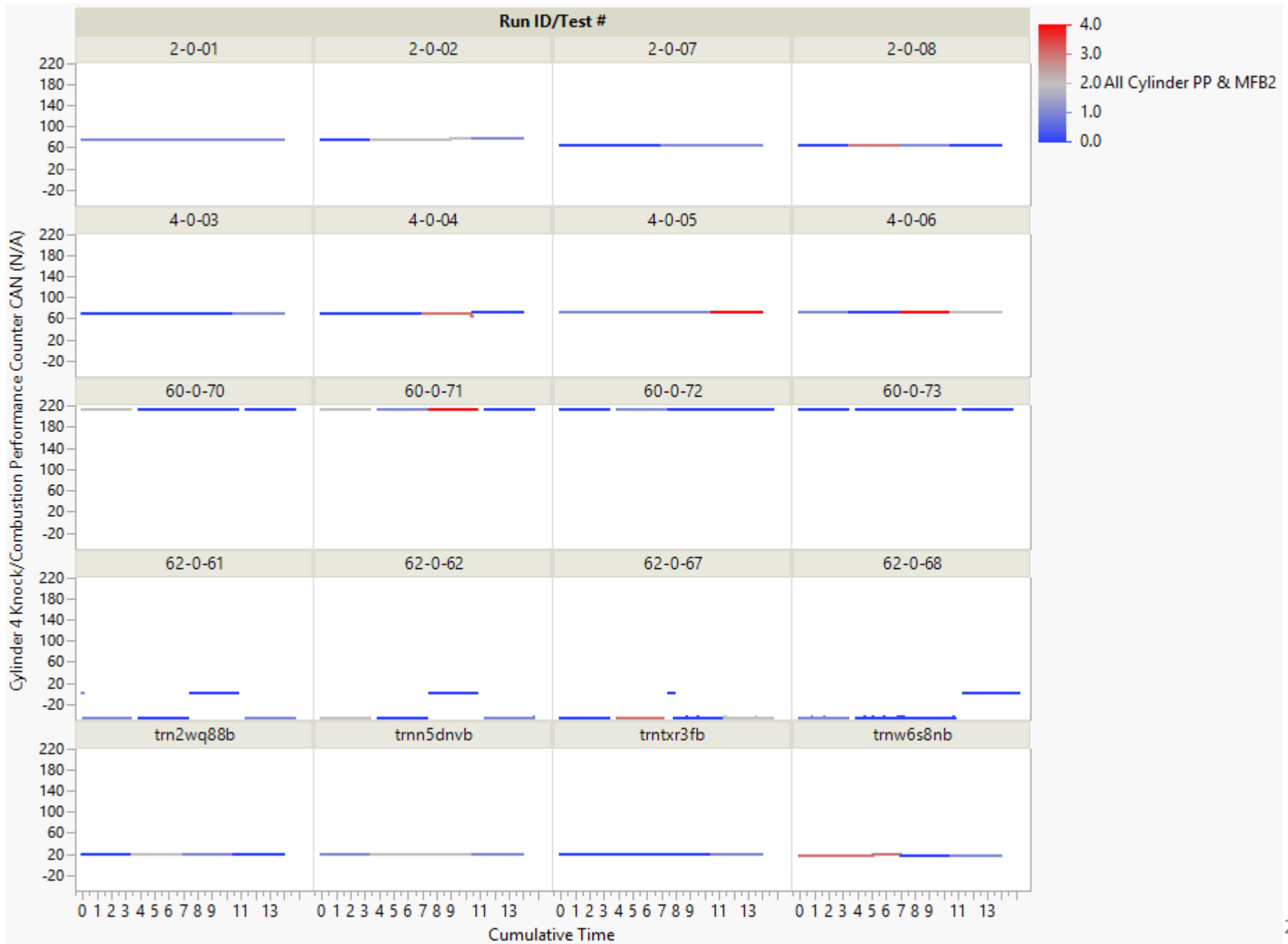
High Event Oil



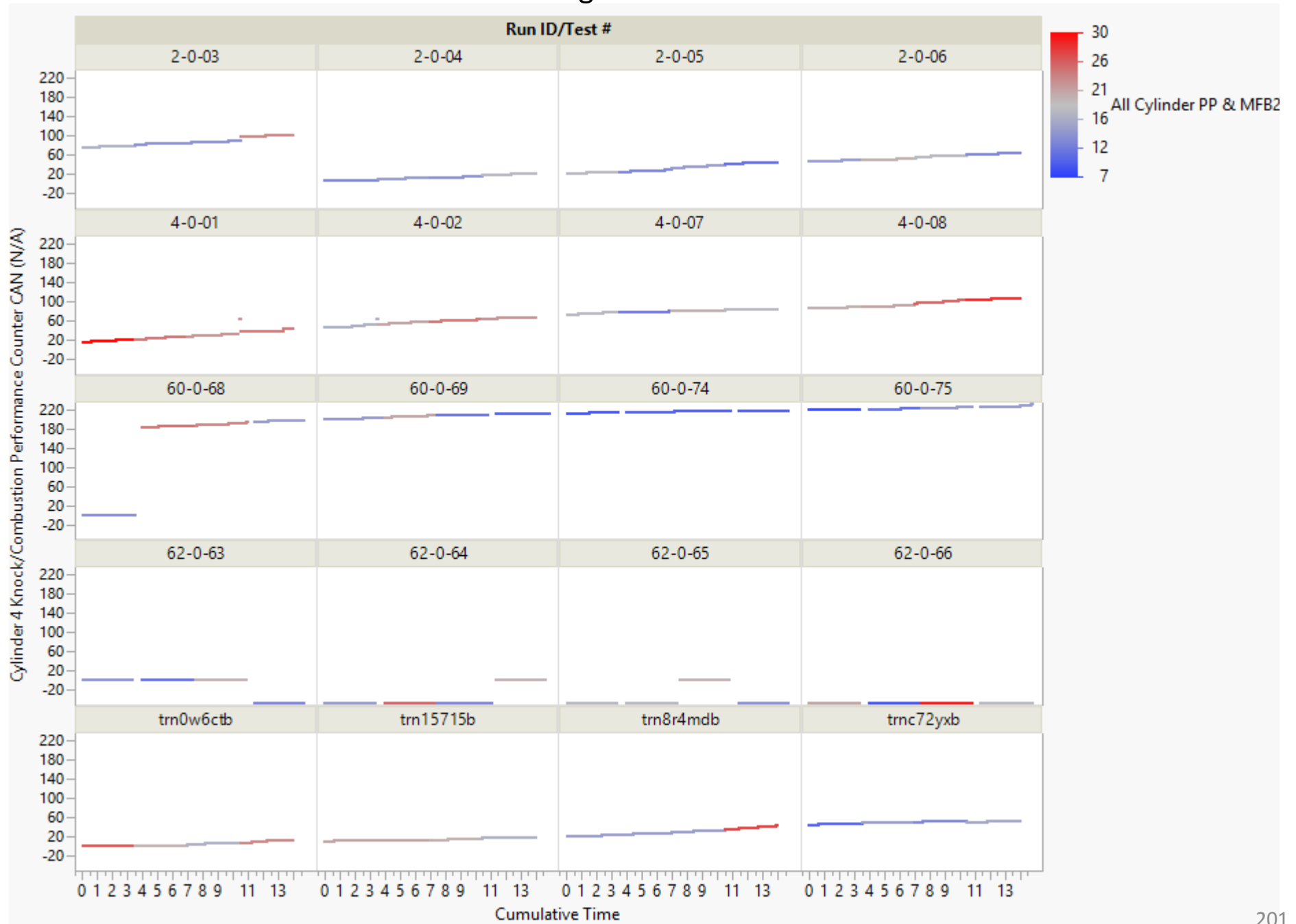
Cylinder 4
Knock/Combustion
Performance
Counter CAN



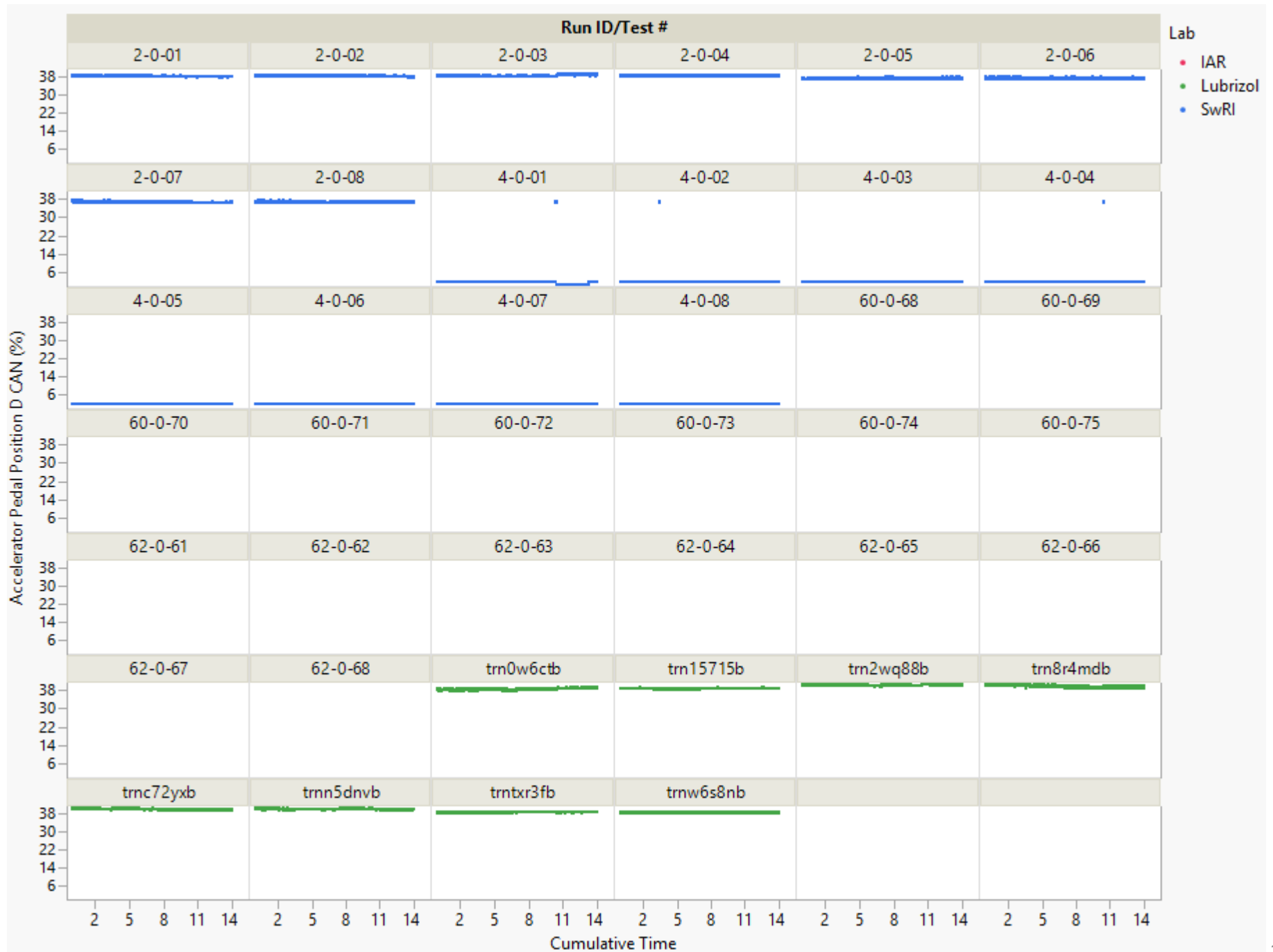
Low Event Oil

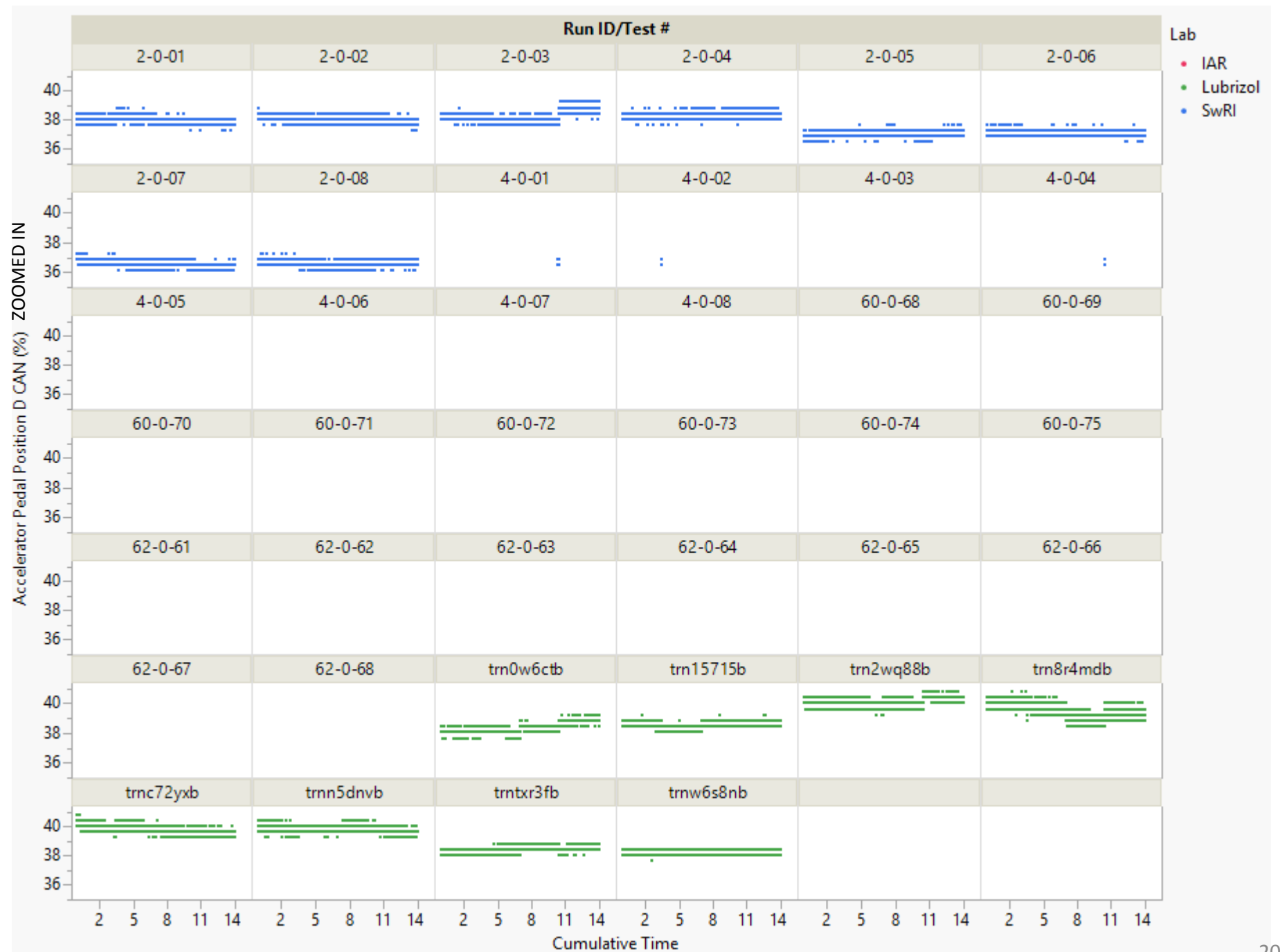


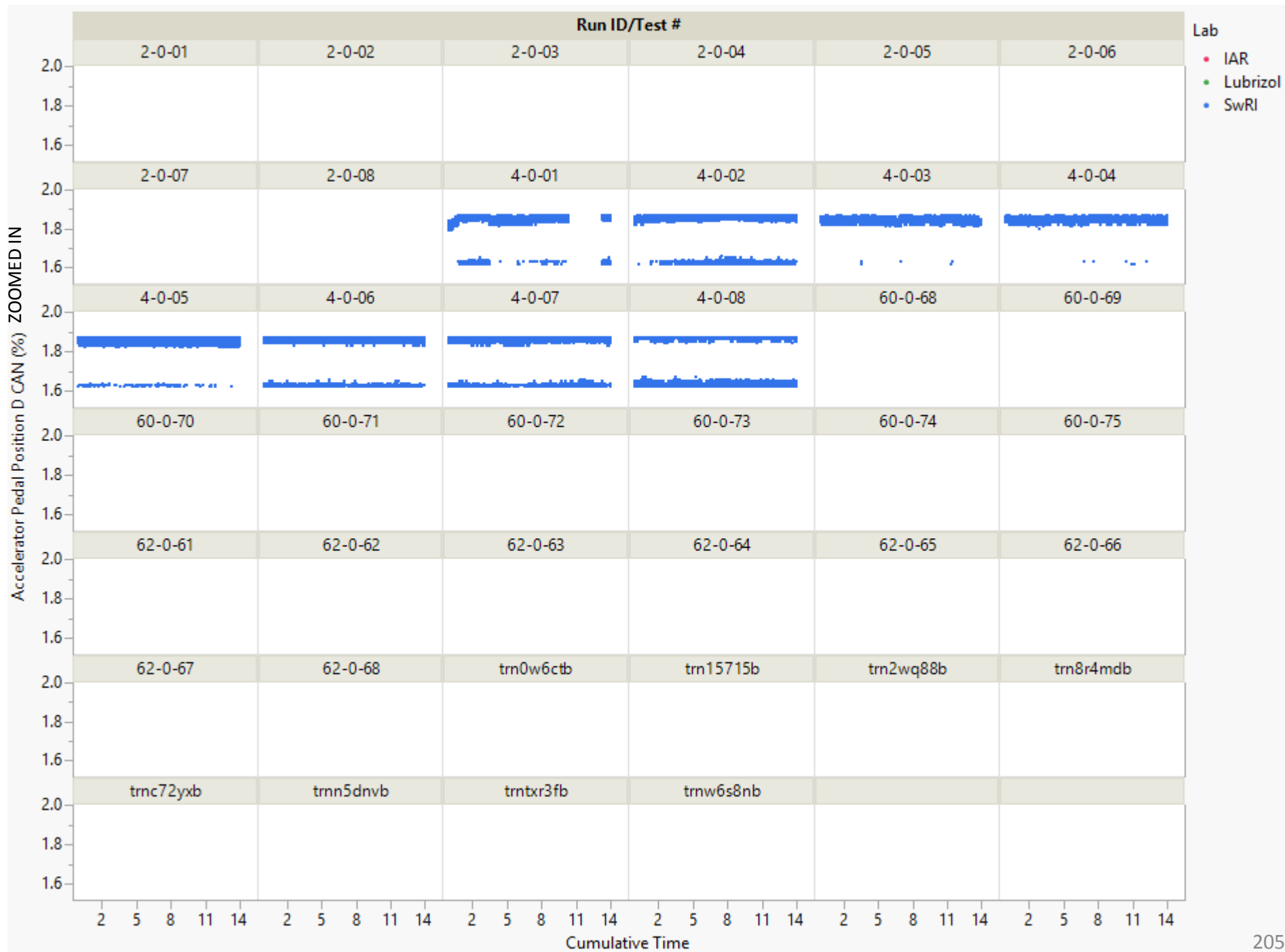
High Event Oil



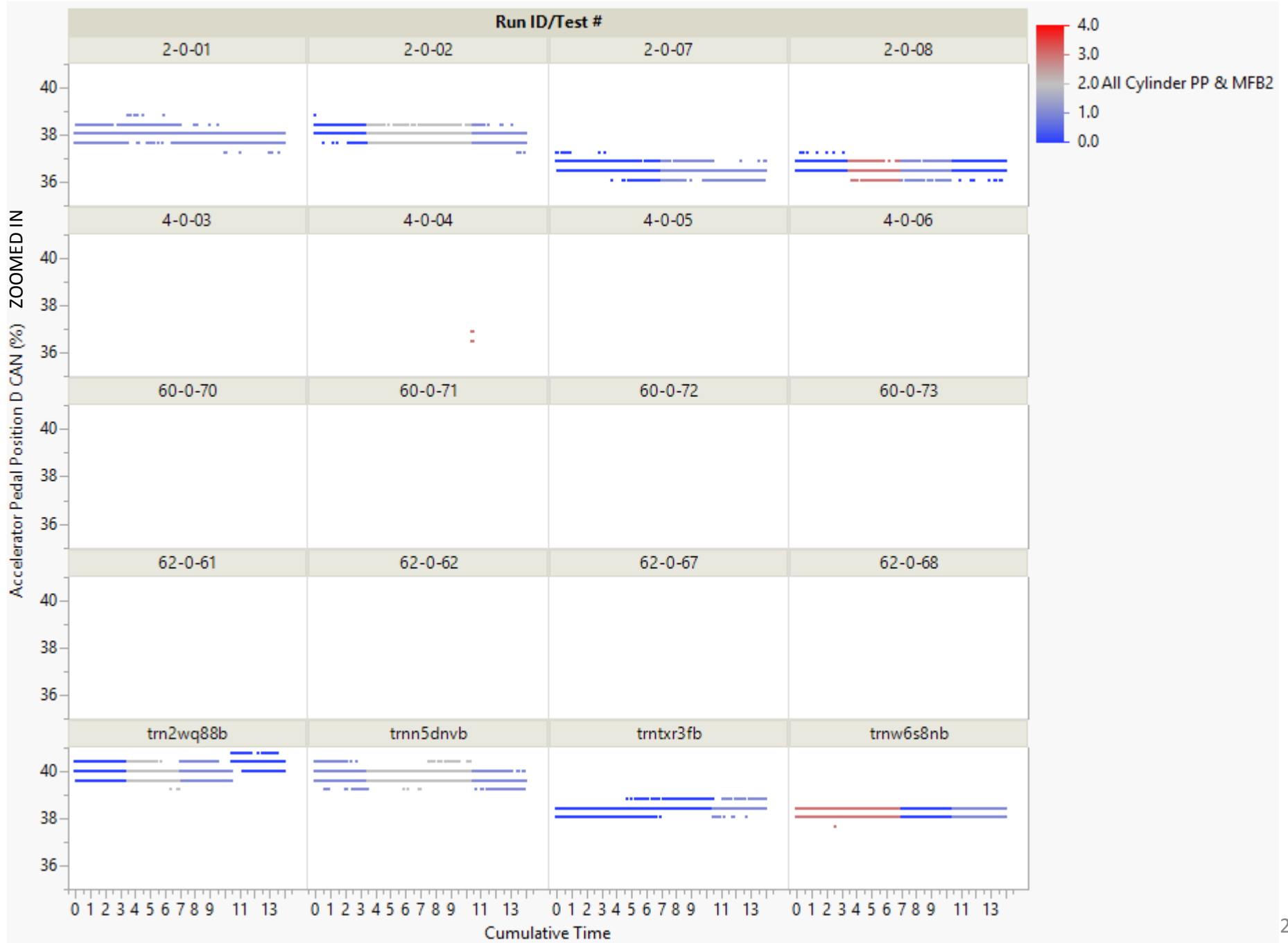
Accelerator Pedal Position D CAN



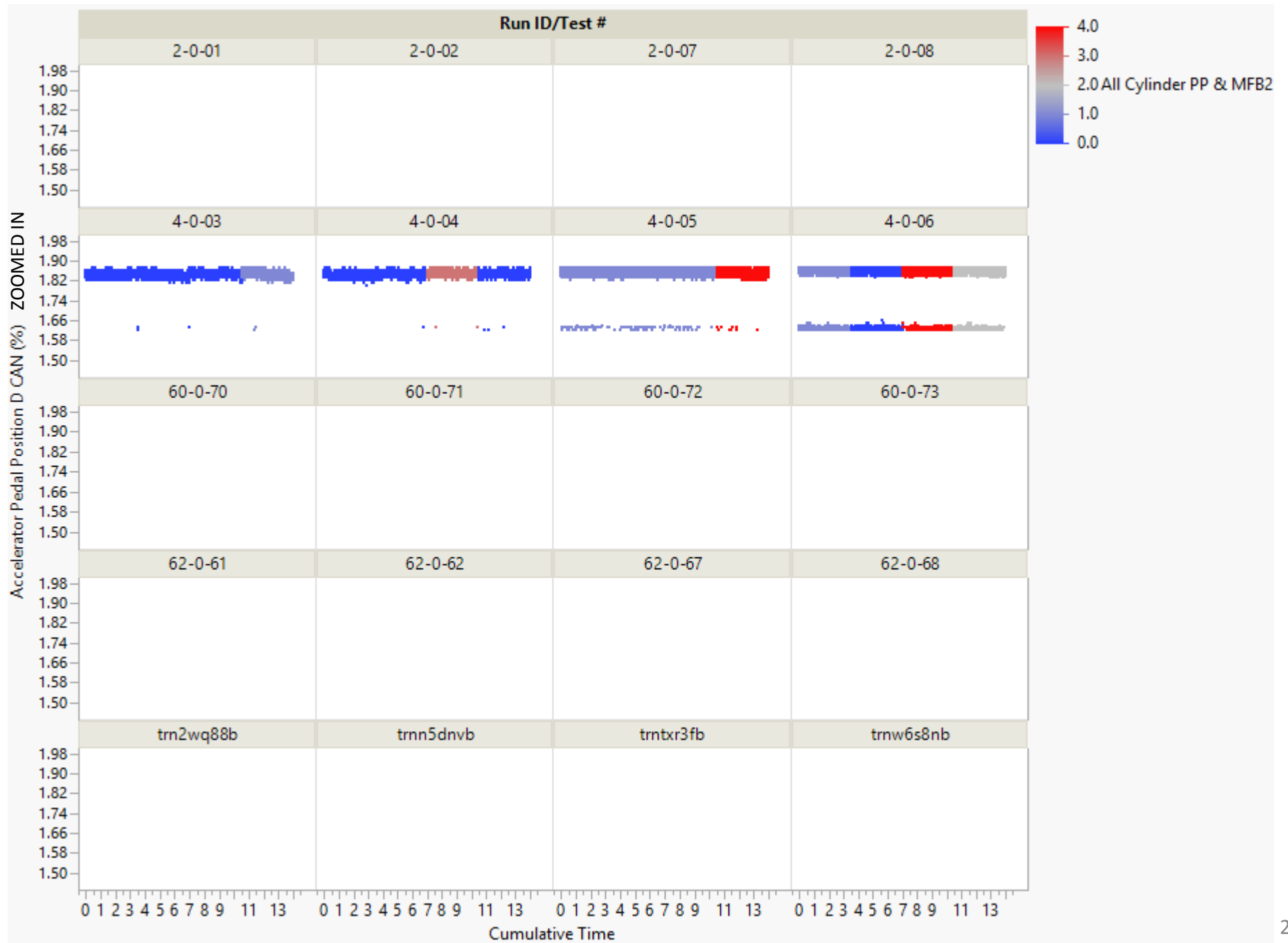




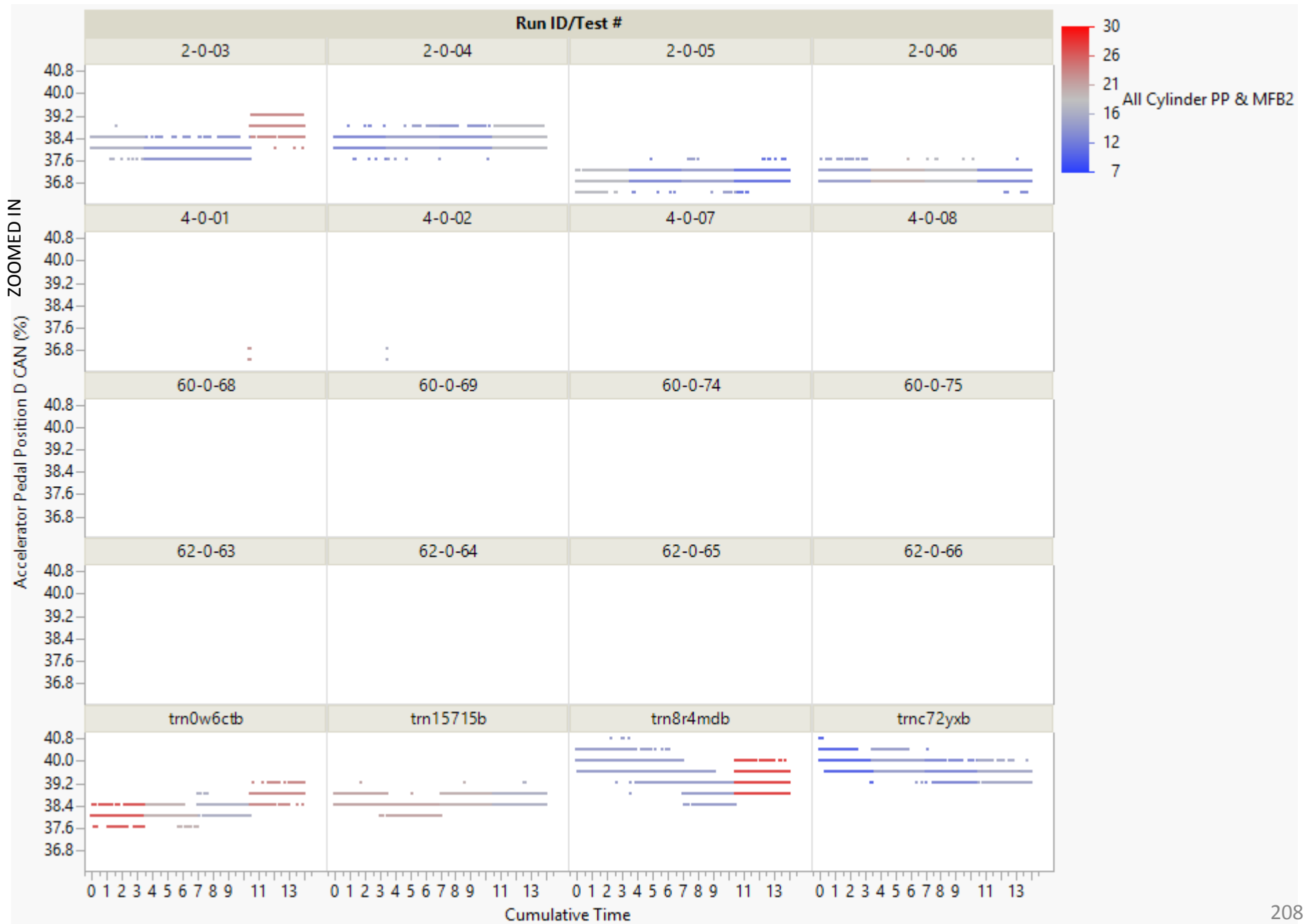
Low Event Oil



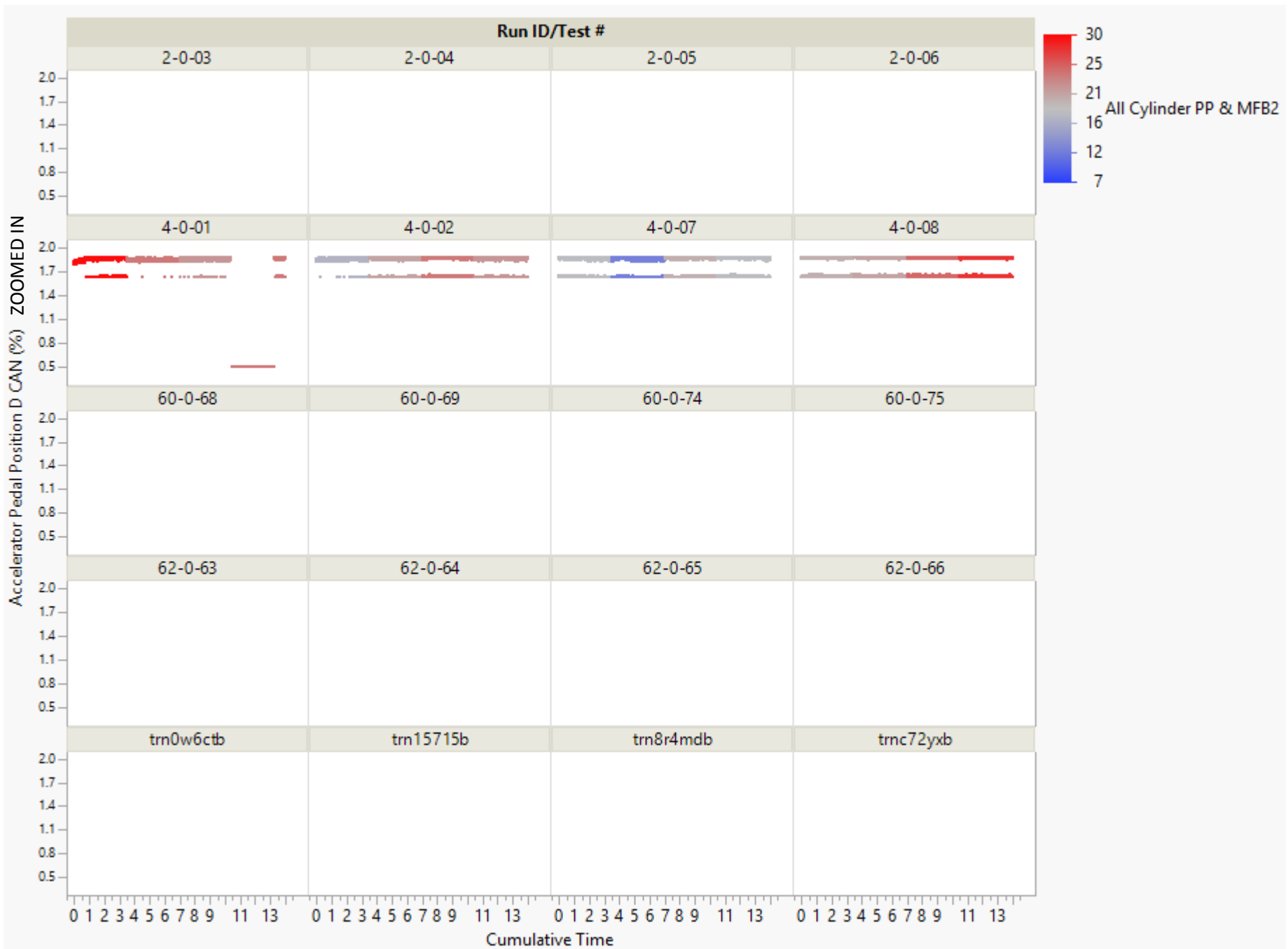
Low Event Oil



High Event Oil



High Event Oil



Build Data

- Average LSPI events per test are plotted versus lab-stand-engine combinations
- The color on the plot is associated with the various build measurements collected

