LSPI AGING INDUSTRY CONFERENCE CALL

Date: 9 July 20

ATTENDANCE

SWRI	Christine Eickstead, Khaled Rais, Travis Kostan
INTERTEK	Al Lopez, Charles Flores
LUBRIZOL	George Szappanos
AFTON	Christian Porter, Brent Calcut, Todd Dvorak
ORONITE	Robert Stockwell
INFINEUM	Doyle Boese
API	
TMC	Rich Grundza
FORD	Ron Romano, Dean Wingert, Mike Deegan
EXXON	Adam Meir, Mike Alessi
GM	Brad Cosgrove
SHELL	Eric Kalberer
VALVOLINE	
CALUMET SPECIALTY	Muibat Gbadamosi
NESTE	
APL	Tim Hadaway
VANDERBILT	Jeremy Styer
HALTERMAN	Prasad Tumati
F C A GROUP	
TOYOTA	
NOVVI	Steve Haffner
KLEEN PERFORMANCE	

Stats Presentation:

Travis presents Operation Data Comparison slides.

Did we calculate QIs? All labs – yes. No negative QIs except SwRI on second test.

- ➔ Slide 4: Load a bit more noisy than expected, function of drive by wire? Rich – yes.
- ➔ Slide 7: Air charge temp – IAR replaced intercooler, fixed problem
- ➔ Slide 8: Inlet air temp – Lopez - problems with chillers, difficulty in the summer keeping tight control
- ➔ Slide 9: Inlet air pressure – Lopez – couple of stands that are cycling nearby, tuning can't keep up with cycles
  - o George – why no readings below zero? Should be able to measure vacuum if that's what's going on
  - o Lopez – will look into that
- ➔ Slide 14: Lambda – Al – maybe calibration of the sensor? Not sure. CAN data – all on top of each other. Other labs also off by as much using stand sensor.
- ➔ Slide 16: Oil Gallery pressure – George – no explanation for that
- ➔ Slide 17: Oil head pressure – George – same, but suggests data is correct for both
- ➔ Slide 29: MAP – resolution issue with SwRI? Reported as whole number only?

- ➔ Al – what we're looking for is why A is more severe.
  - o Discussion: MAP – lab A higher? Spread all over, just resolution difference, but still overall higher than group

Al presents results of aging runs to keep overall goal in mind as we go through Travis' slides.

- ➔ Ron – lab A was okay on FF, others, no significant differences, nothing stands out
- ➔ George – haven't looked at BB yet…., Al – have looked at CCP and those data looked okay

Back to Travis' presentation:

- ➔ Slide 35: Absolute load – lab A slightly higher, didn't show this difference on torque
  - o Absolute load and engine load don't match up….
- ➔ Al – TAN – big difference with Lab A
- ➔ Slide 39: Boost absolute pressure – same for both measurements except lab B
  - o Lab A – did SwRI report the same values for both? Check MAP too.
- ➔ Slide 41: Intake camshaft position – Ron – didn't lock the cams on CW, only for LSPI
  - o Christine looking into this value.
  - o George – if really at -17, would see influence on other parameters, likely a recording issue
  - o Christian – old presentation shows same thing, will send to Christine

Out of time, will cover remaining topics next week.

Updated Matrix:

- o **Afton**
- o **Infineum**
- o **Lubrizol**
- o **Oronite**
- o **Intertek**
- o **SwRI**
- o **GM**
- o **Ford**
- o **API**

Aging Cycle Runs	Lubrizol	IAR	SwRI
1	A Aging Cycle	A Aging Cycle	B Aging Cycle
2	B Aging Cycle	B Aging Cycle	A Aging Cycle

LSPI Runs	Lubrizol	IAR	SwRI
1	A Fresh	A Aged	B Aged
2	A Aged	A Fresh	B Fresh
3	B Aged	B Fresh	A Fresh - CANCELLED
4	B Fresh	B Aged	A Aged

Sequence IX
Oil Aging Operational Data Plots

June 2020

The Data Set

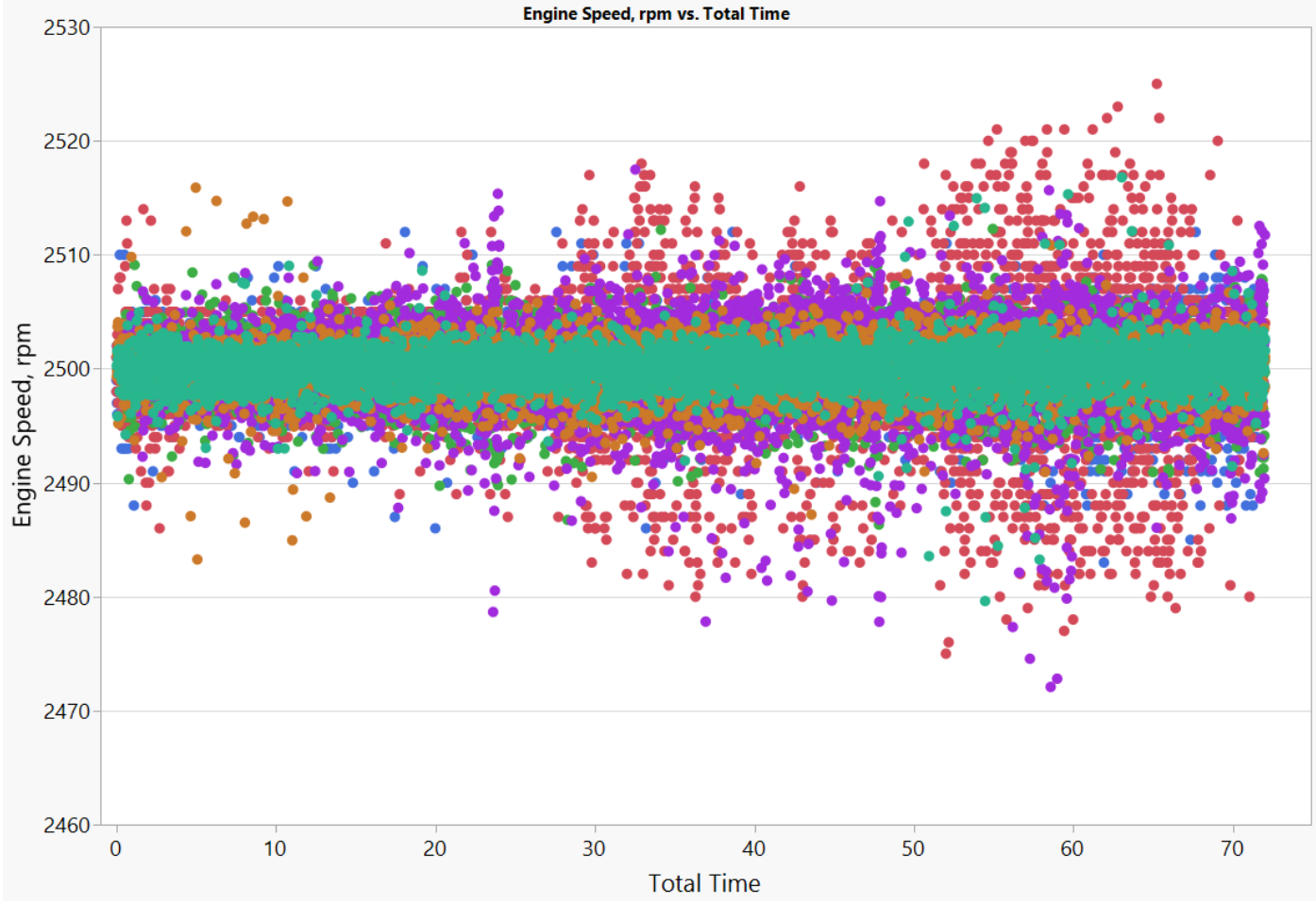
- 6 Tests from 3 Labs on 2 Oils, which are named in the plots as:
  - Lab A – Oil A
  - Lab A – Oil B
  - Lab B – Oil A
  - Lab B – Oil B
  - Lab G – Oil A
  - Lab G – Oil B

- For a review of the results of the tests, see presentation titled "Sequence IX Oil Aging Data Review" dated May 29, 2020.

Engine Speed

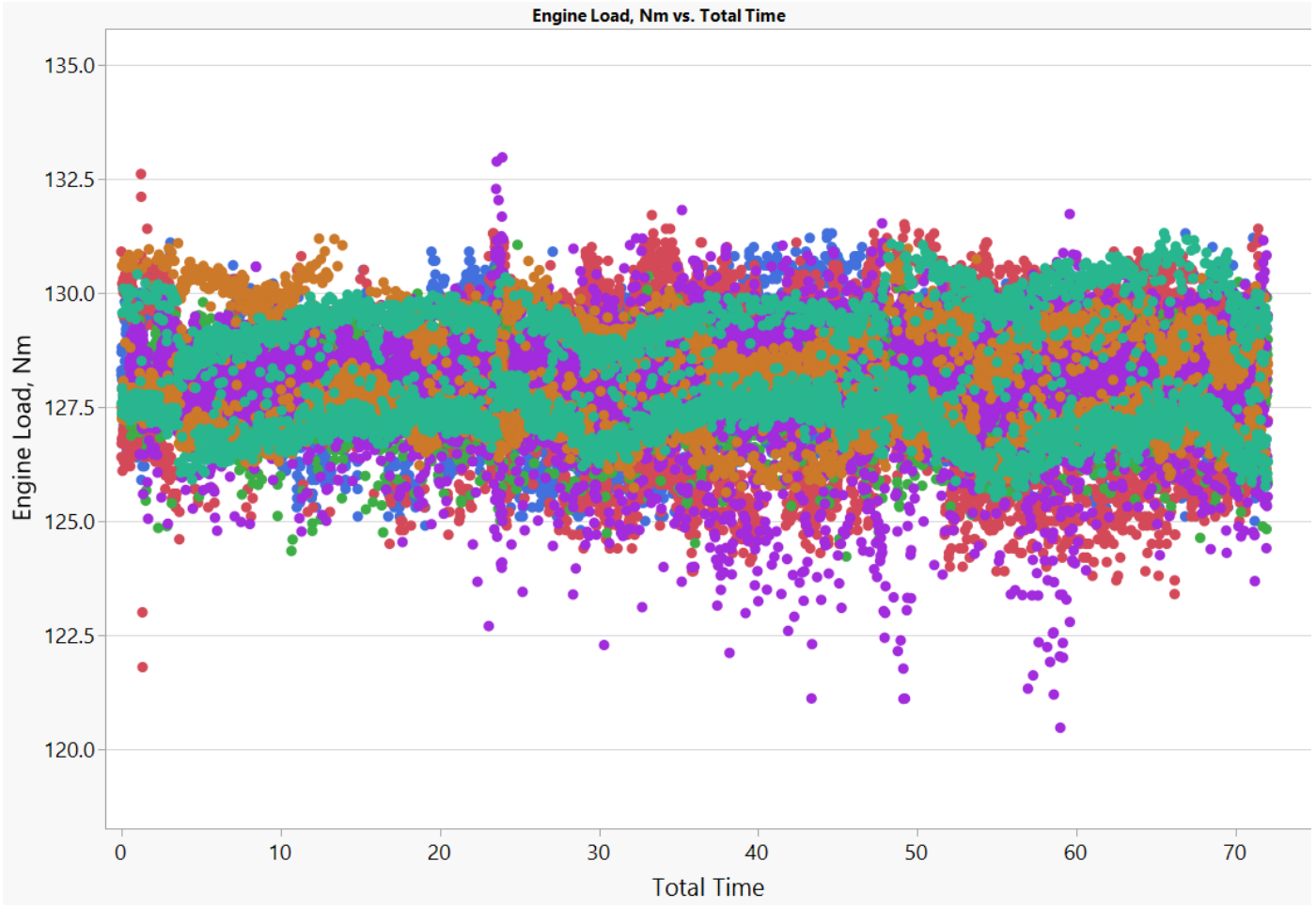
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

Limit = 2500 rpm +/- 5 rpm



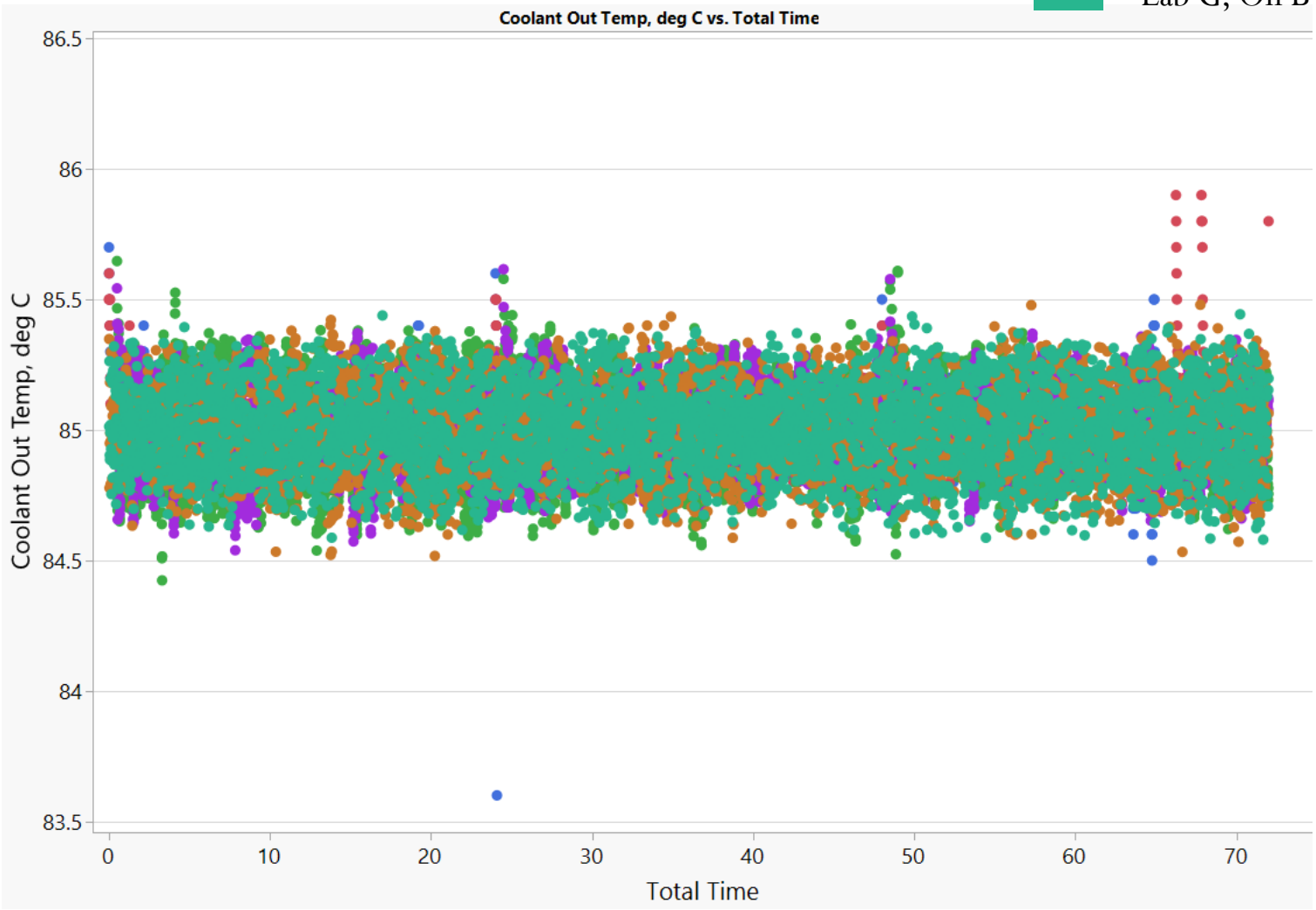
Engine Load

Limit = 128 +/- 2



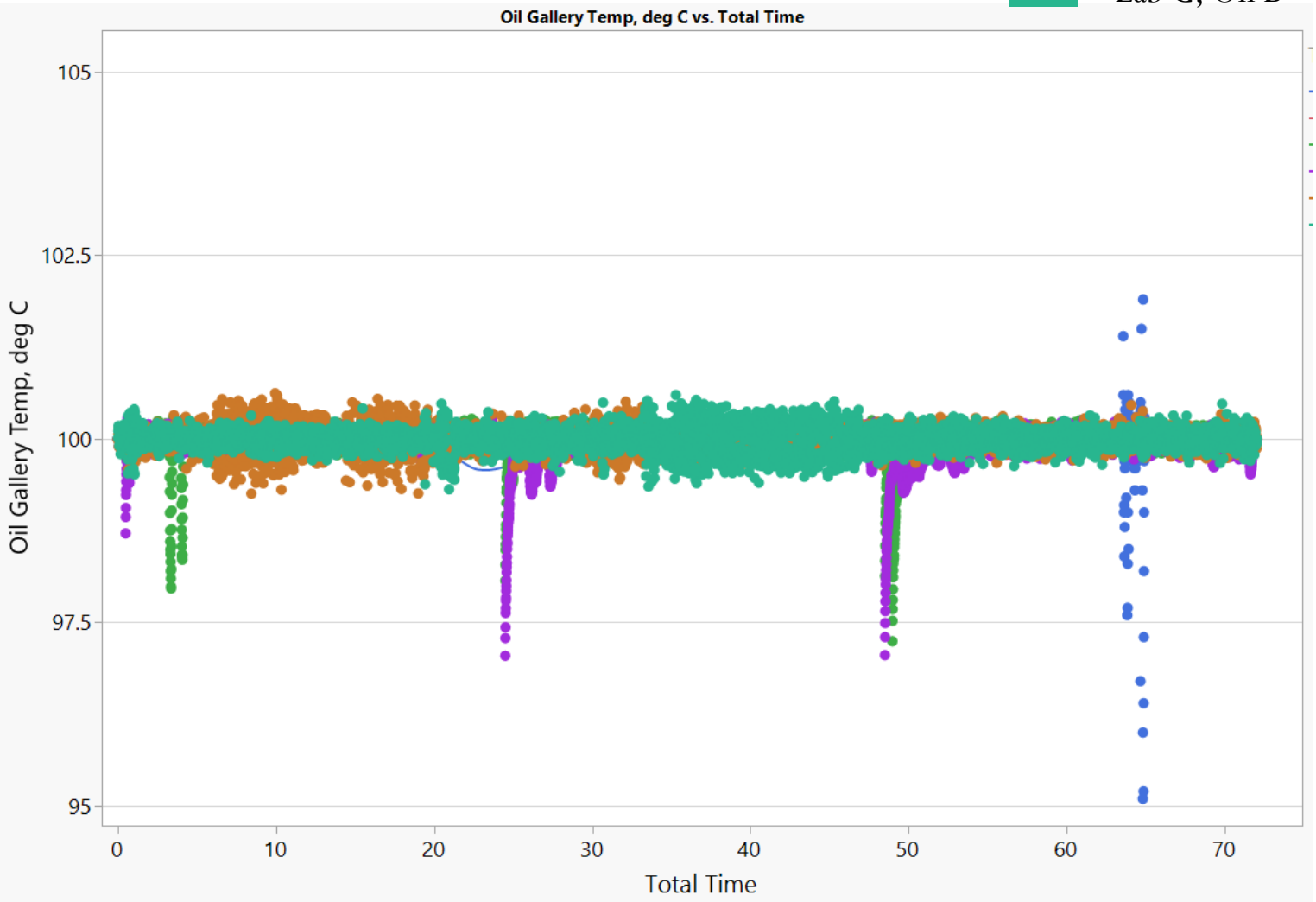
Coolant Out Temp

Limit = 85 +/- 0.5



Oil Gallery Temp

Limit = 100 +/- 0.5



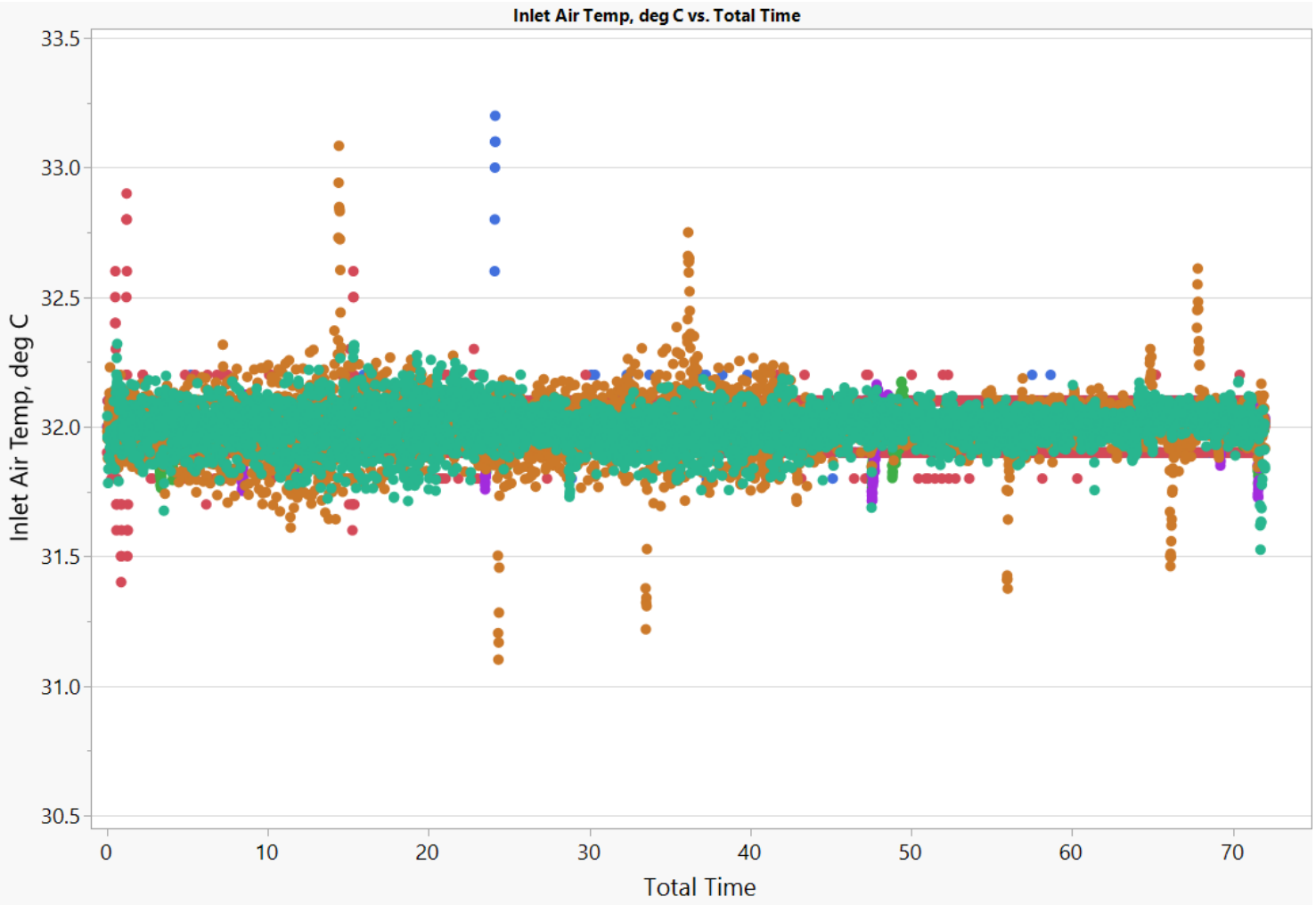
Air Charge Temp

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

Limit = 30 +/- 0.5

Inlet Air Temp

Limit = 32 +/- 0.5

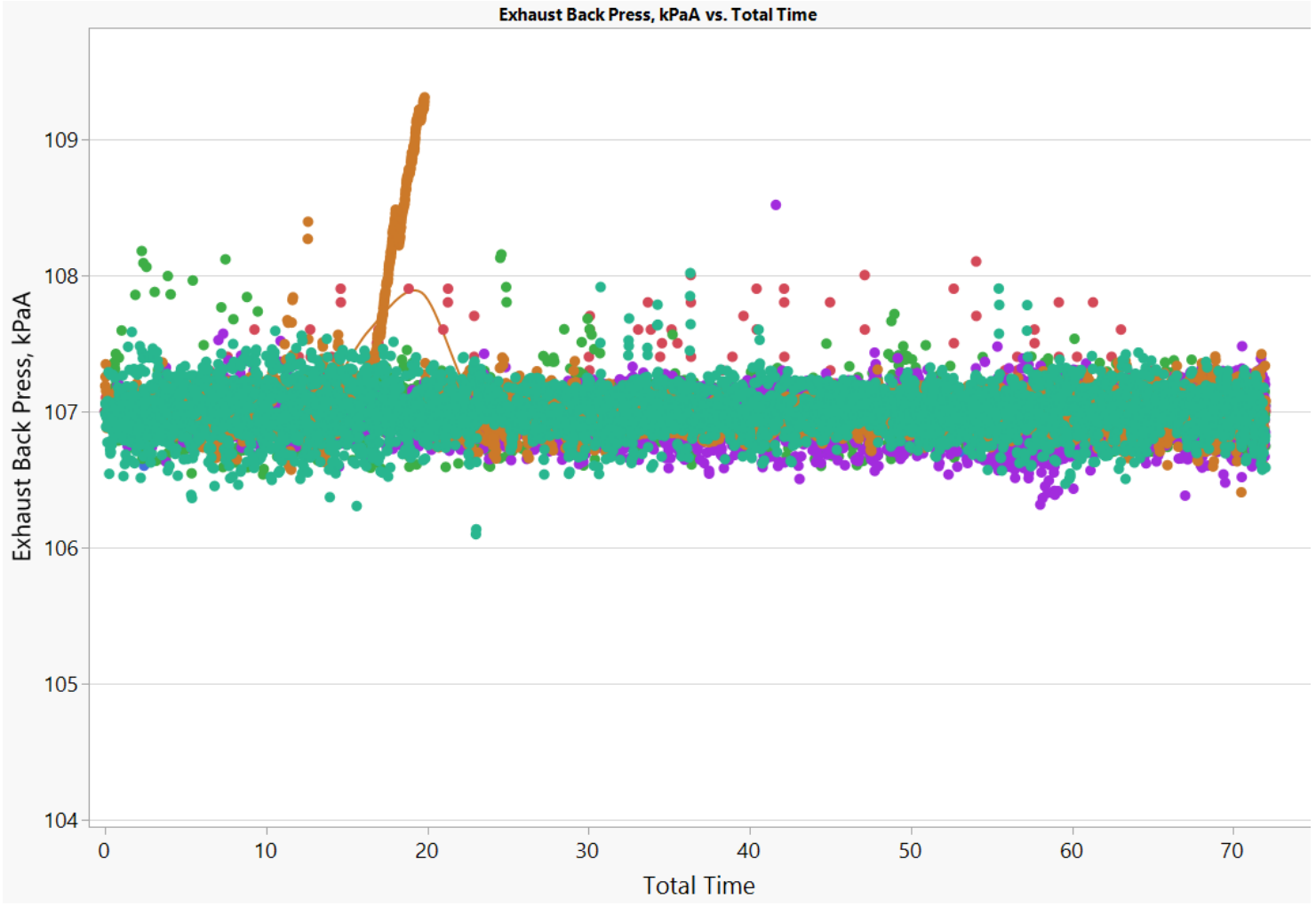


Inlet Air Pressure

Limit = 0.05 +/- 0.02

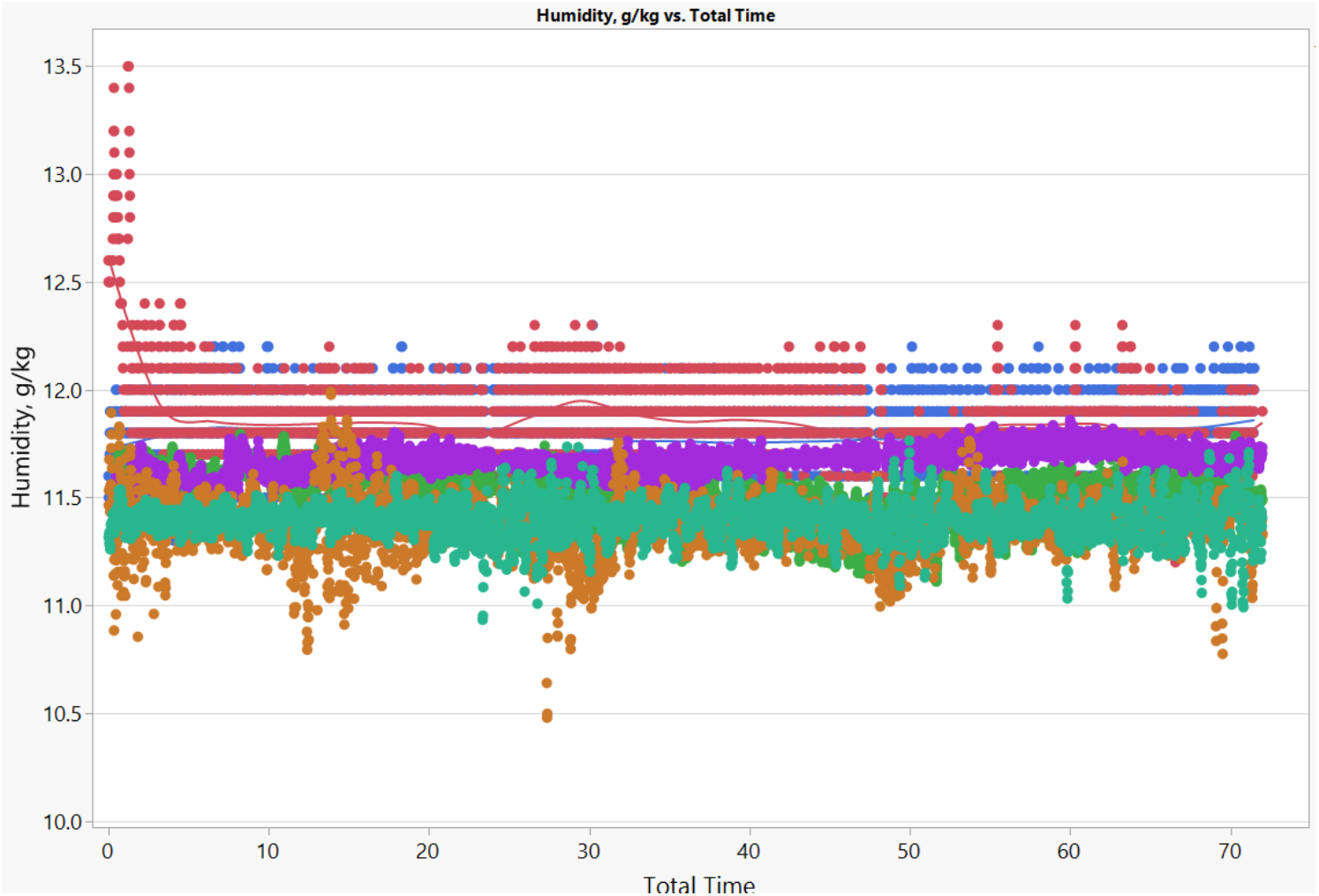
Exhaust Back Pressure

Limit = 107 +/- 2



Humidity

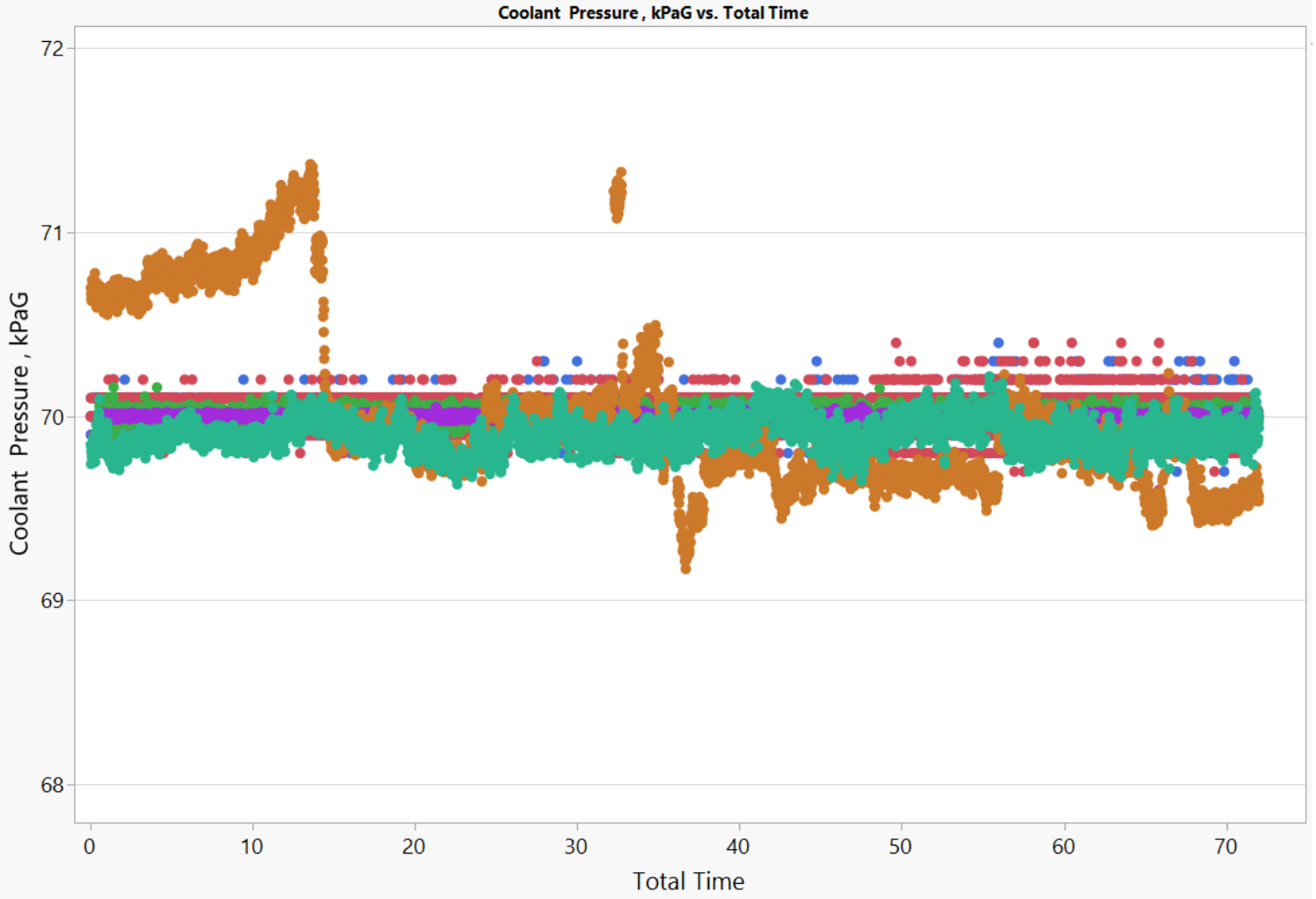
Limit = 11.4 +/- 1.0



Coolant Pressure

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

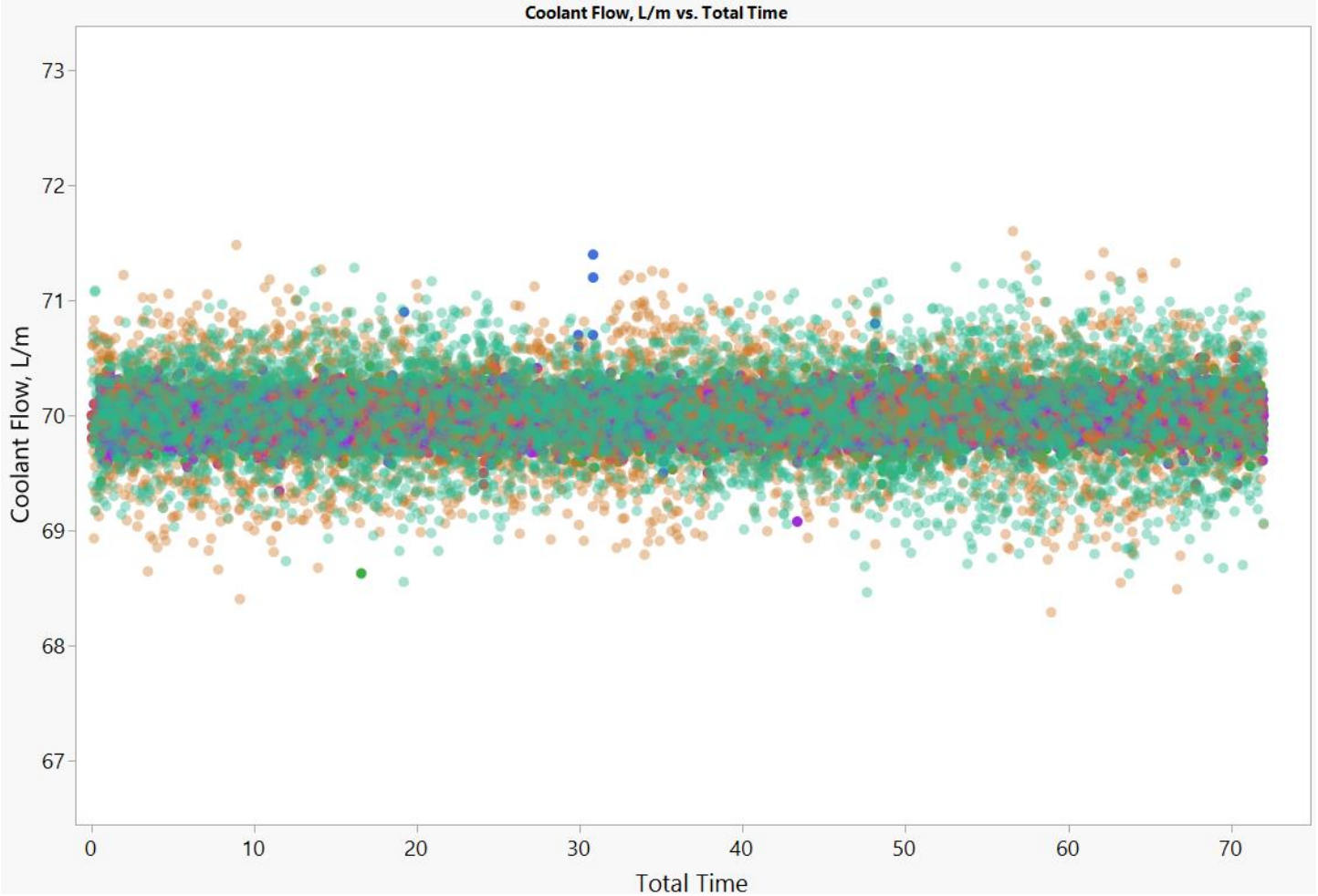
Limit = 70 +/- 2



Coolant Flow

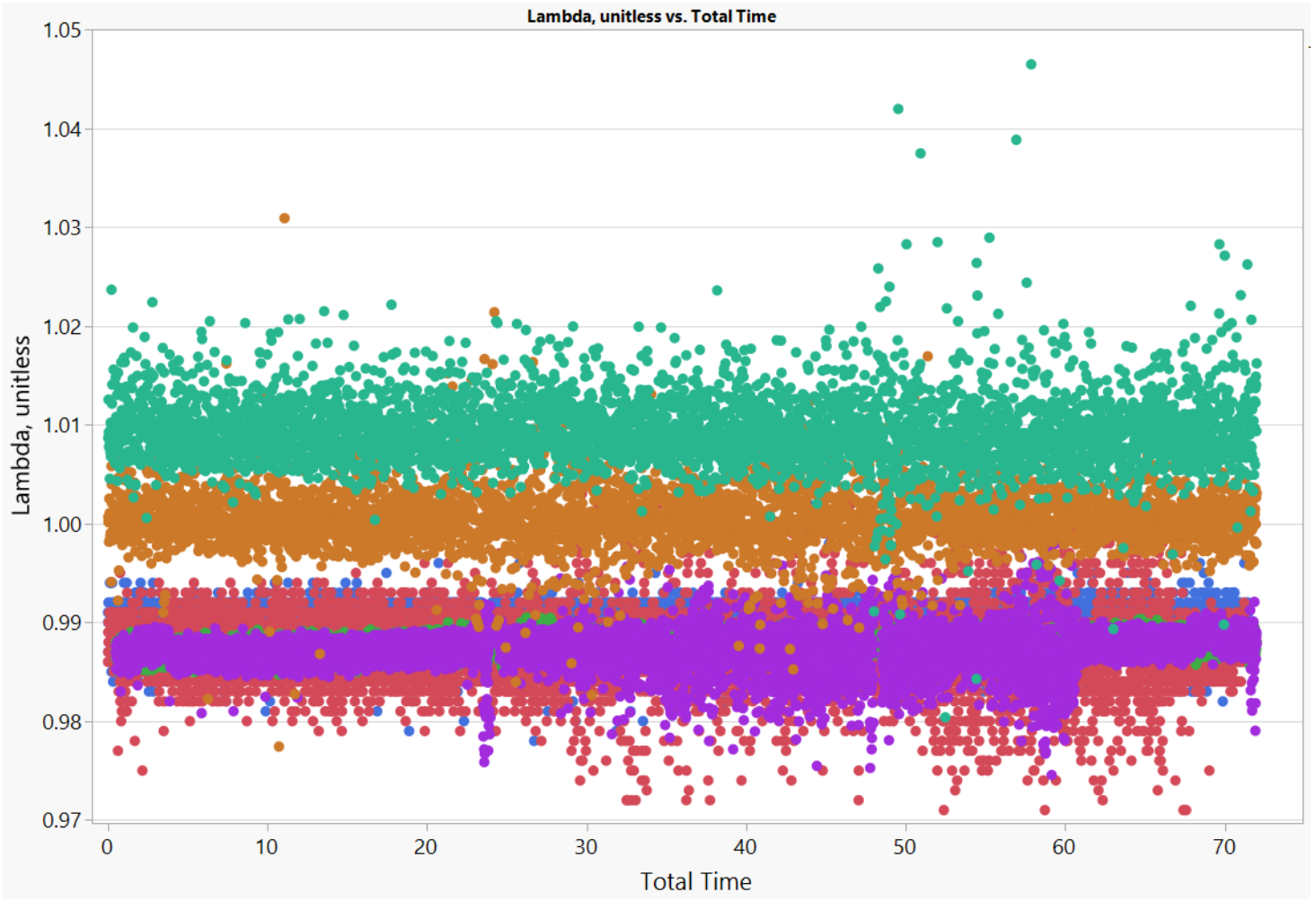
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

Limit = 70 +/- 2

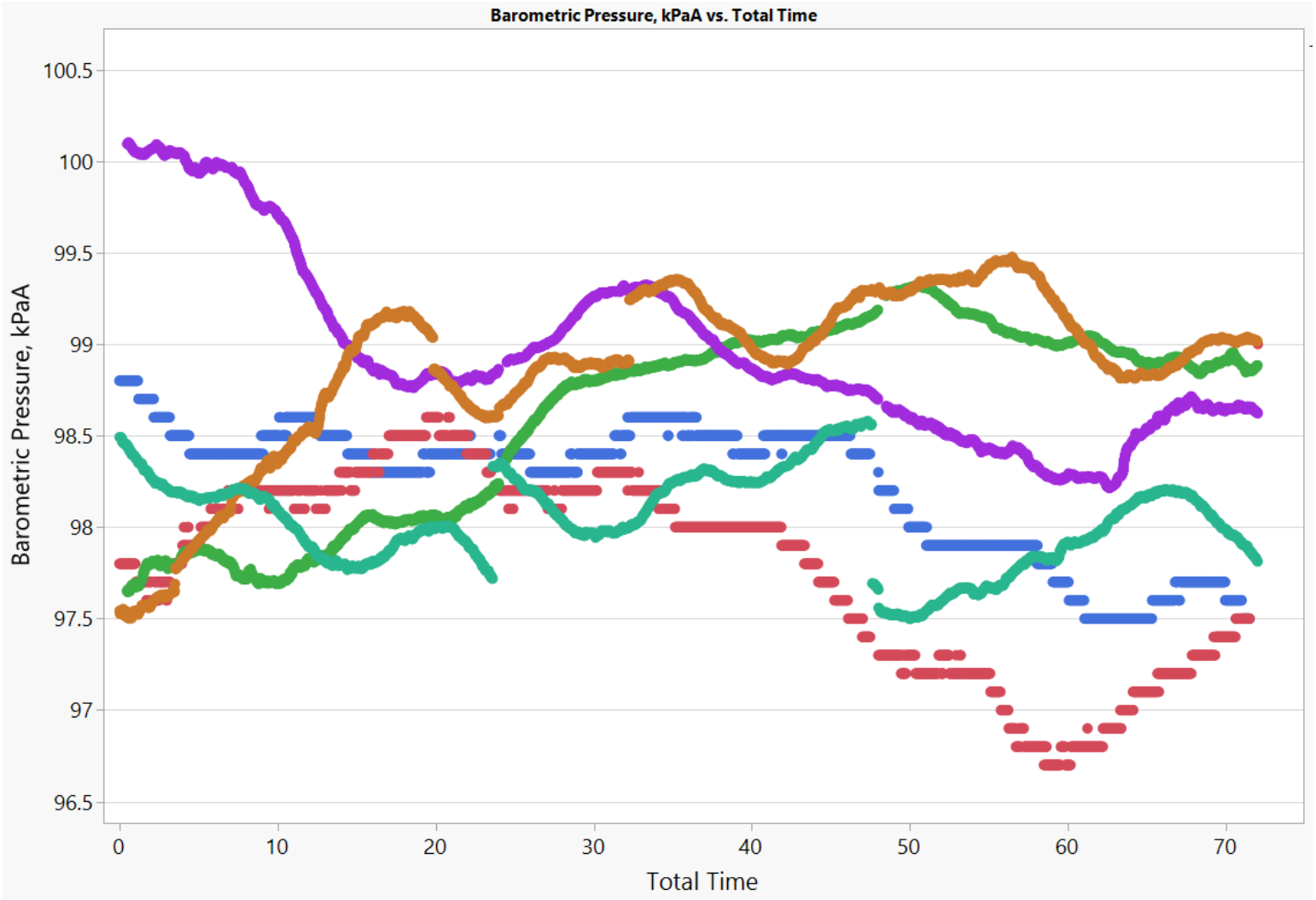


Lambda

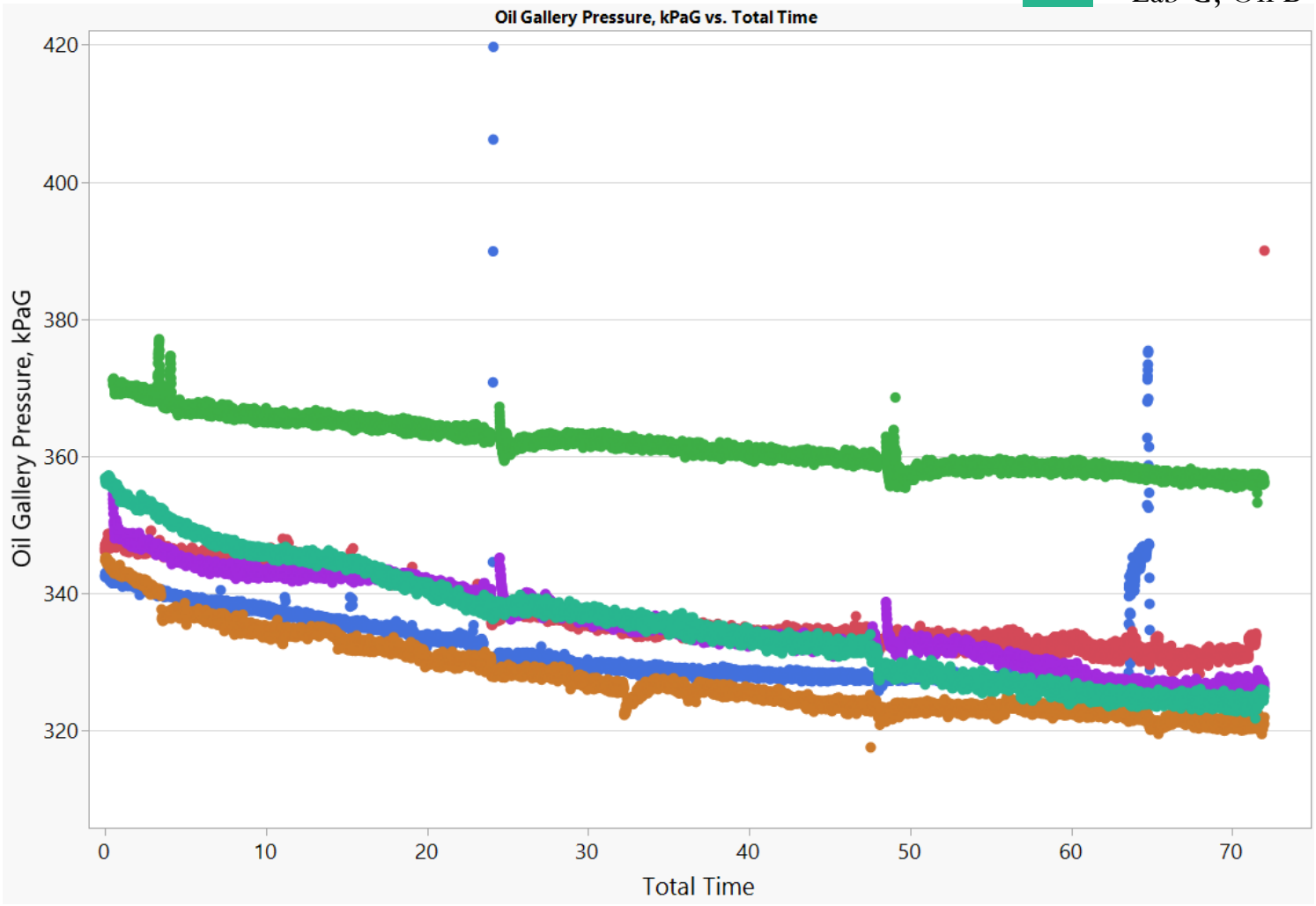
Limit = 1.0 +/- 0.05



Barometric Pressure



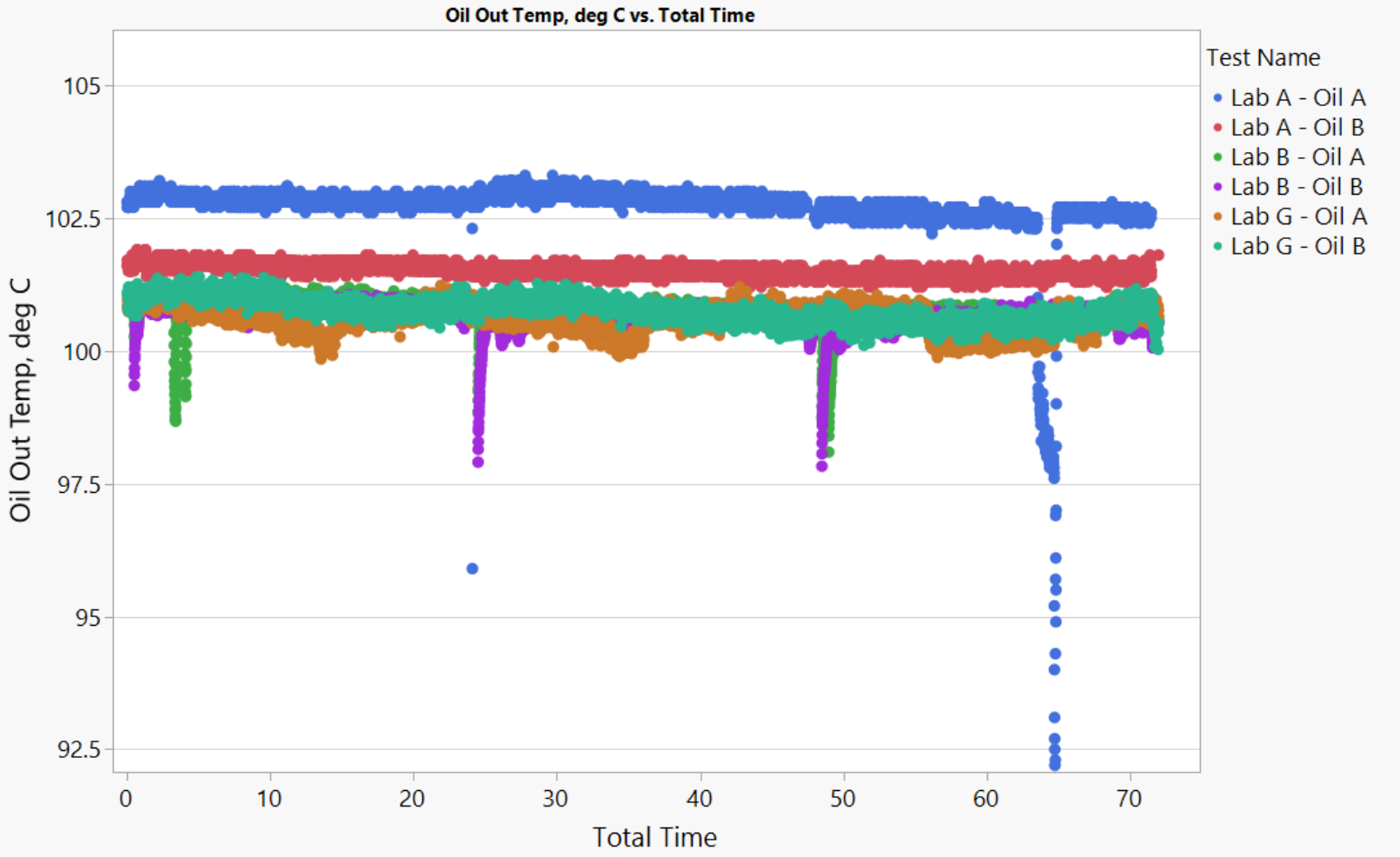
Oil Gallery Pressure



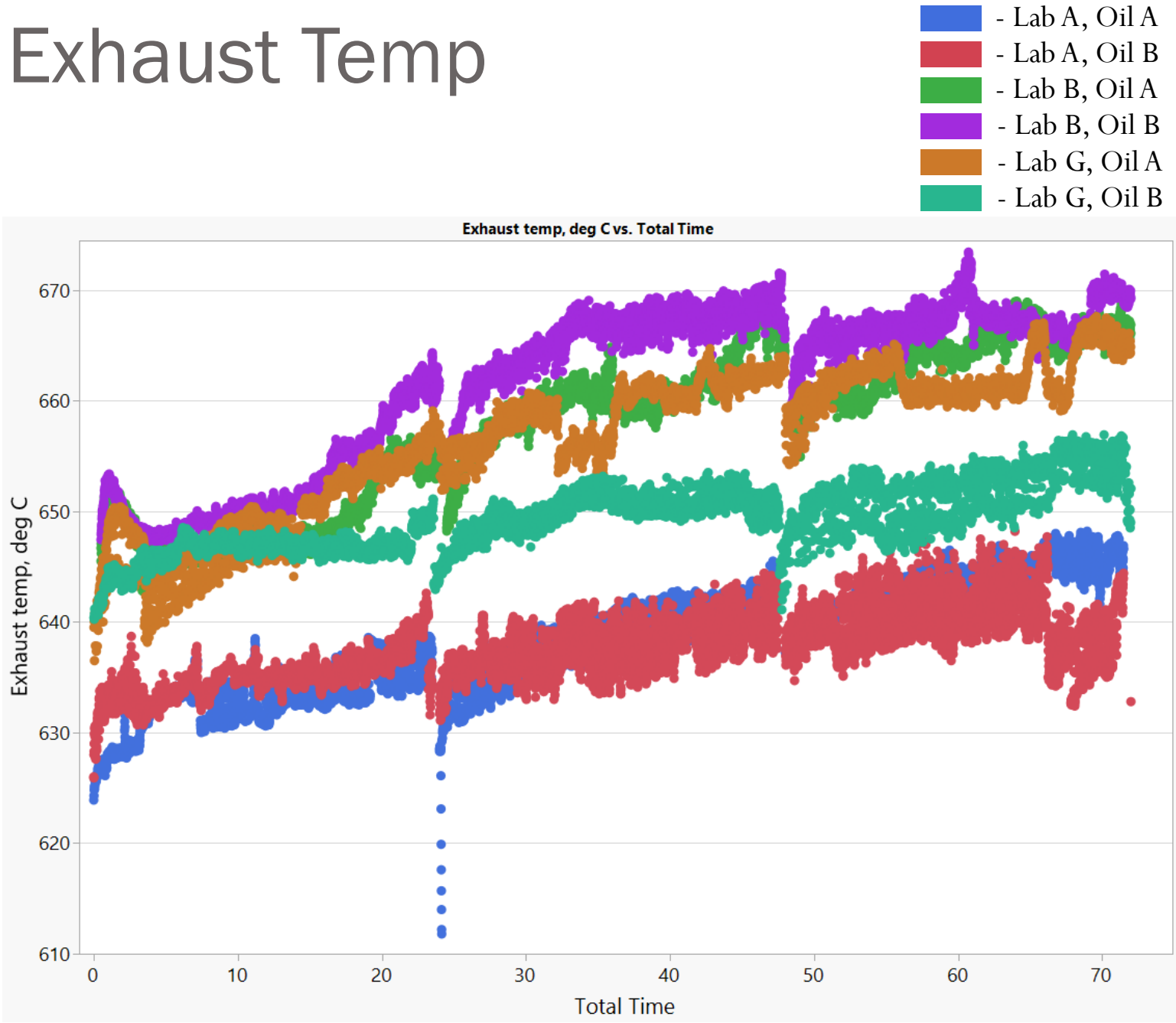
Oil Head Pressure

Oil Out Temp

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



Exhaust Temp

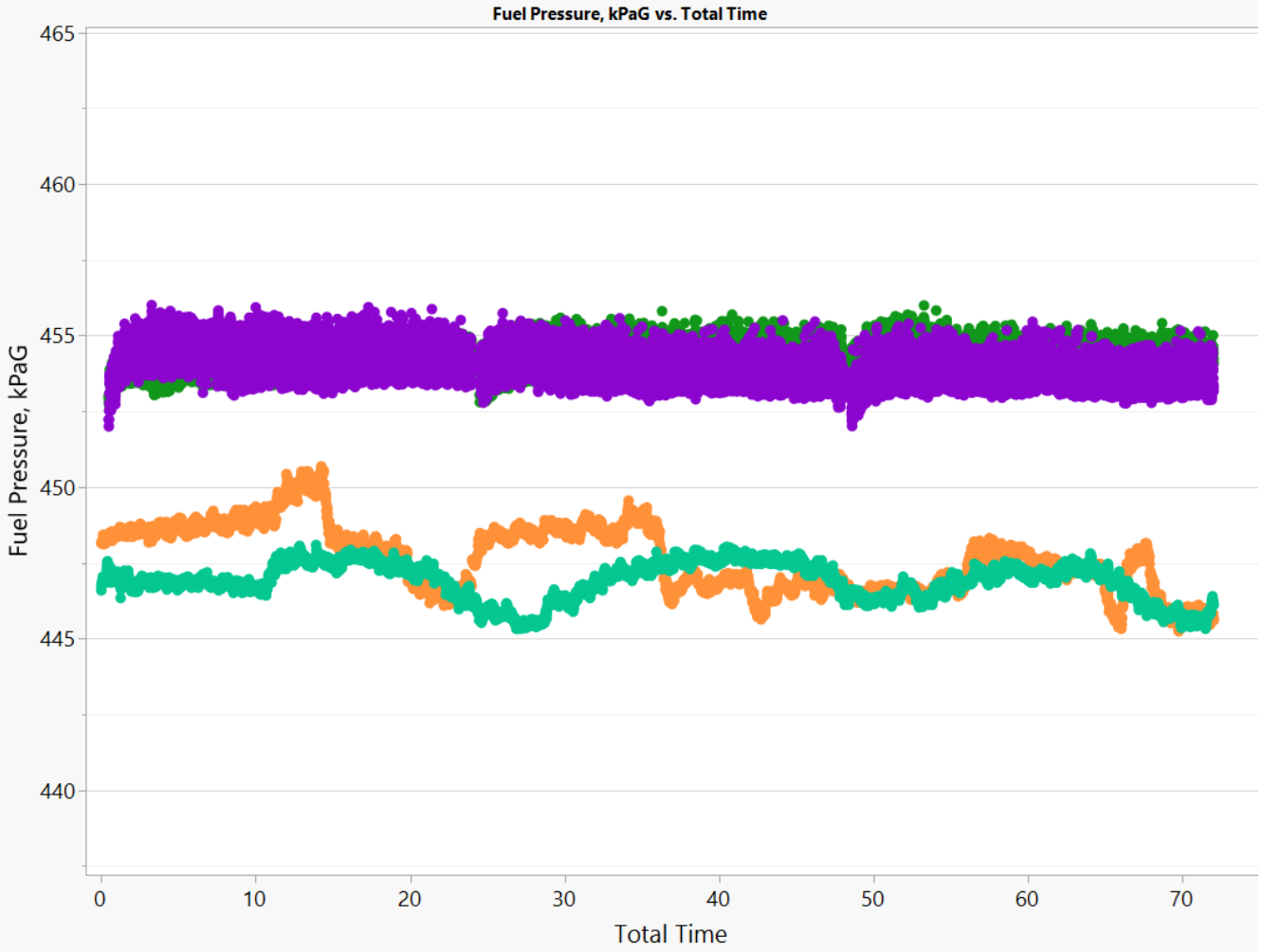


Crank Case Pressure

Fuel Pressure

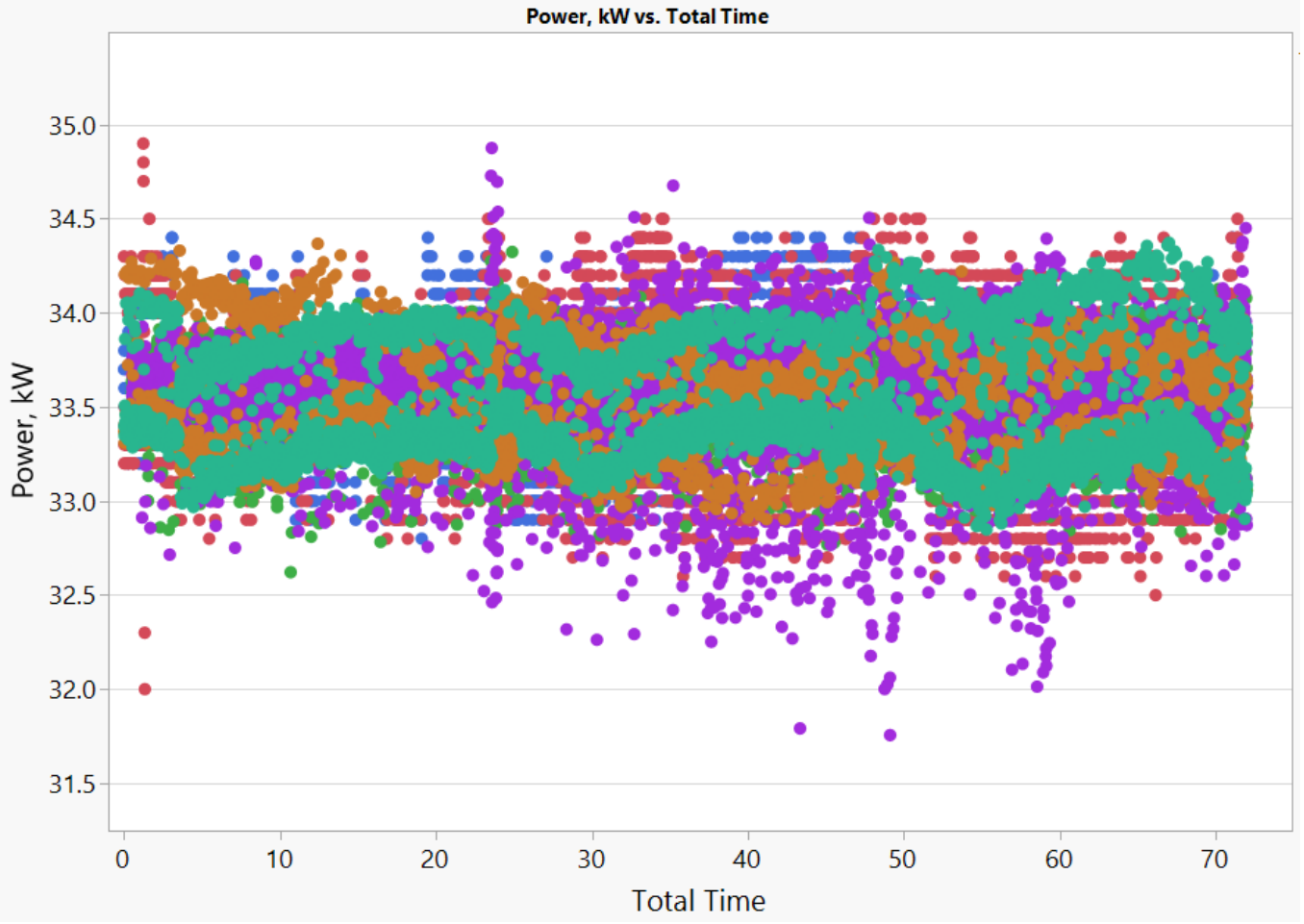
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

*Lab A faulty transducer

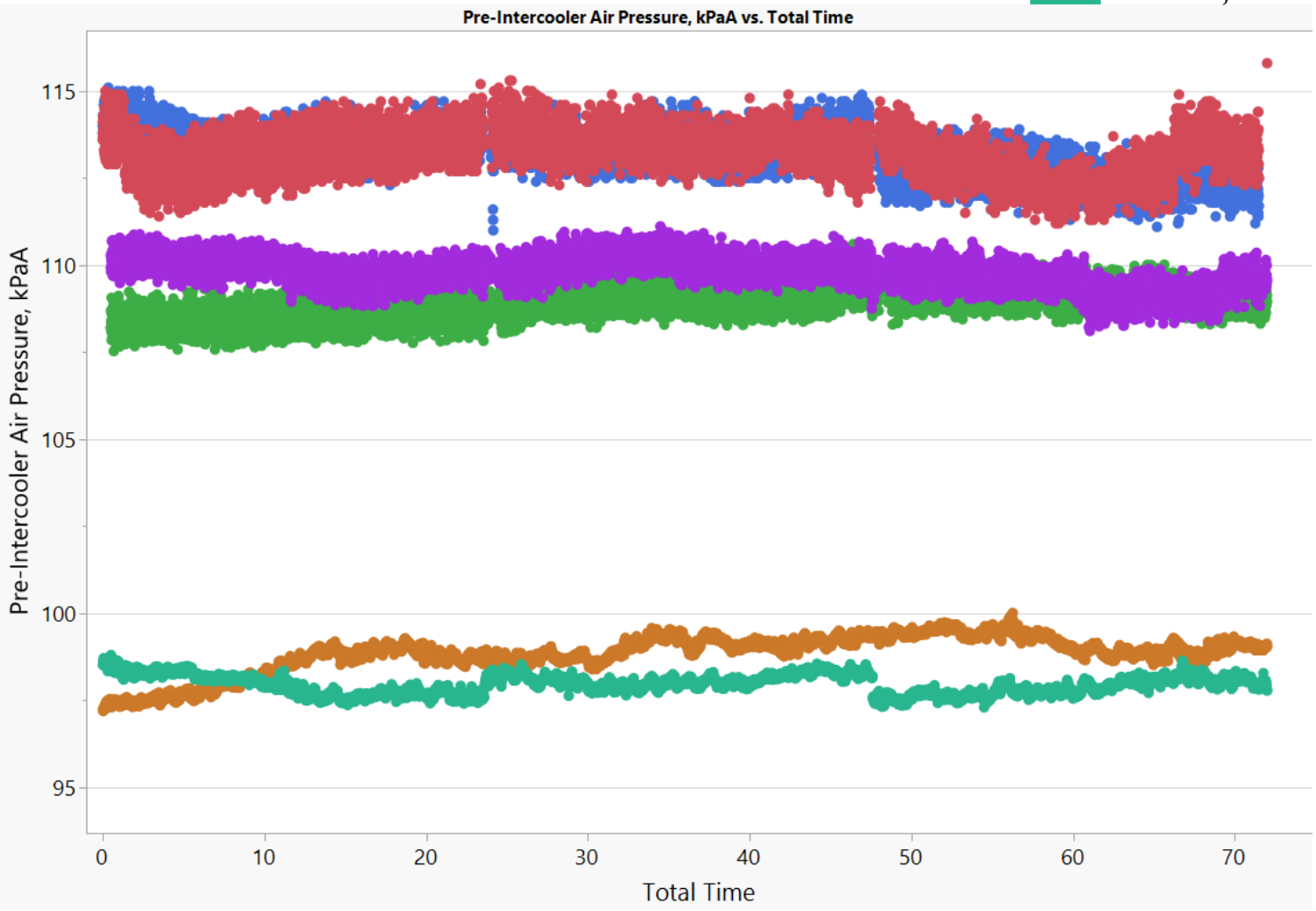


Power

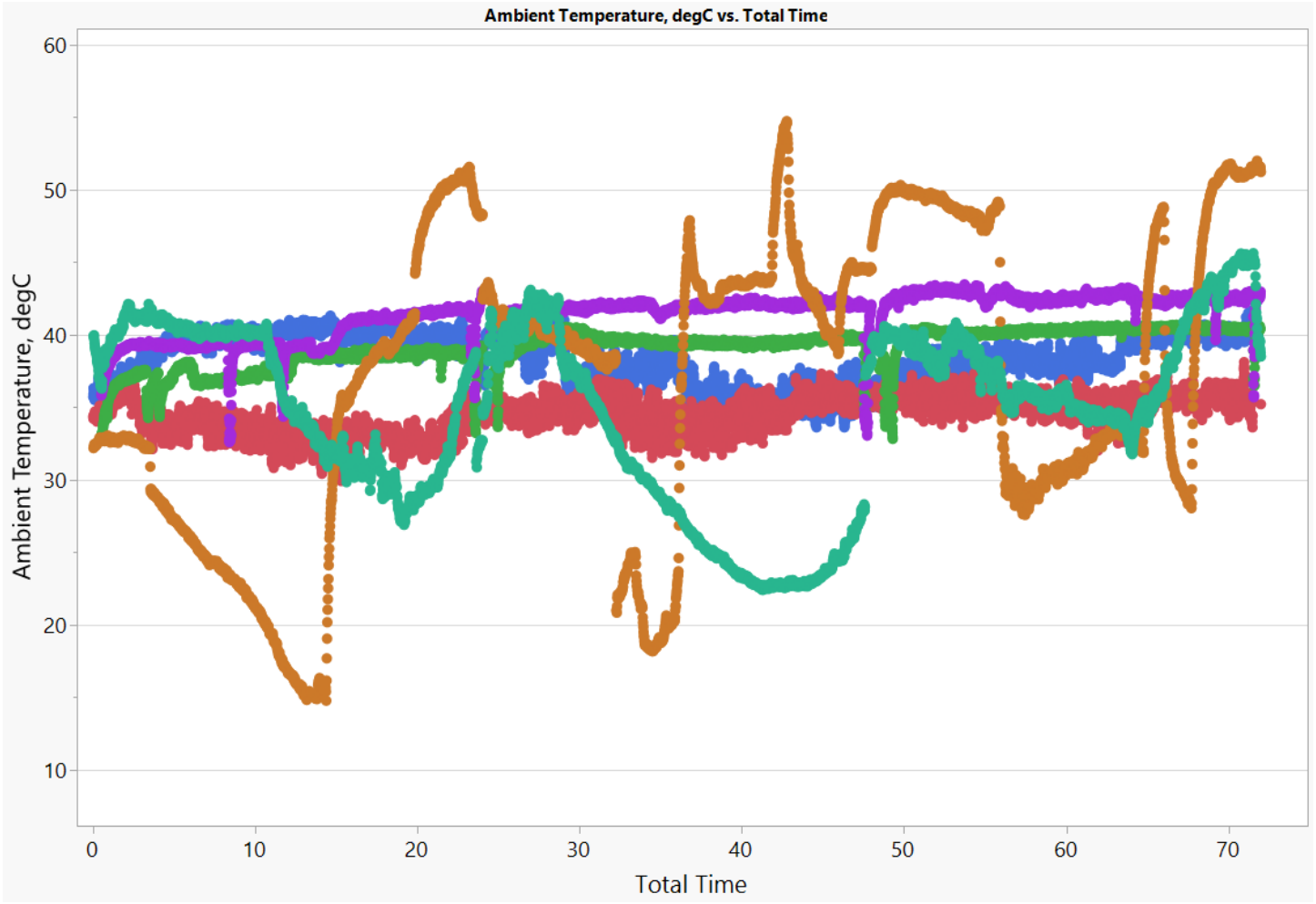
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



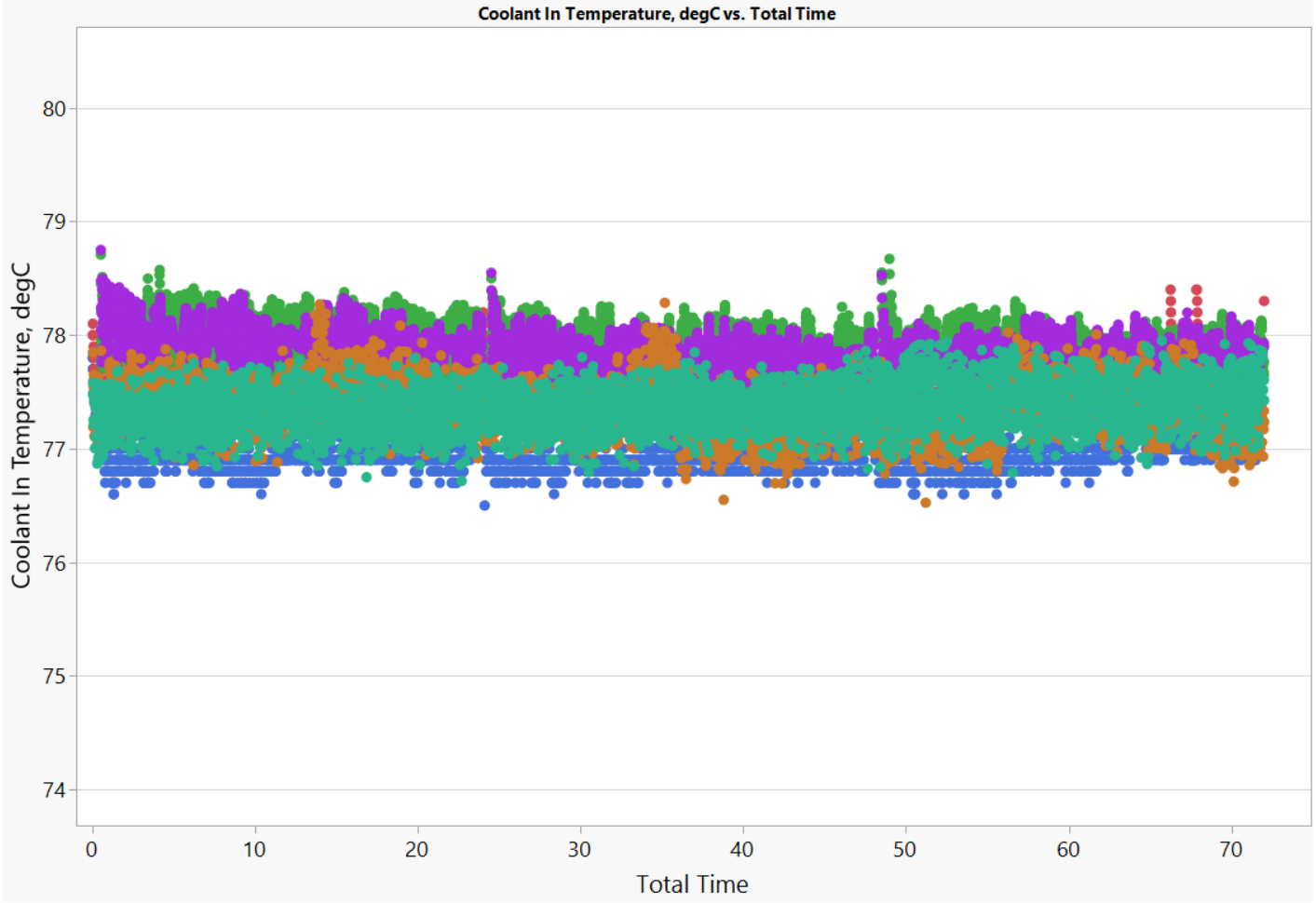
Pre-Intercooler Air Pressure



Ambient Temp.



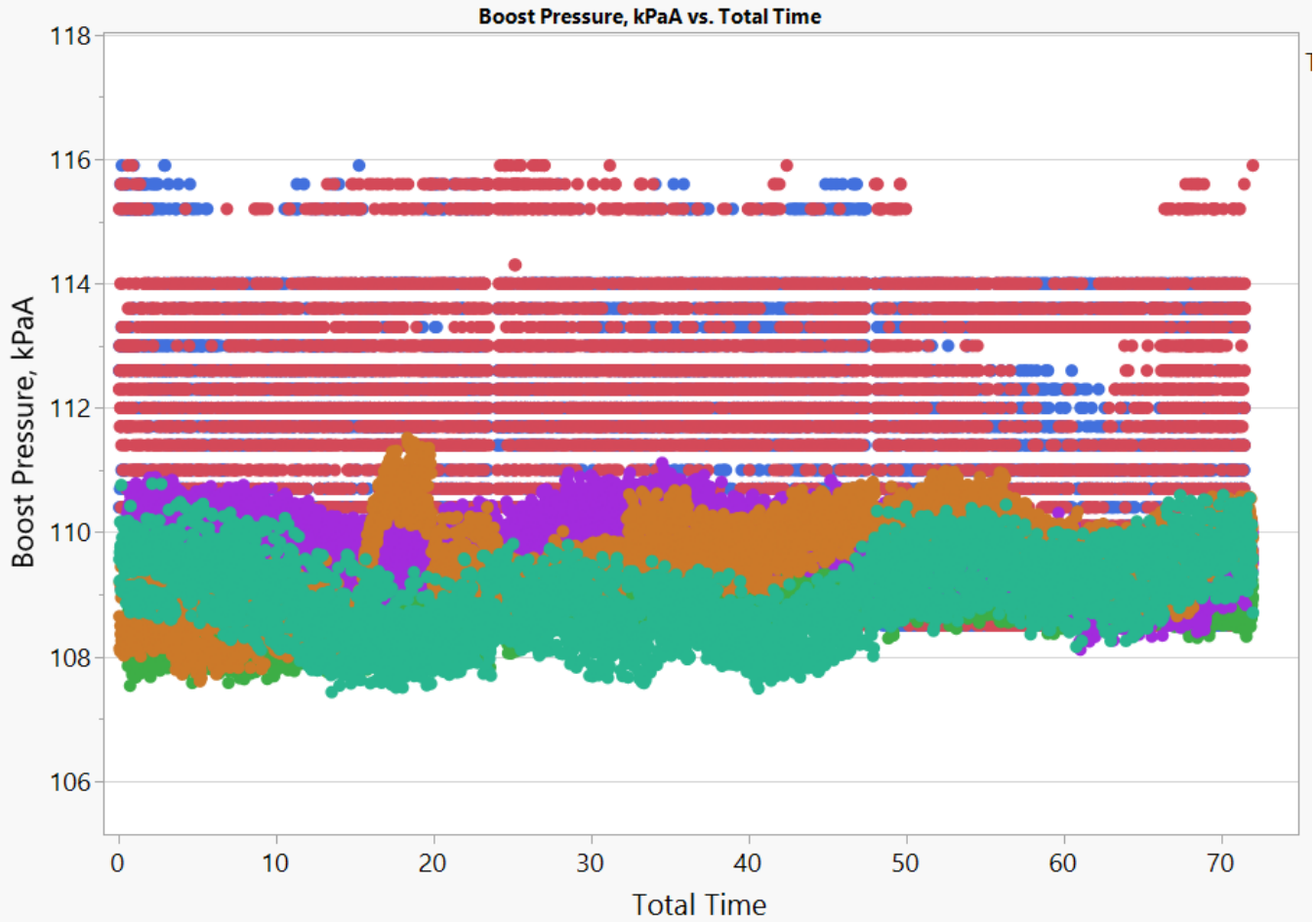
Coolant In Temp



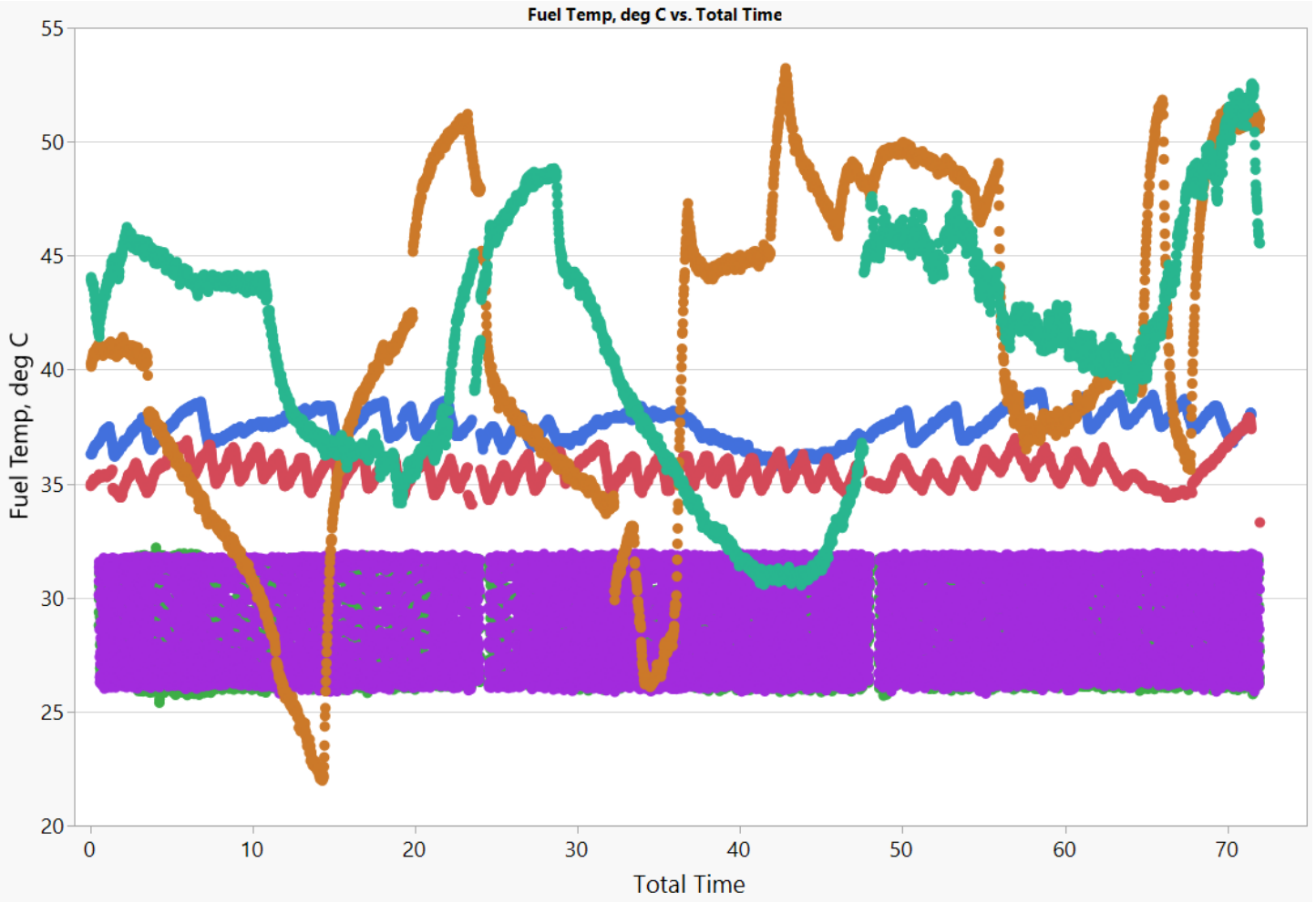
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

Boost Pressure

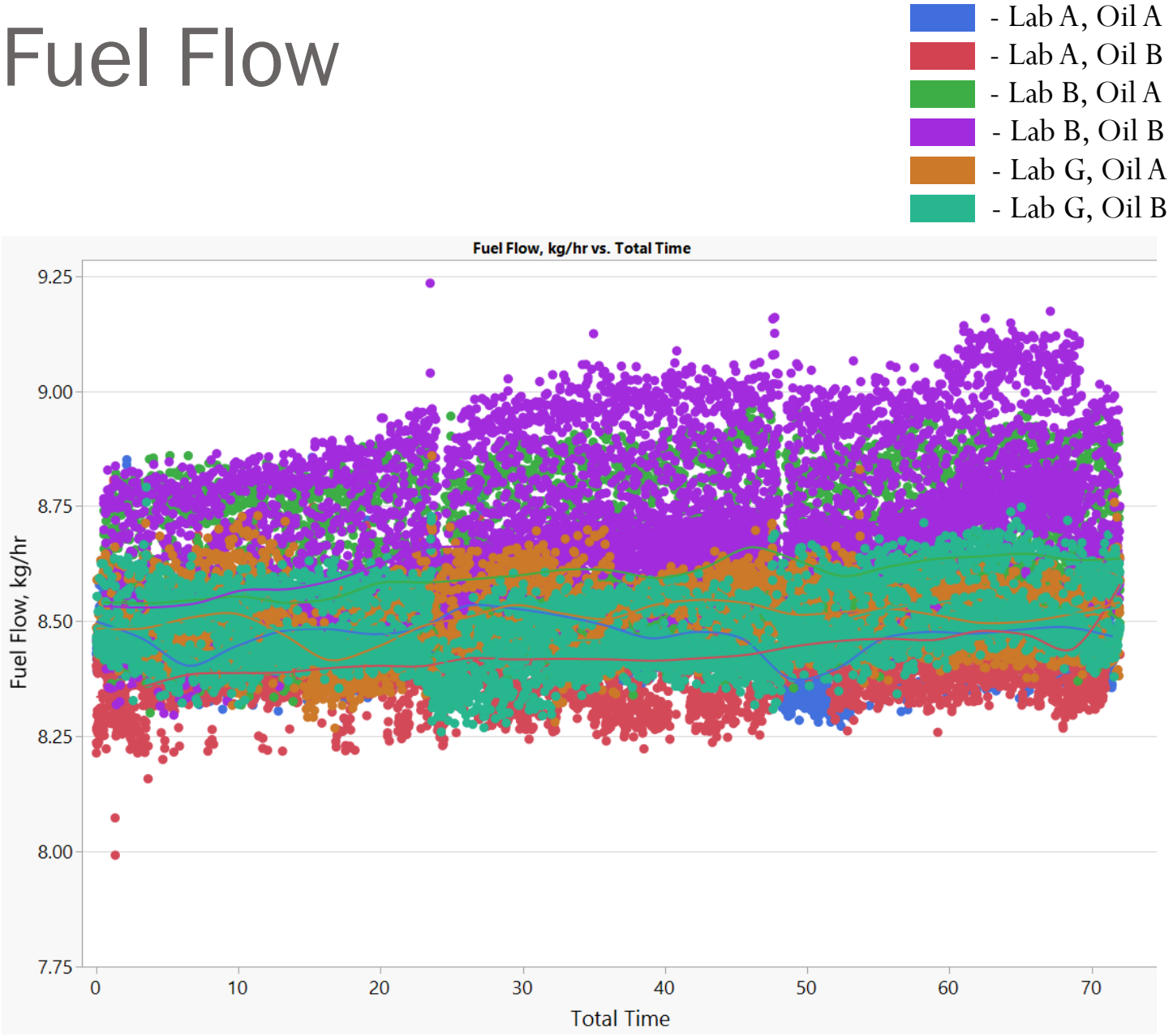
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



Fuel Temp

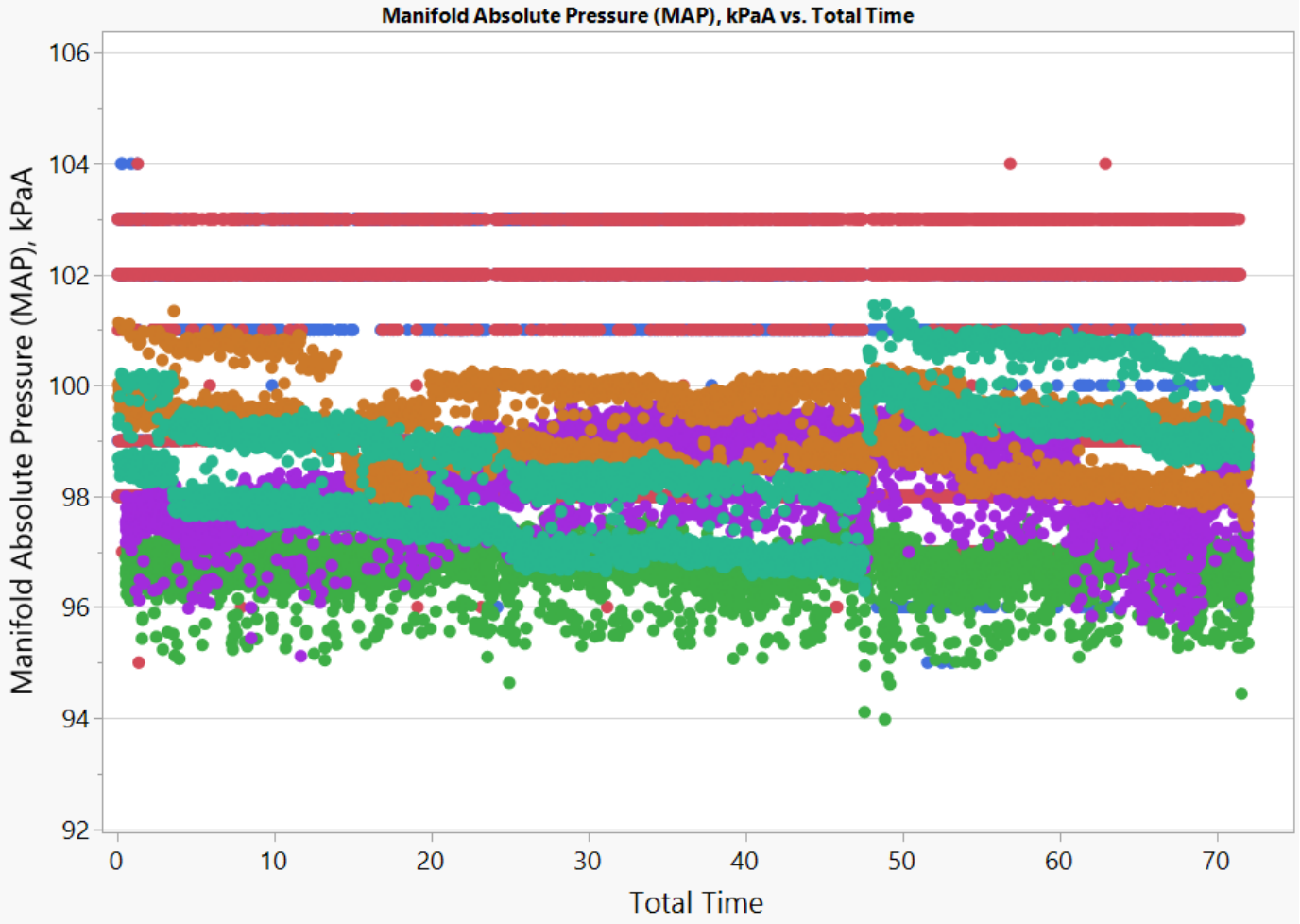

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B
Fuel Temp, deg C vs. Total Time
Fuel Temp, deg C
55
50
45
40
35
30
25
20
0
10
20
30
40
50
60
70
Total Time

Fuel Flow


- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B
Fuel Flow, kg/hr vs. Total Time
Fuel Flow, kg/hr
9.25
9.00
8.75
8.50
8.25
8.00
7.75
0
10
20
30
40
50
60
70
Total Time

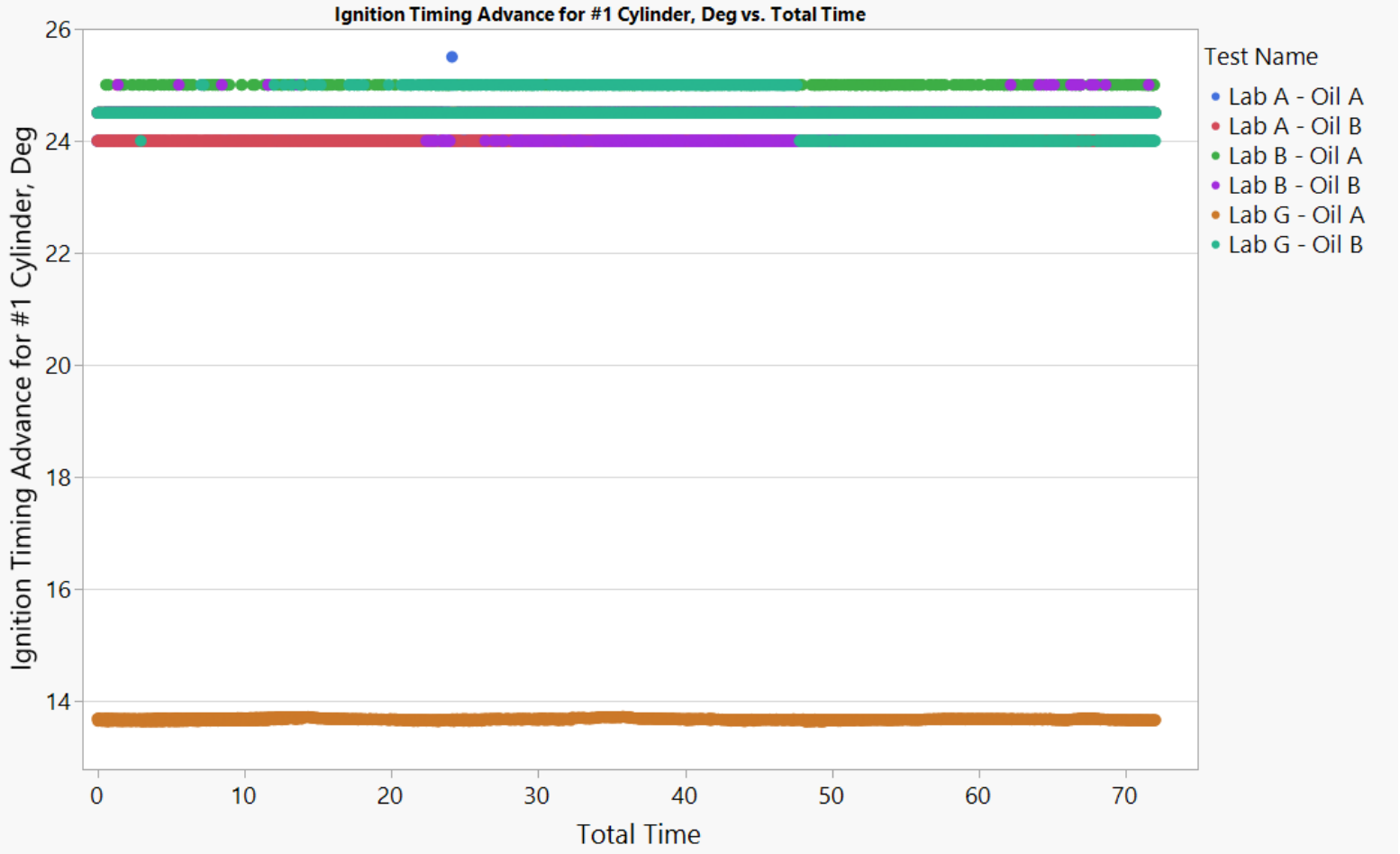
MAP

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

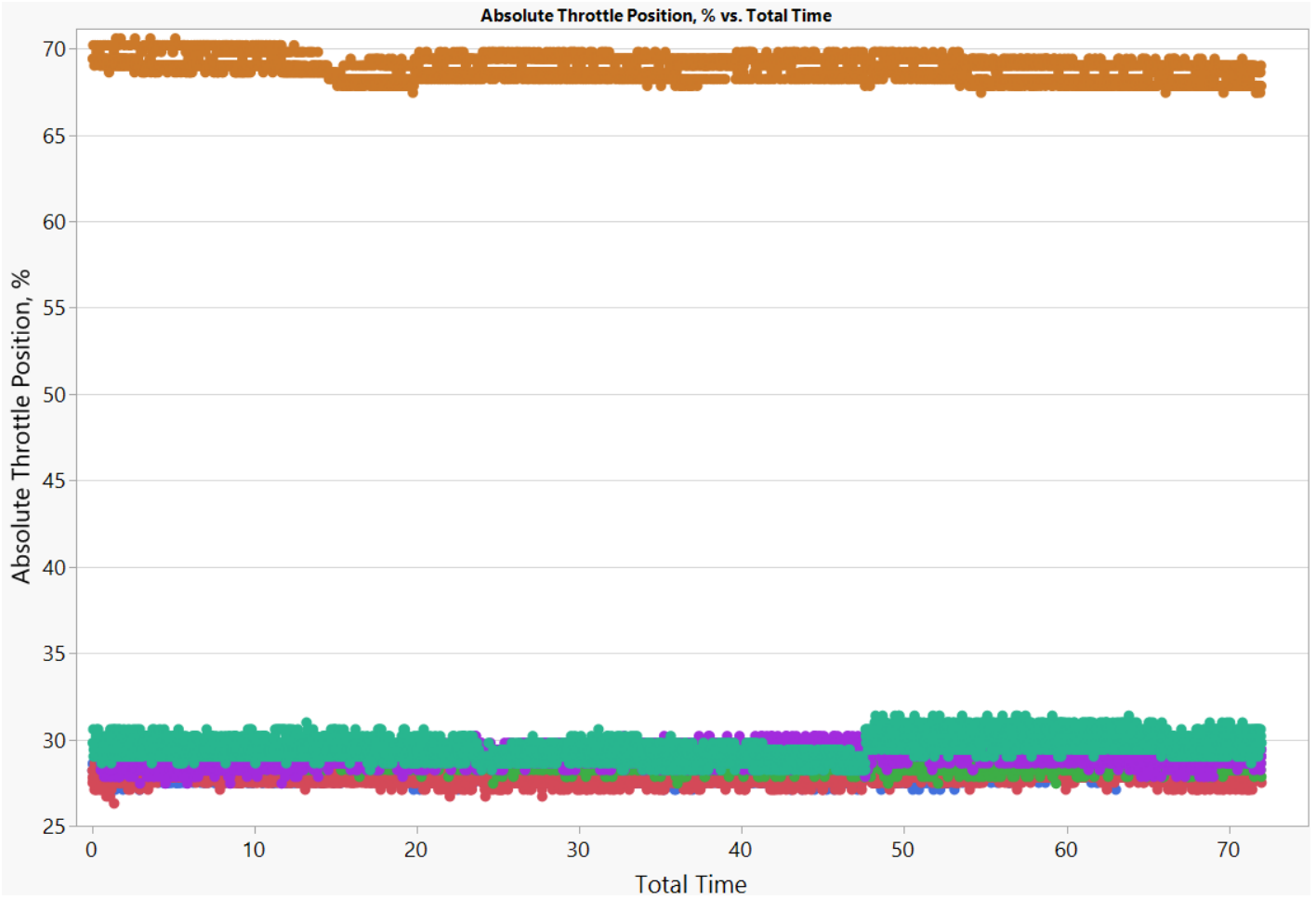


Ignition Timing Advance Cyl.#1

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

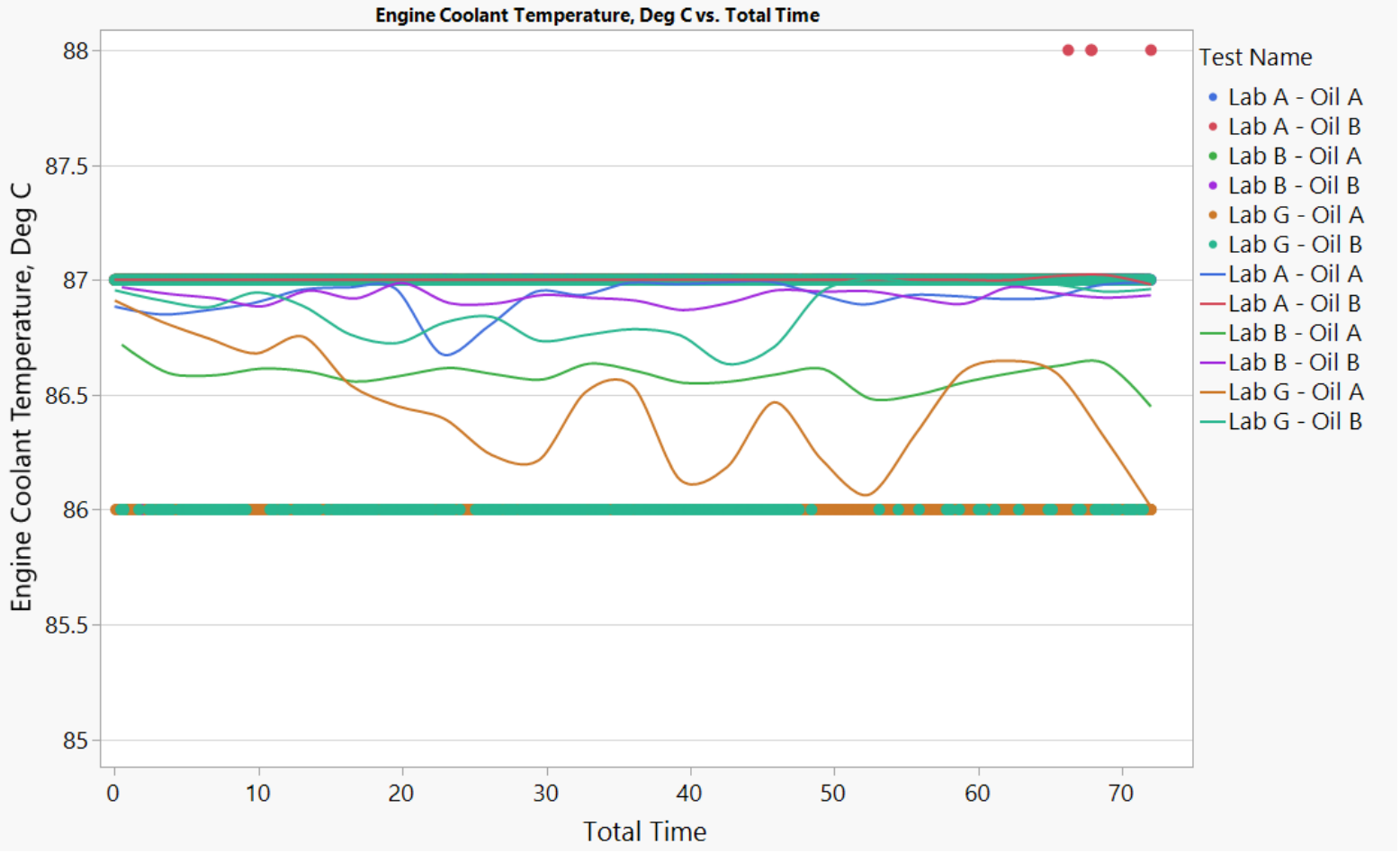


Absolute Throttle Position



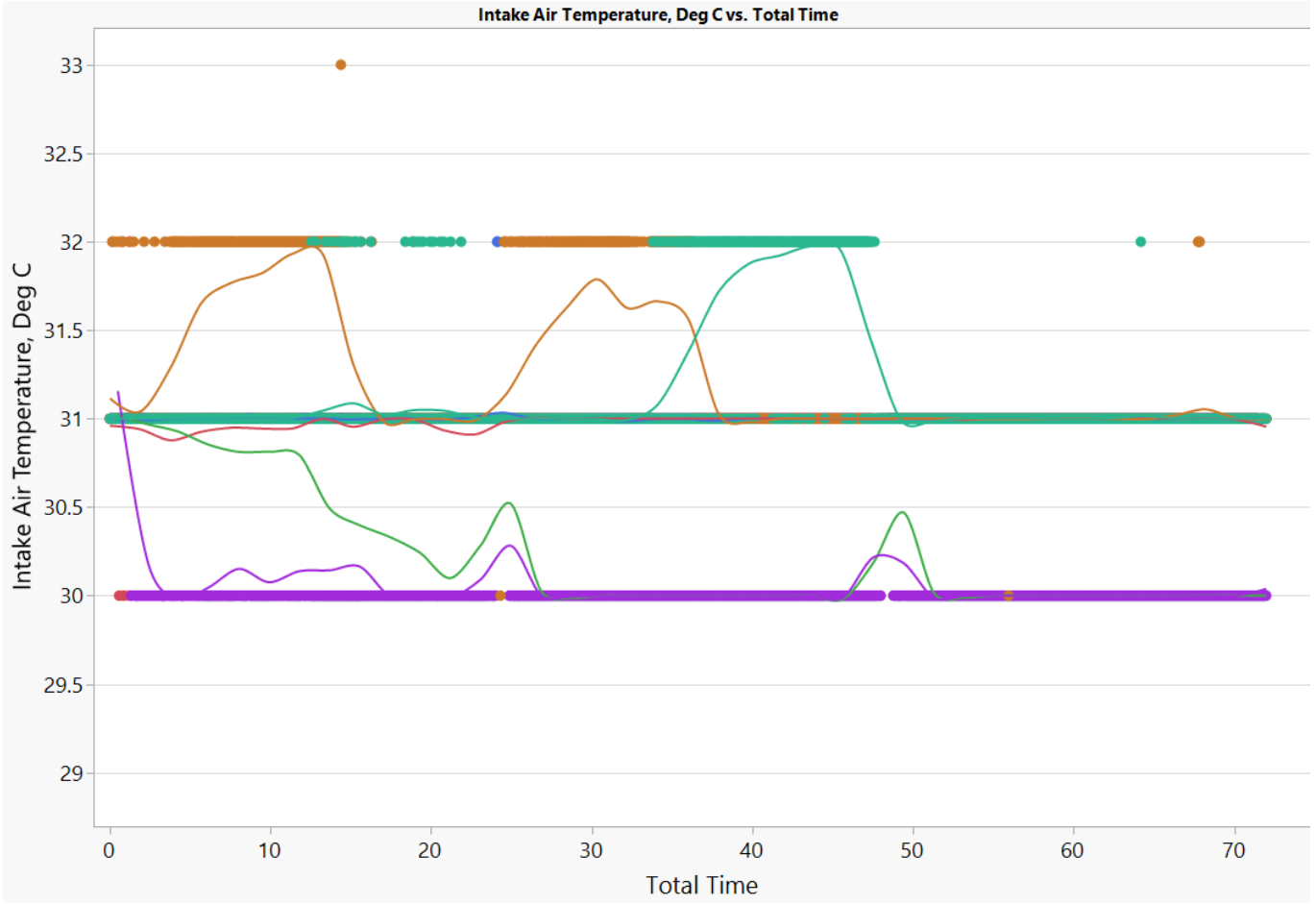
Engine Coolant Temp

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

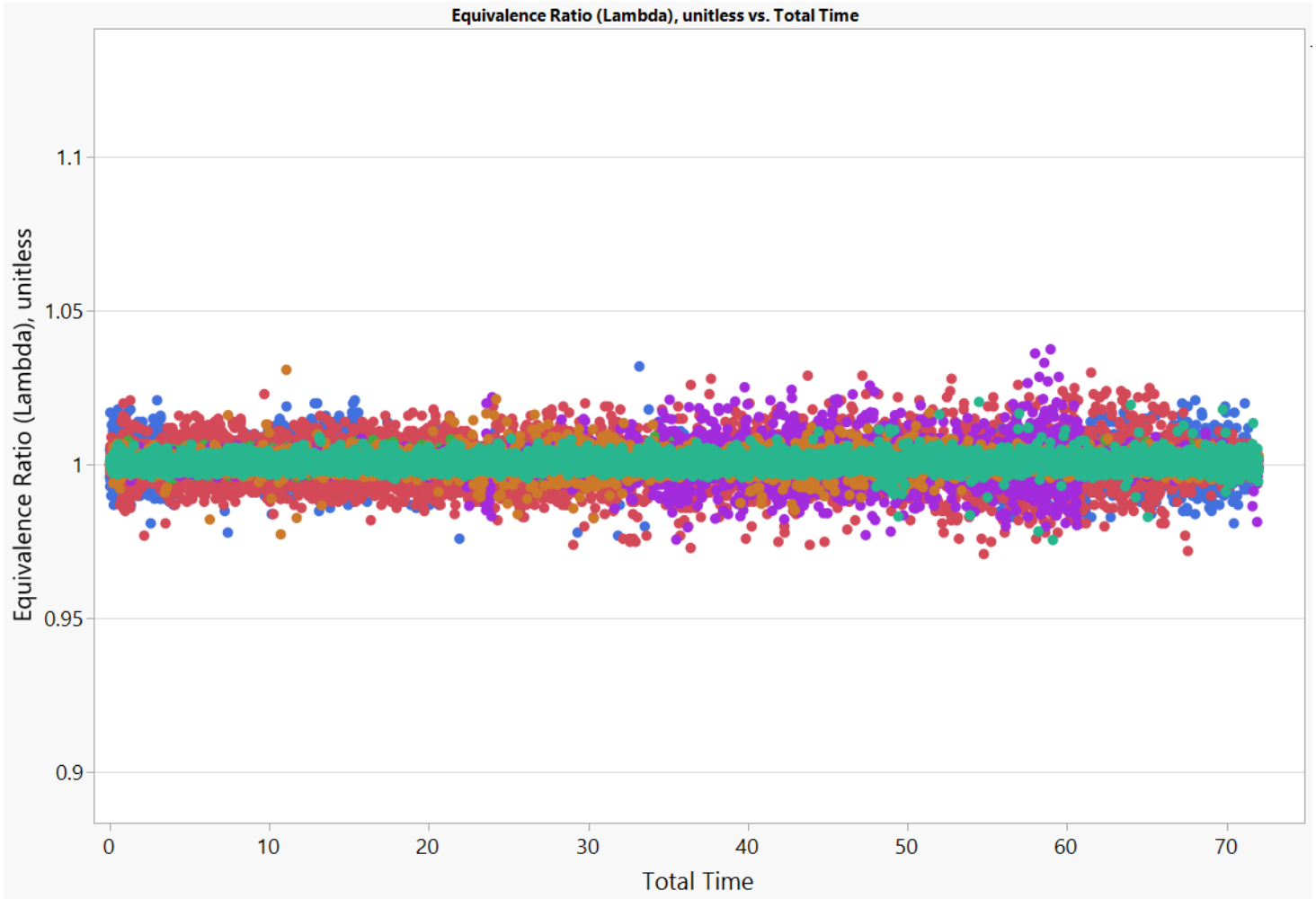


Intake Air Temp

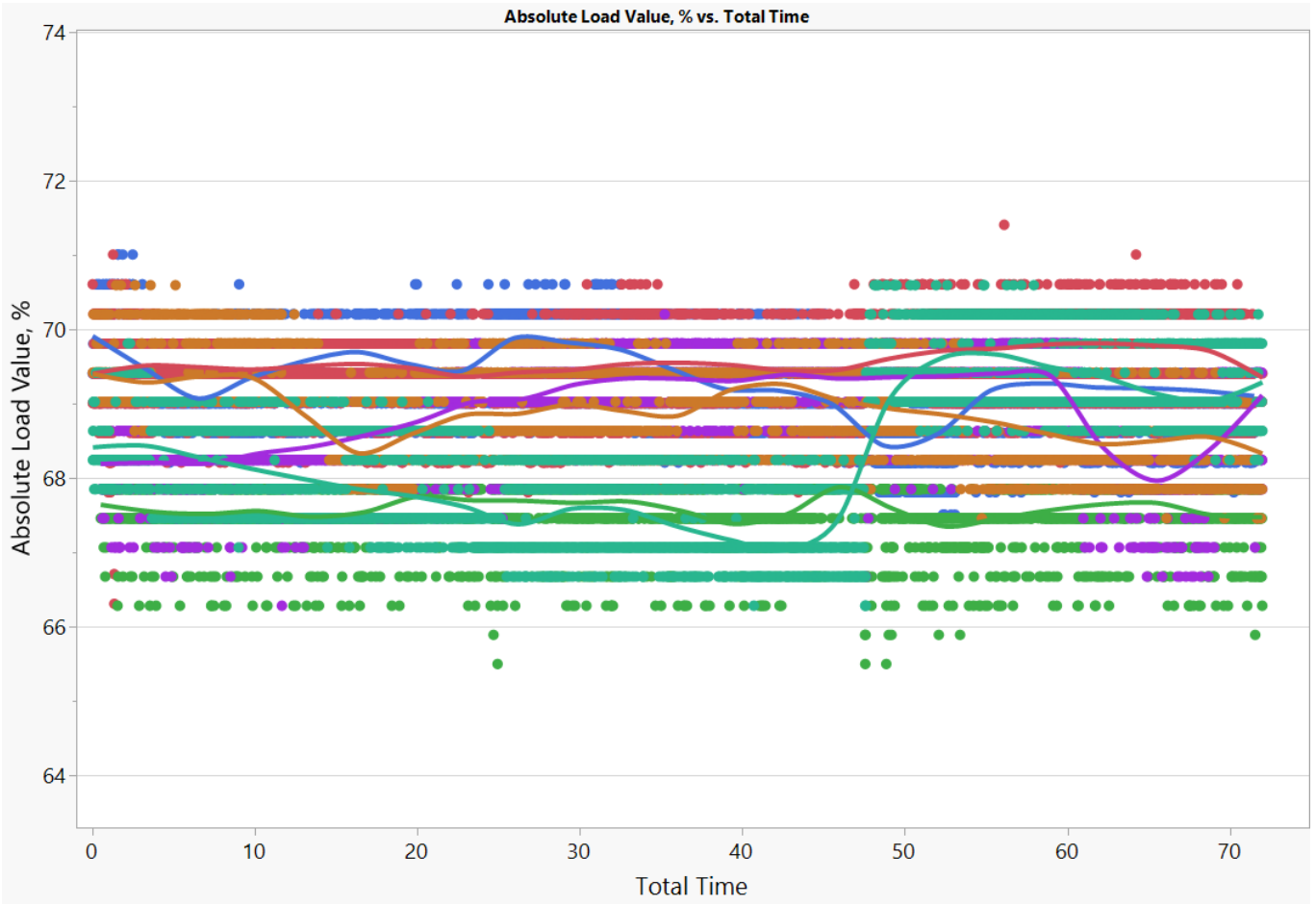
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



Equivalence Ratio (Lambda)

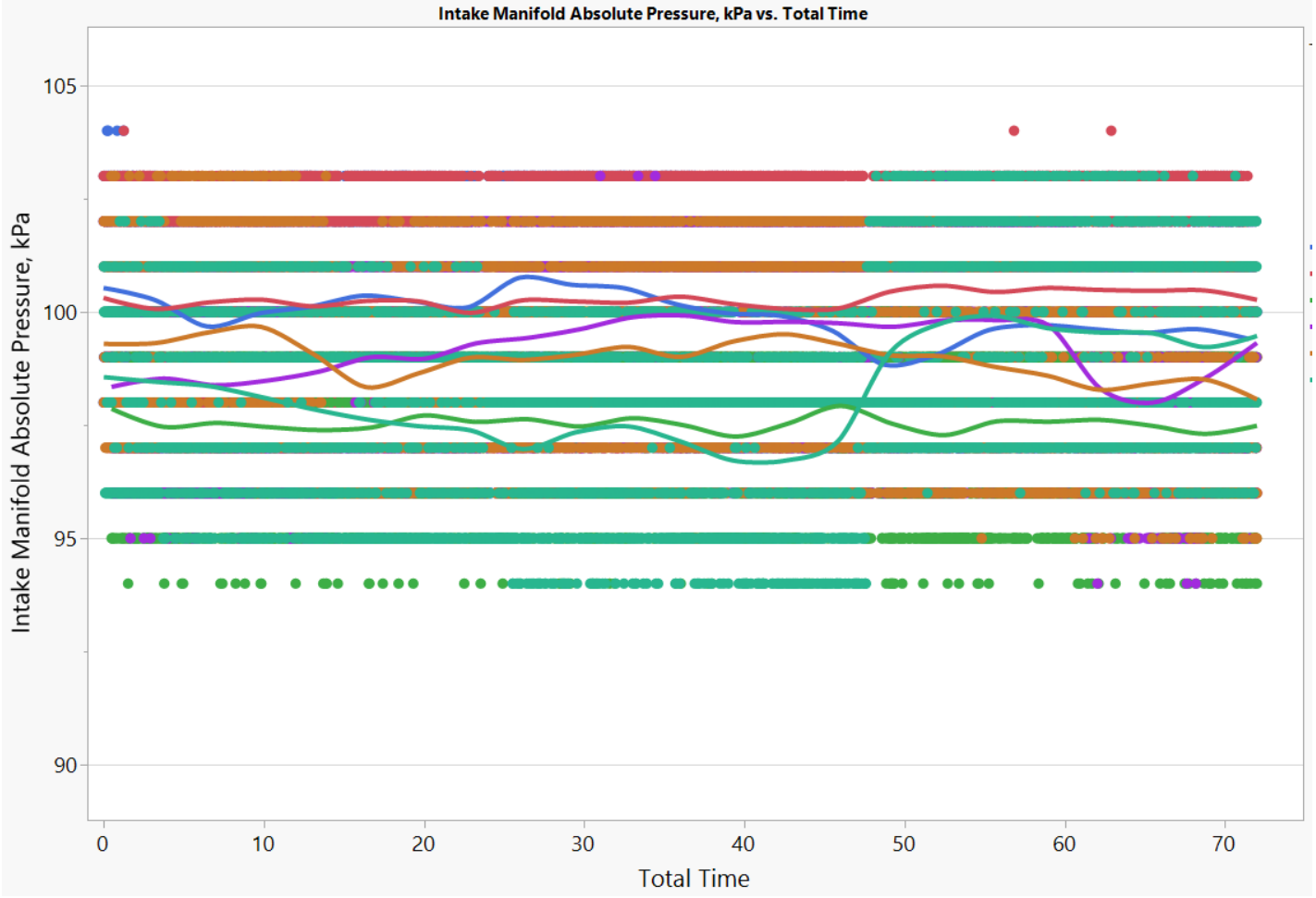


Absolute Load



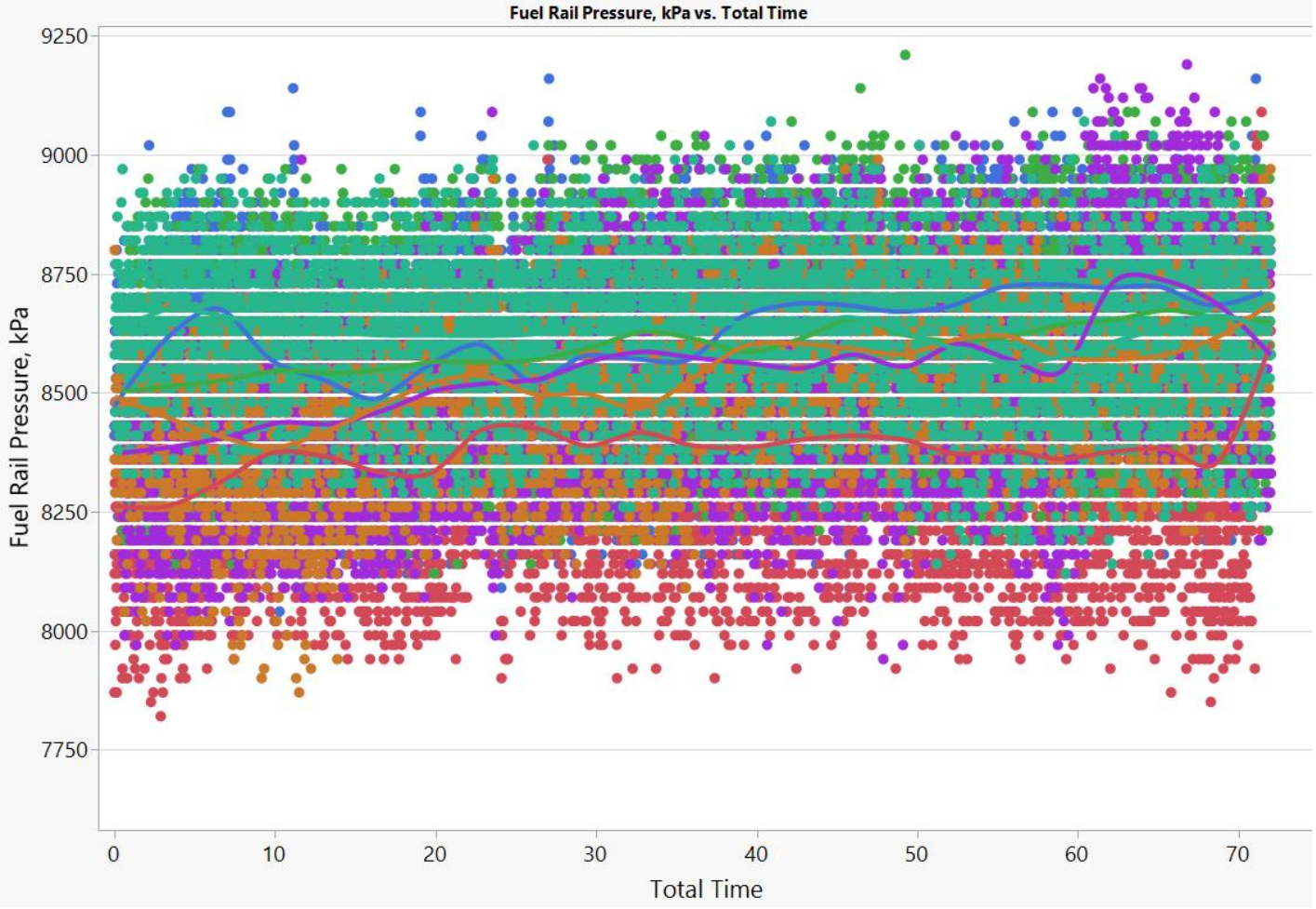
Intake Manifold Absolute Pressure

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

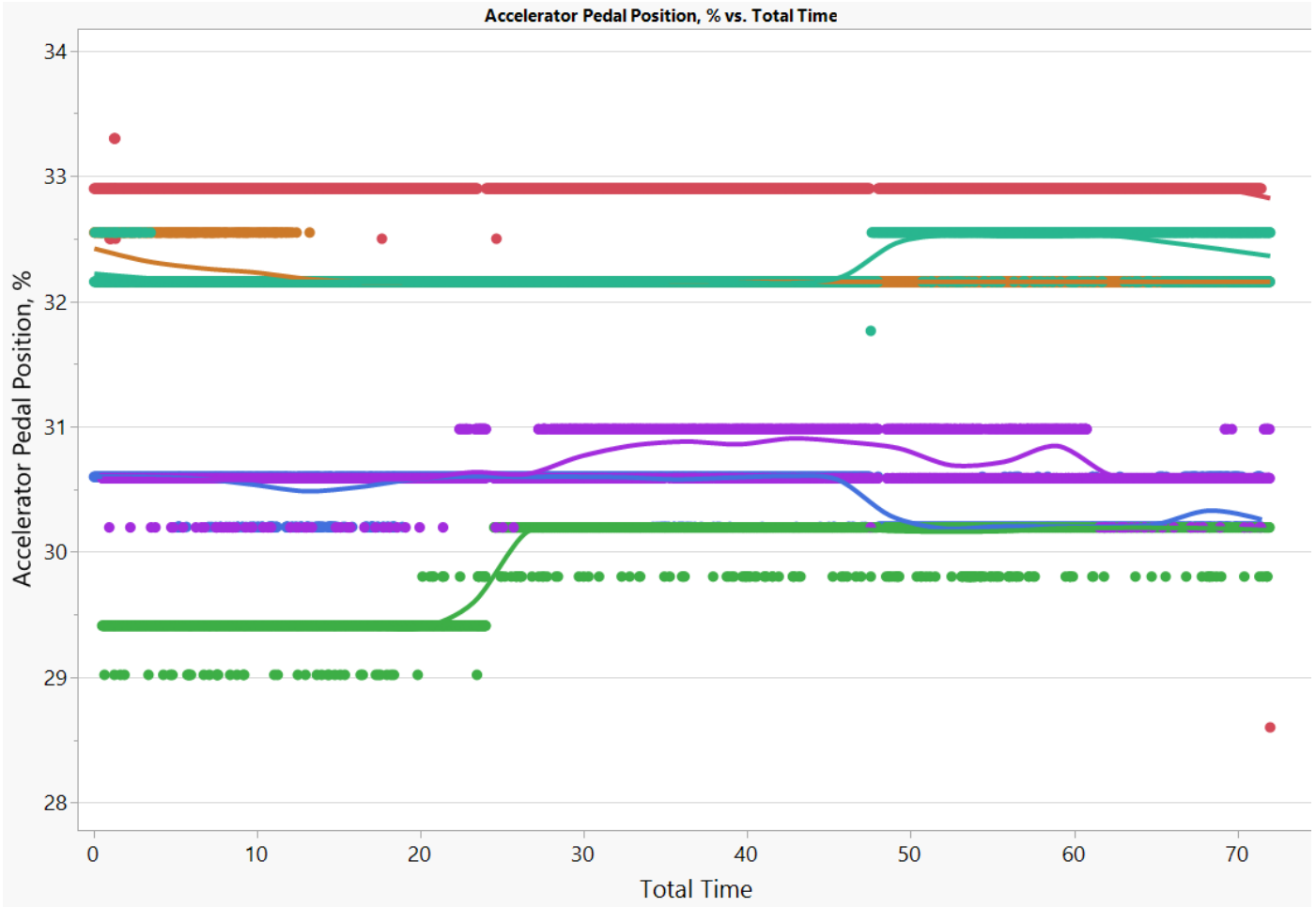


Fuel Rail Pressure

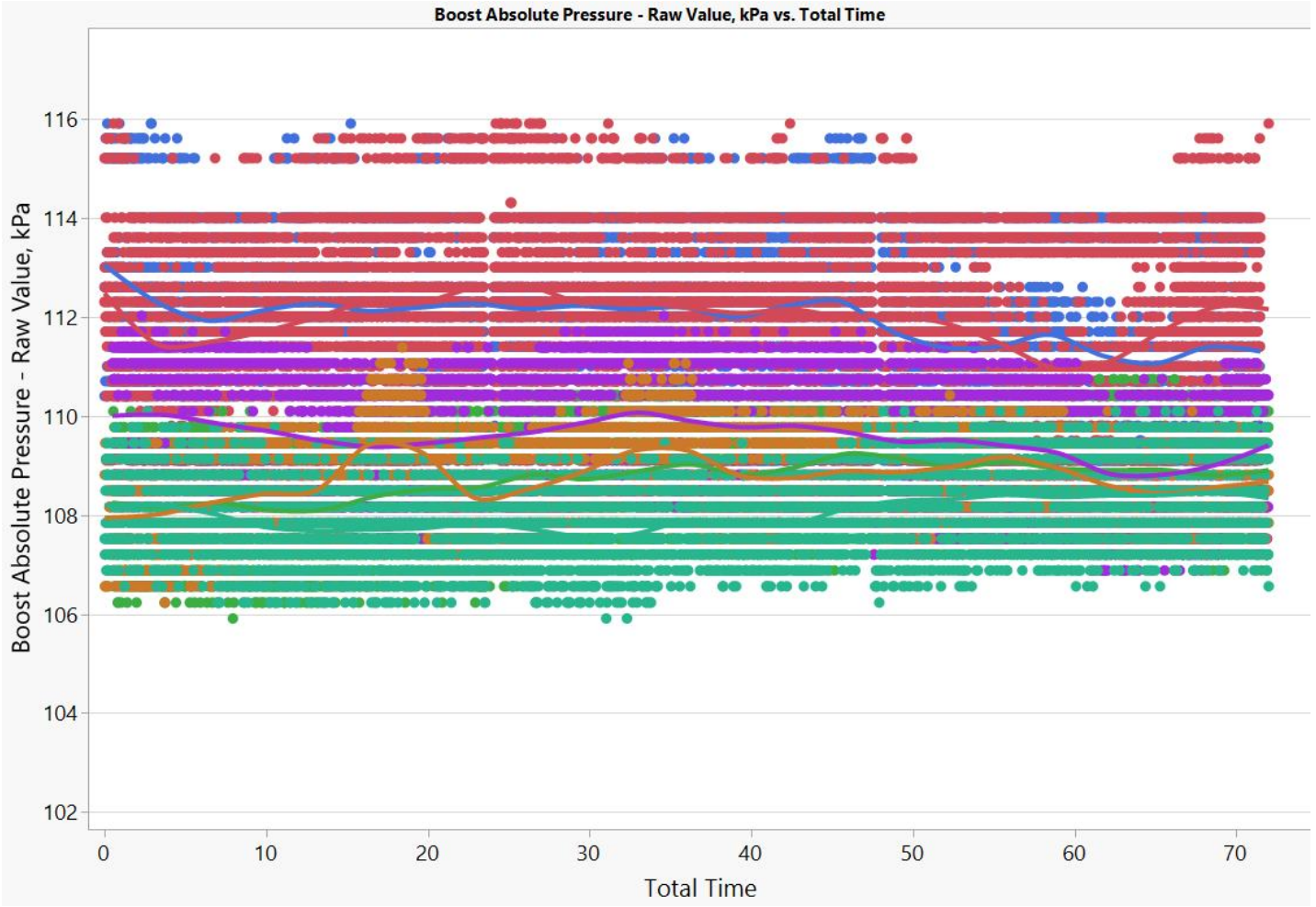
- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



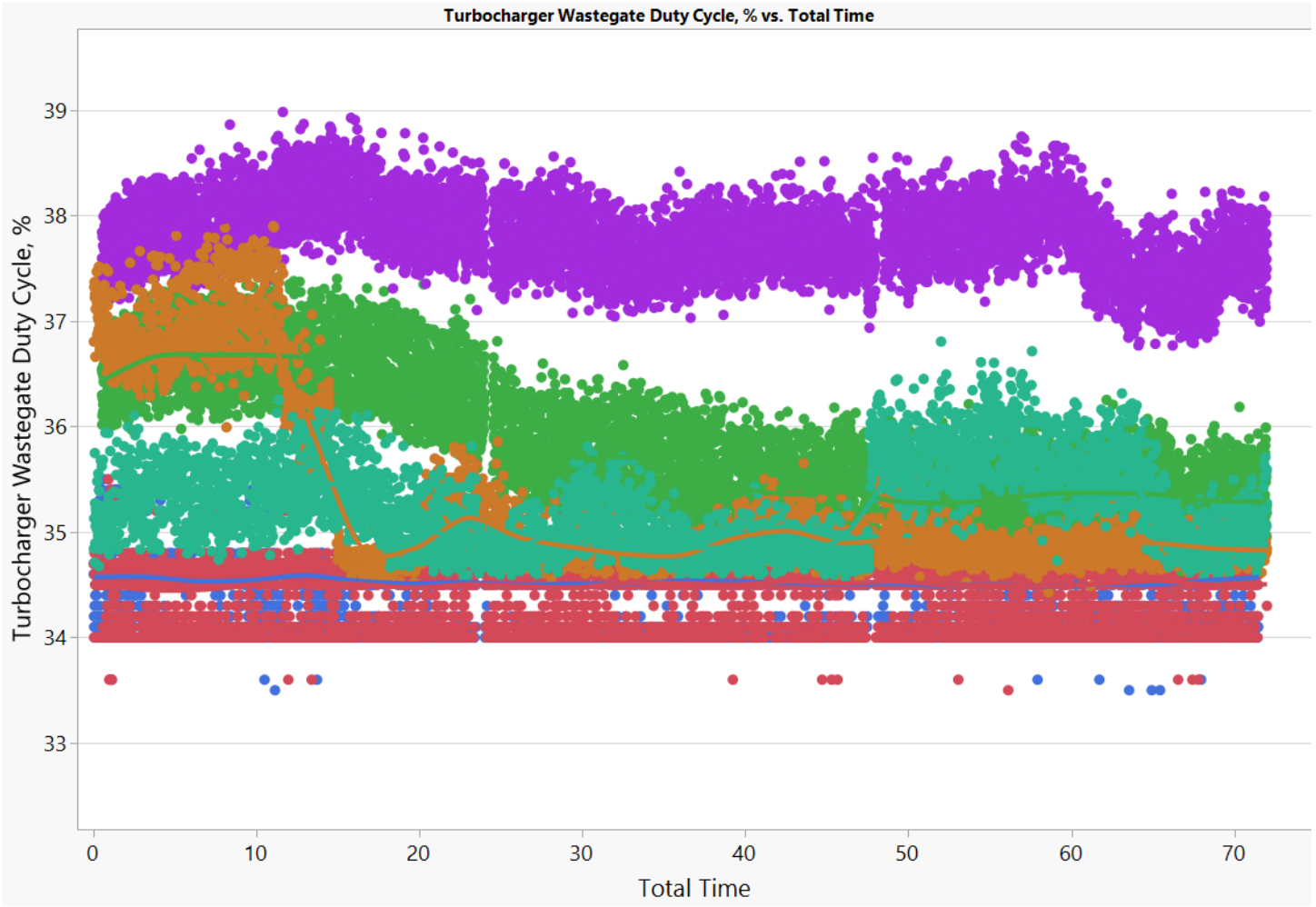
Accelerator Pedal Position



Boost Absolute Pressure – Raw Value

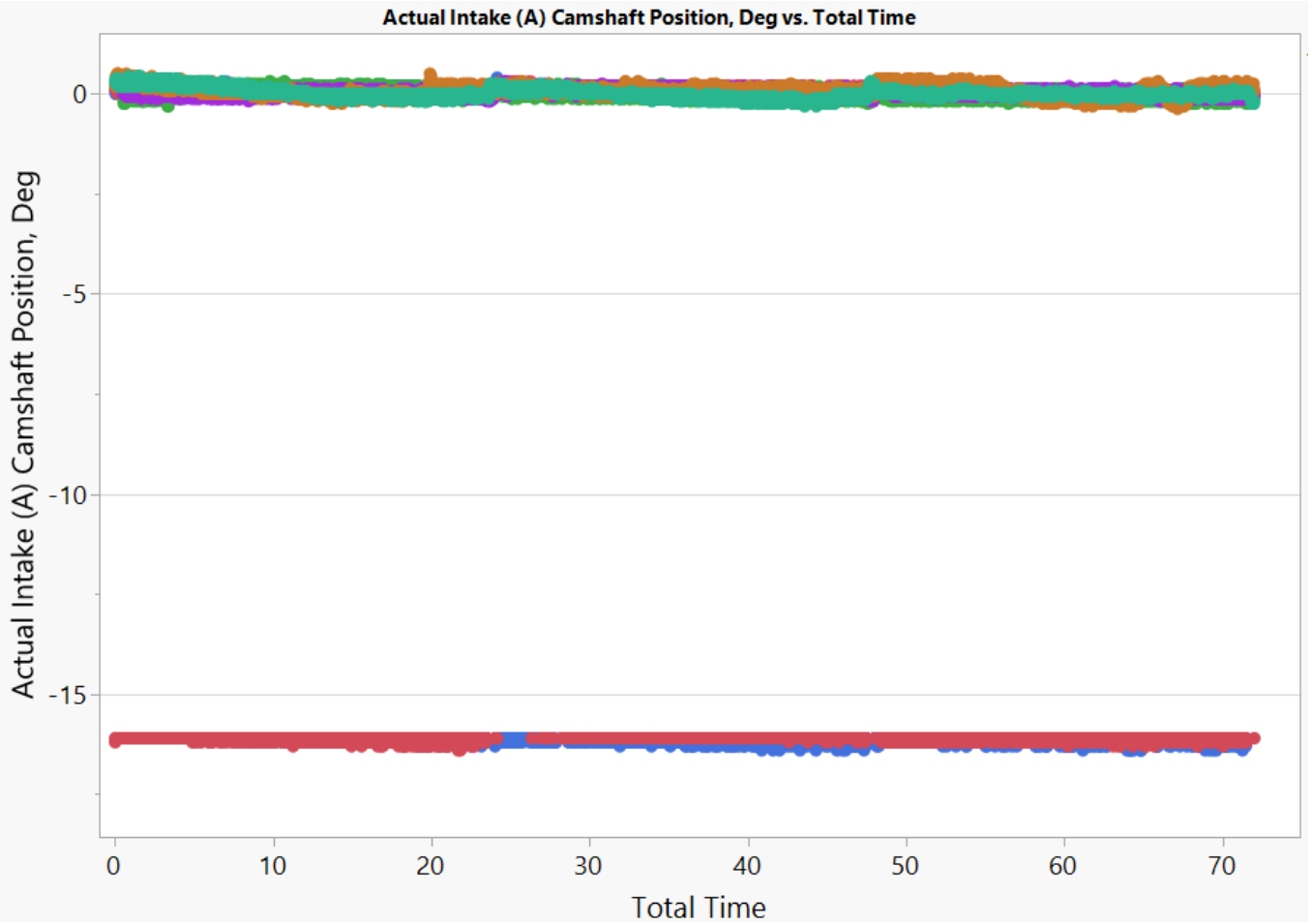


Turbocharger Wastegate Duty Cycle



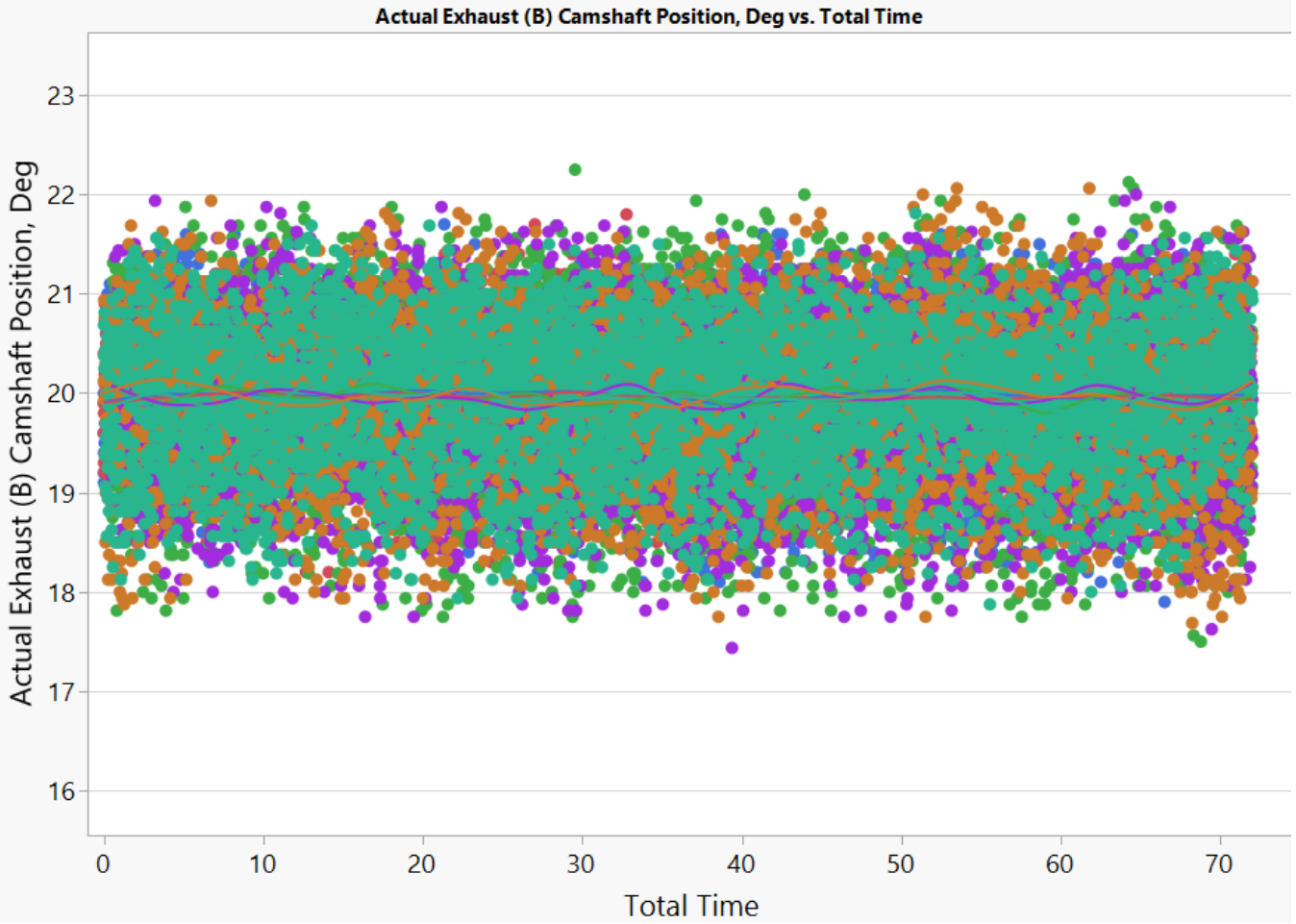
Actual Intake Camshaft Position

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B

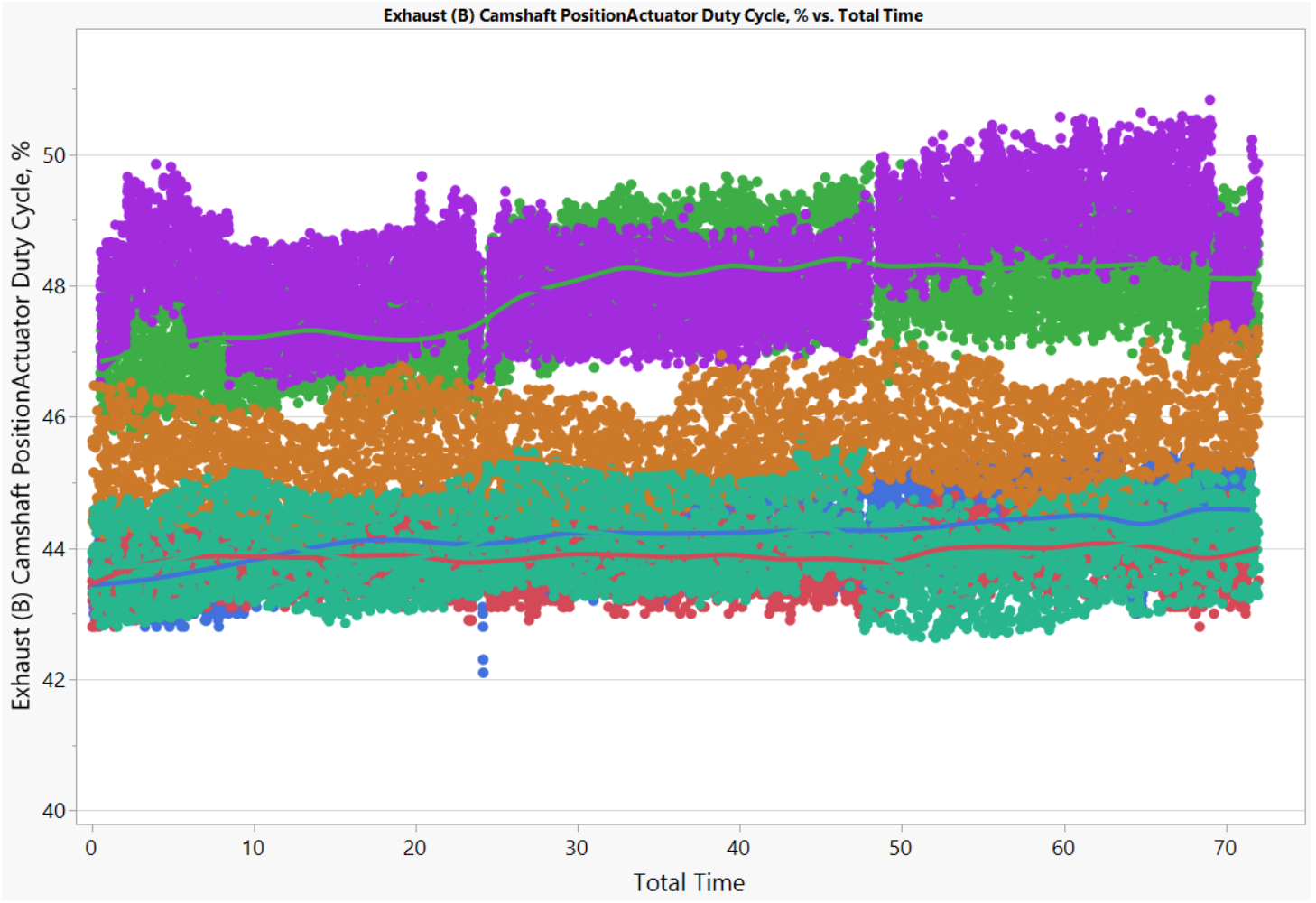


Actual Exhaust Camshaft Position

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B



Exhaust Camshaft Position Actuator Duty Cycle



Charge Air Cooler Temp

- Lab A, Oil A
- Lab A, Oil B
- Lab B, Oil A
- Lab B, Oil B
- Lab G, Oil A
- Lab G, Oil B