

Alternatively Sourced T-13 Mahle Piston Rings

SOUTHWEST RESEARCH INSTITUTE®



Mahle Rings Background

- SwRI direct sourced rings from Mahle via online distributor (Jegs.com)
- Packaging states made in Brazil
- Seem readily available.
 - 60 ring kits delivered 2 days after ordering.
 - Have not inquired about supply chain volume
- Pistons do not seem to be available direct (only older DI3/MP8 piston without valve reliefs)



OE# 20 747 511/21 253 763

Assembly 21253763

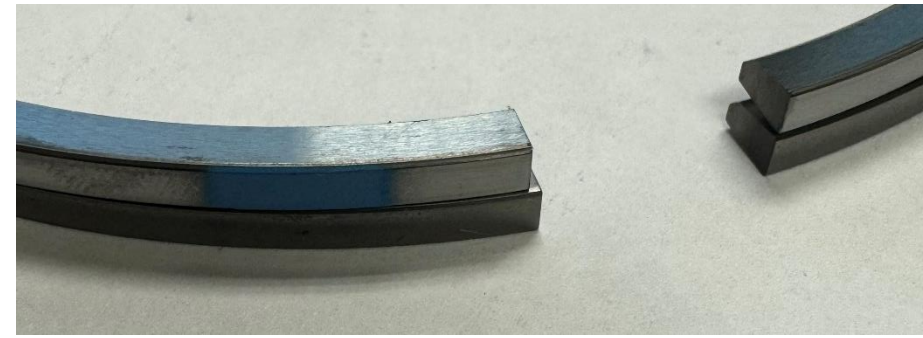
Part No.
21251596
20590309
20568155

Top Ring	21251596 P03
Second Ring	20590309 P32
Oil Ring	20568155 P34

Physical Comparison

- Very similar to Volvo dealership sourced rings.
- Do not have paint marks from Volvo QC processes
- Similar ID numbering (1100k+ series), however etchings are flipped 180 degrees

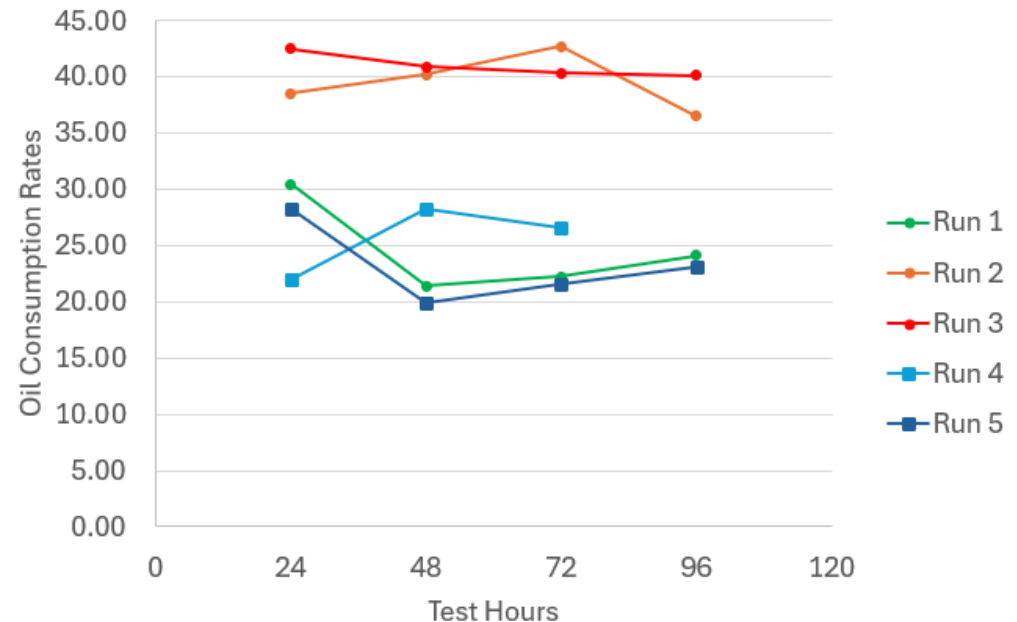
(Top ring shown, but similar formatting on second/oil rings)



OC Performance

- Shakedown testing with T-13 operating conditions on same oil (5W-30)
 - Conducted as resources were available over the last 18 months. Did not run consecutively. Different engine blocks/heads as available. All ran in the same test stand.
 - Each run was conducted with new power cylinder parts (liners, piston, and rings) and ran standard break-in process
- Mahle direct sourced rings appear to produce normal OC rates (20-30 g/hr range) with newest 0423 pistons

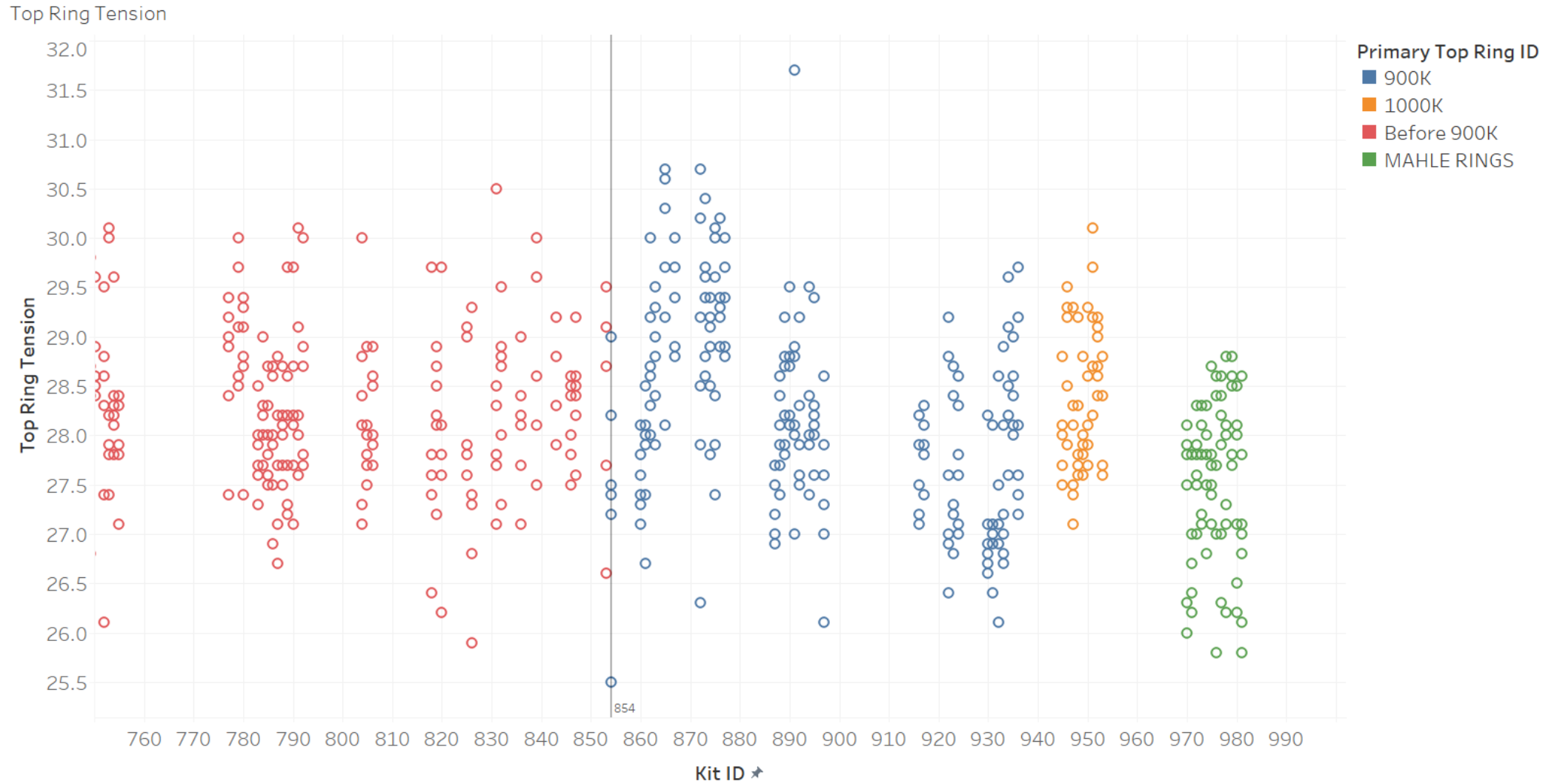
Run	Liner Batch	Top Rings	Pistons	Avg OC (g/hr)
1	A	Volvo/TEI (500k)	Pre-0619	24.5
2	D	Volvo/TEI (900/934k)	0522	39.5
3	D	Volvo/TEI (939/959/967k)	0822/0922	41.0
4	D	Mahle (1189k)	0423	25.6
5	D	Mahle (1189k)	0423	23.2



Ring Comparison Summary

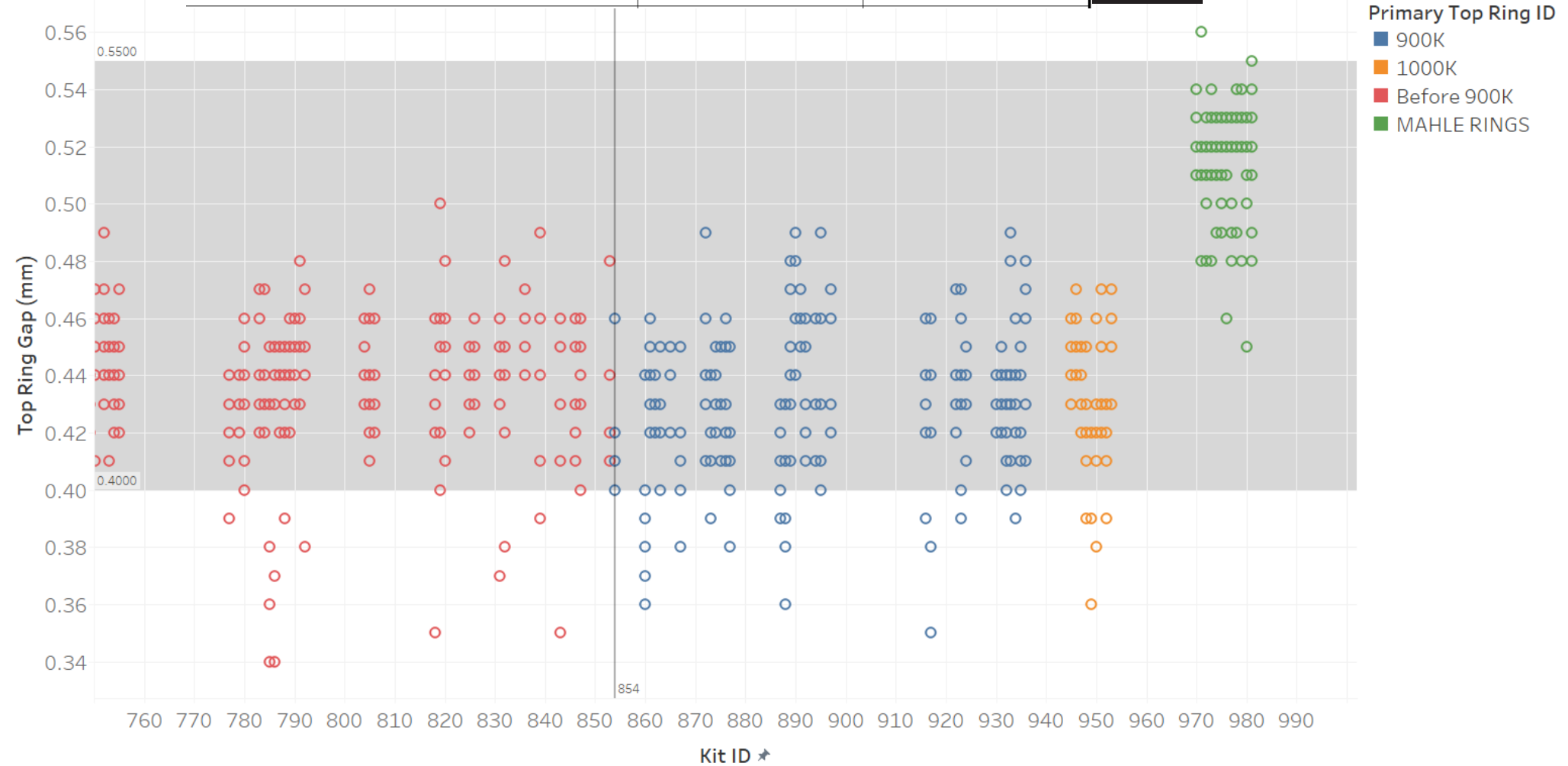
- Following slides are comparison of the standard TEI measurements between recent test kits and SwRI sourced Mahle rings (green data).
 - Kit data is color coded based on predominate top ring ID etching series (900k, 1000k, etc).
 - Kit 854 is highlighted as introduction of 900k series rings, which aligns with when SwRI observed upward step shift in OC rates in candidate testing.
 - With the introduction of the 900k and 1000k rings, top ring face width had a notable shift to lower end of historical range. Mahle sourced rings sit more on upper end of the range.
 - Mahle ring gaps are slightly larger, but fall (mostly) within bands of MP8 published service manual tolerances.
- SwRI conducted SEM analysis on cross section of Volvo and Mahle top ring. No significant differences found. Same coating technology.

TEI Ring Measurement Comparison



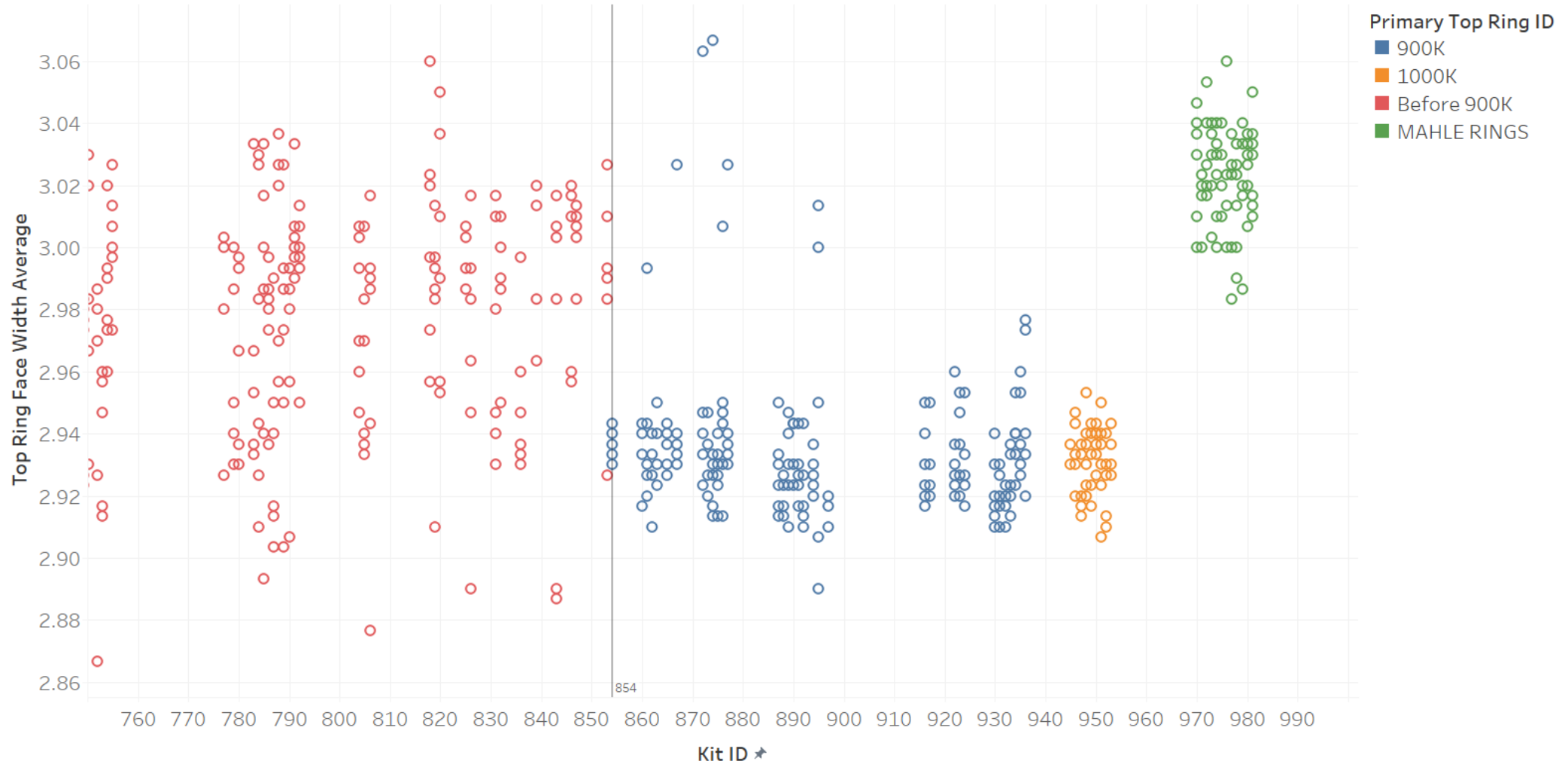
TEI Ring Measurement Comparison

PISTON RINGS			JULY 2009 (REVISED) 5-113	
Top Ring Gap	Compression Ring End Gap — Upper	0.40–0.55 mm		0.0157–0.0217 in.
	Compression Ring End Gap — Upper: Wear Tolerance	0.9 mm max.		0.0354 in. max.



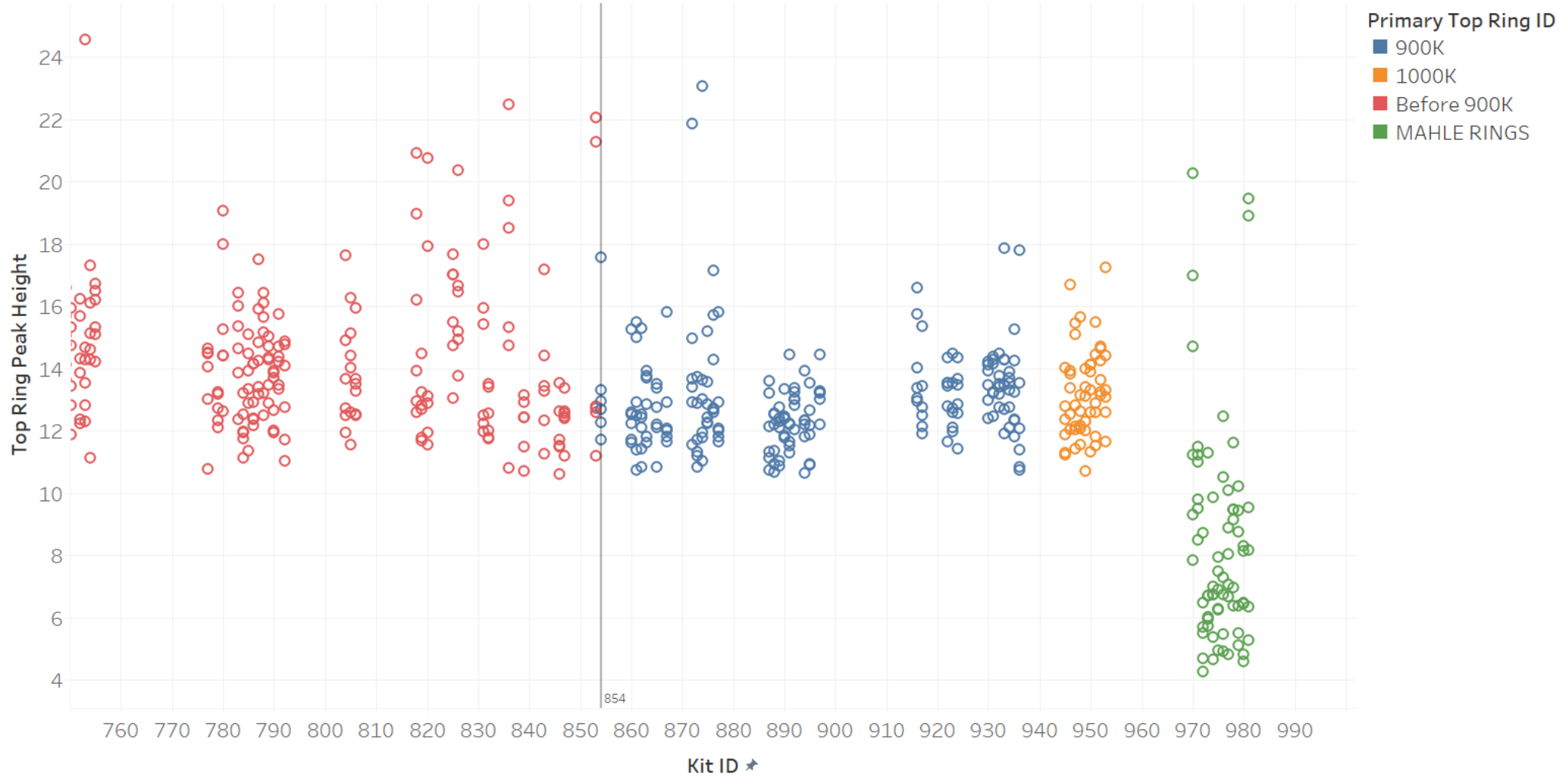
TEI Ring Measurement Comparison

Top Ring Face Width (Average of 3 Locations)



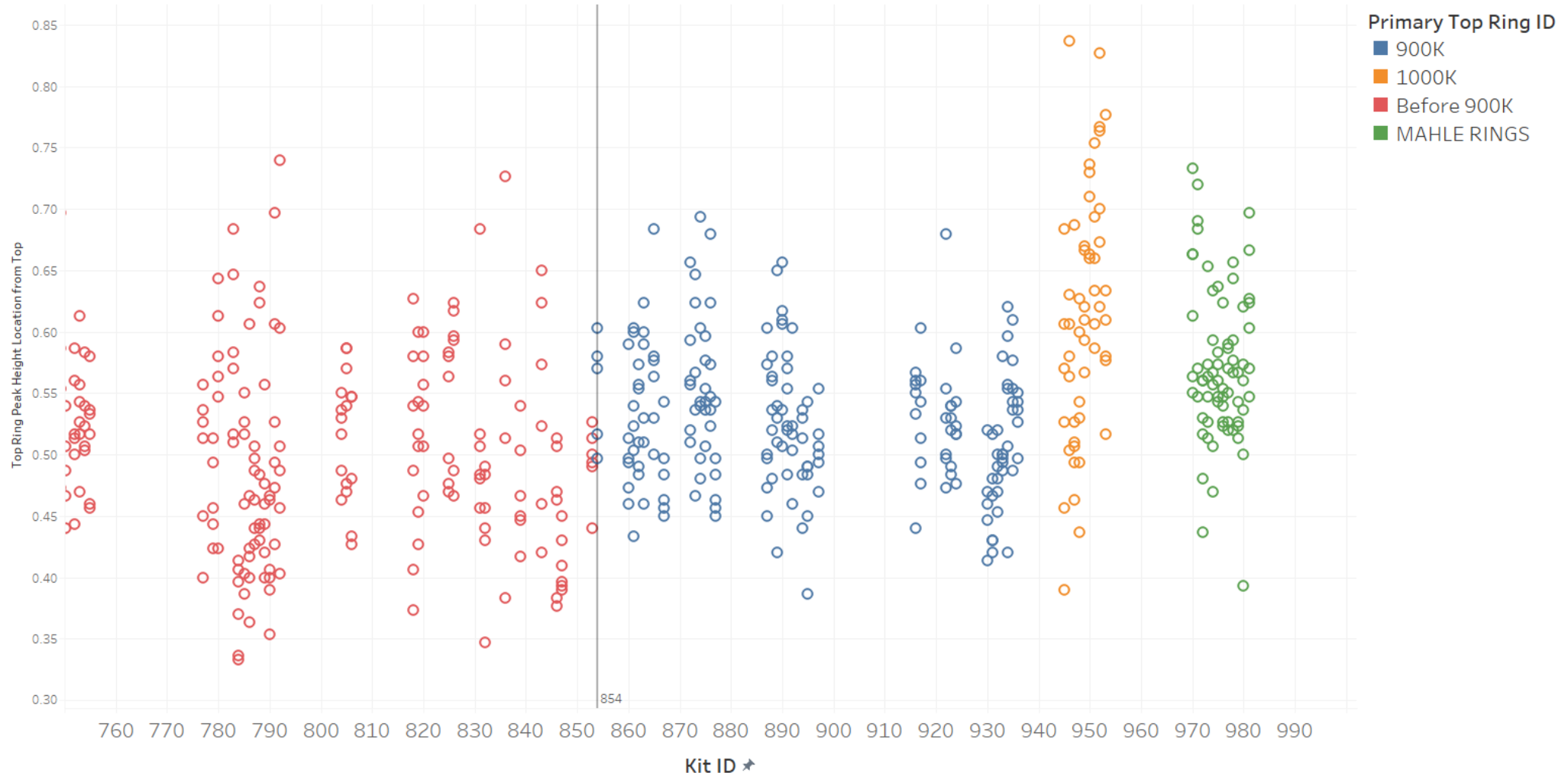
TEI Ring Measurement Comparison

Top Ring Peak Height (Average of 3 Locations)

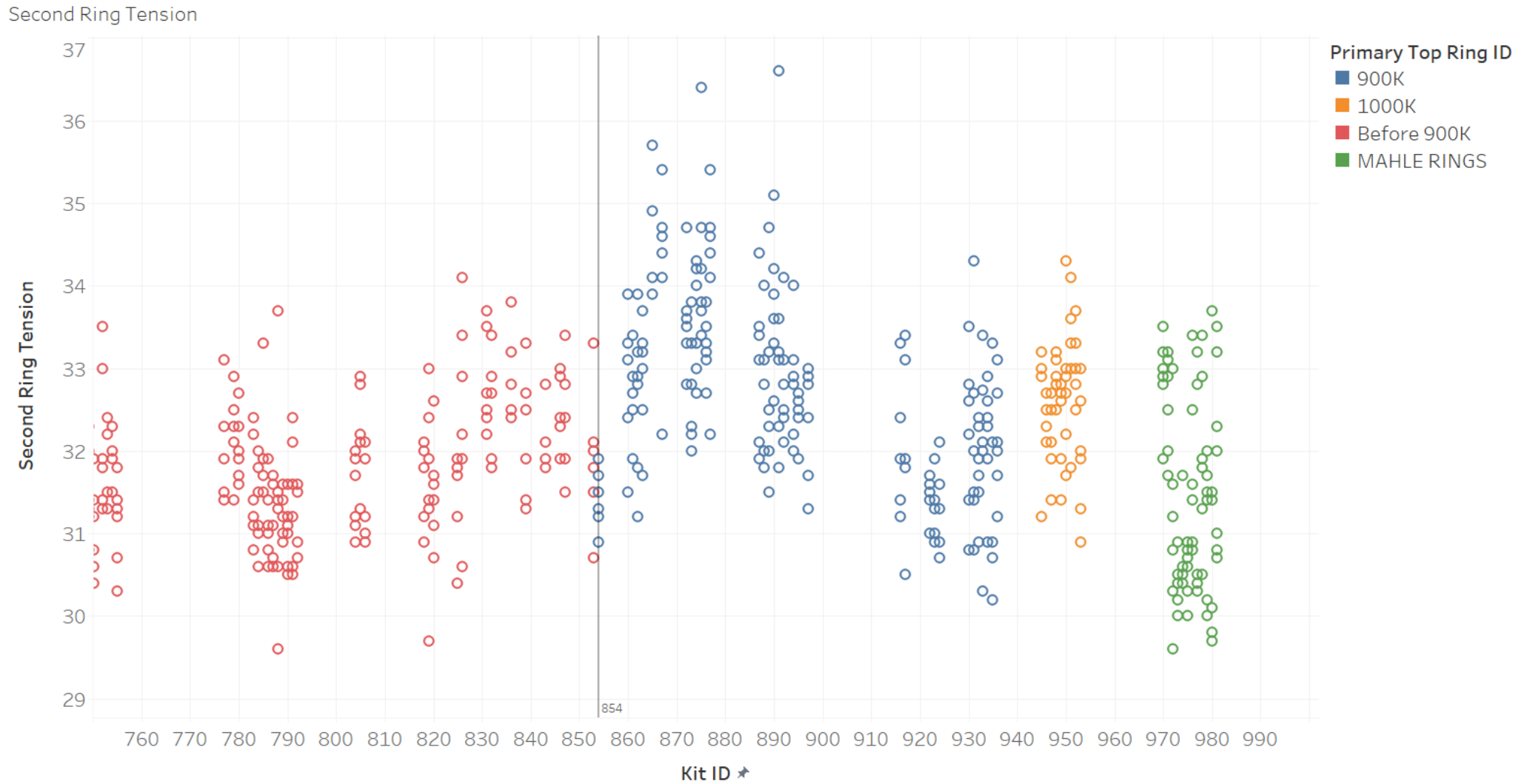


TEI Ring Measurement Comparison

Top Ring Peak Height Location From Top (Average of 3 Locations)



TEI Ring Measurement Comparison

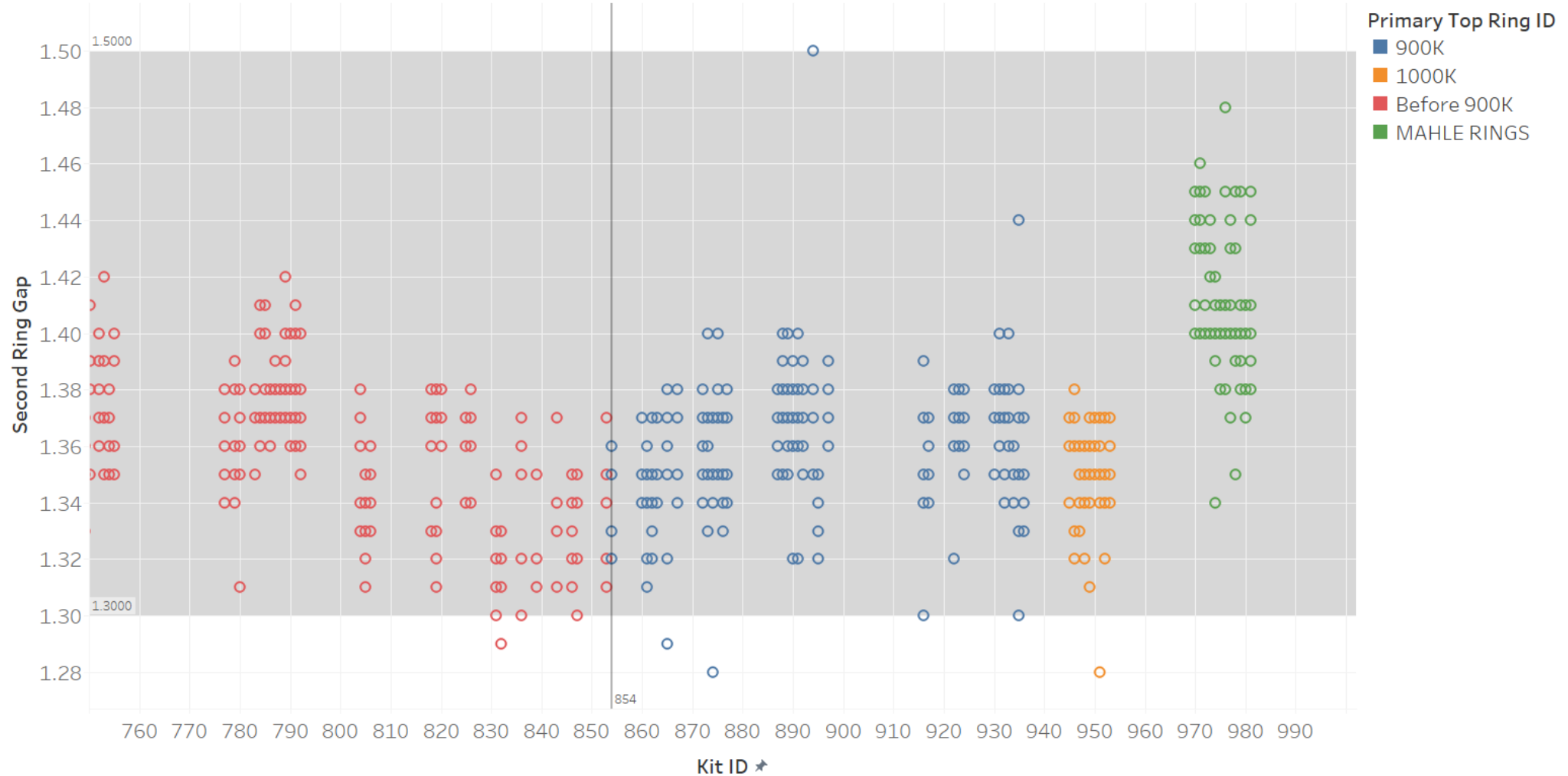


TEI Ring Measurement Comparison

Compression Ring End Gap — Lower	1.3–1.5 mm	0.0512–0.0591 in.
Compression Ring End Gap — Lower: Wear Tolerance	1.3 mm max.	0.0512 in. max.

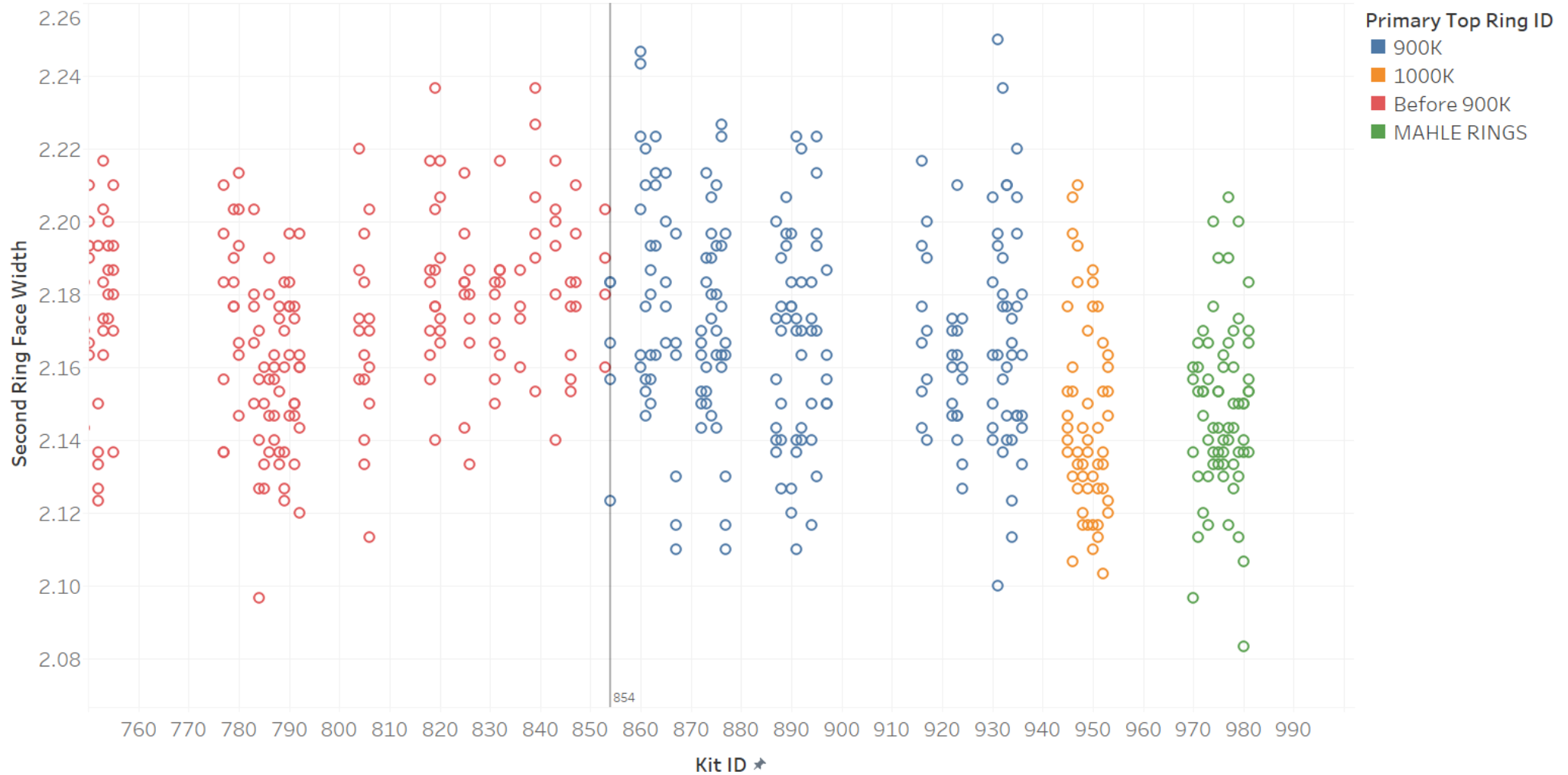
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Second Ring Gap



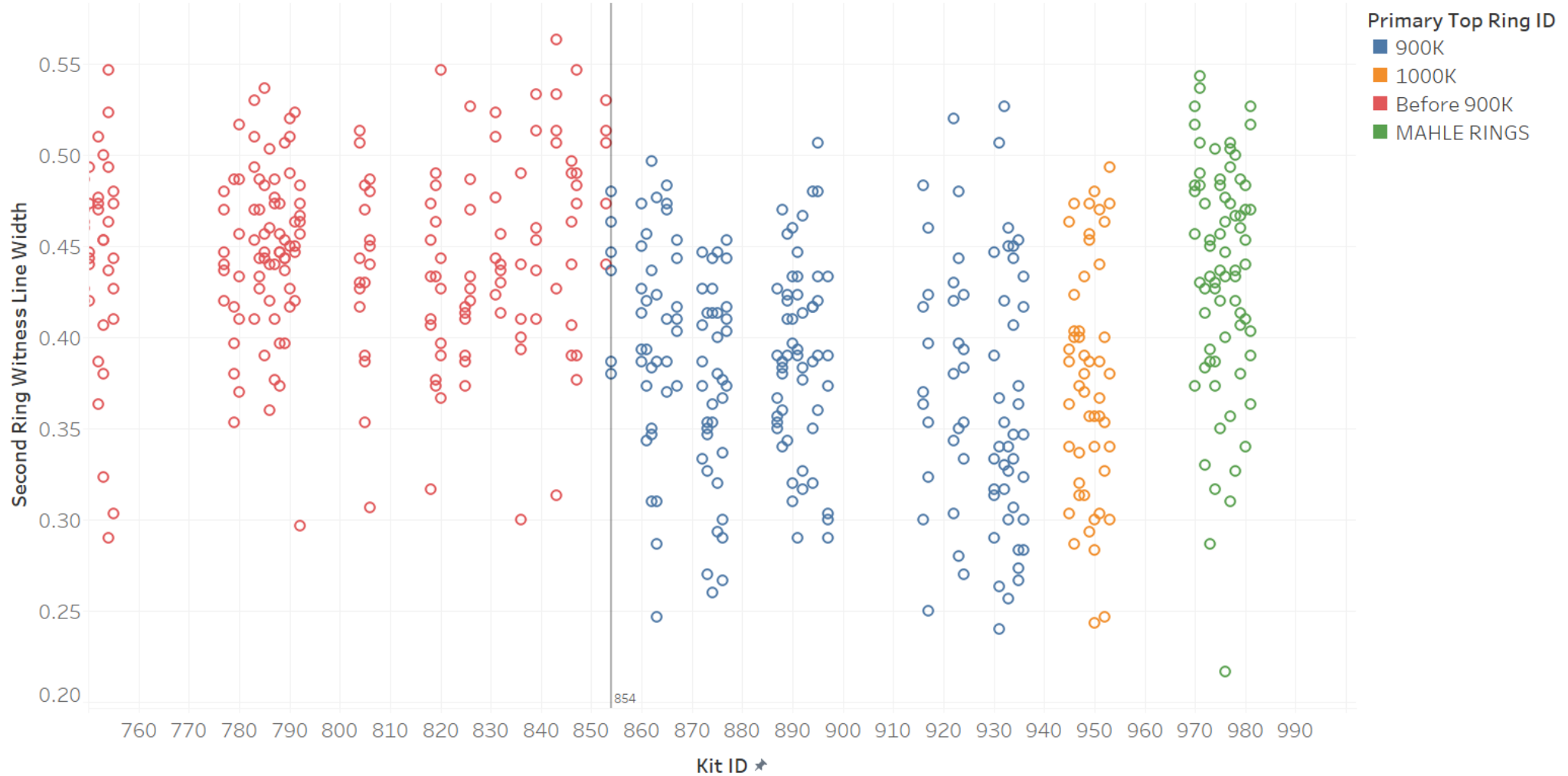
TEI Ring Measurement Comparison

Second Ring Face Width (Average of 3 Locations)



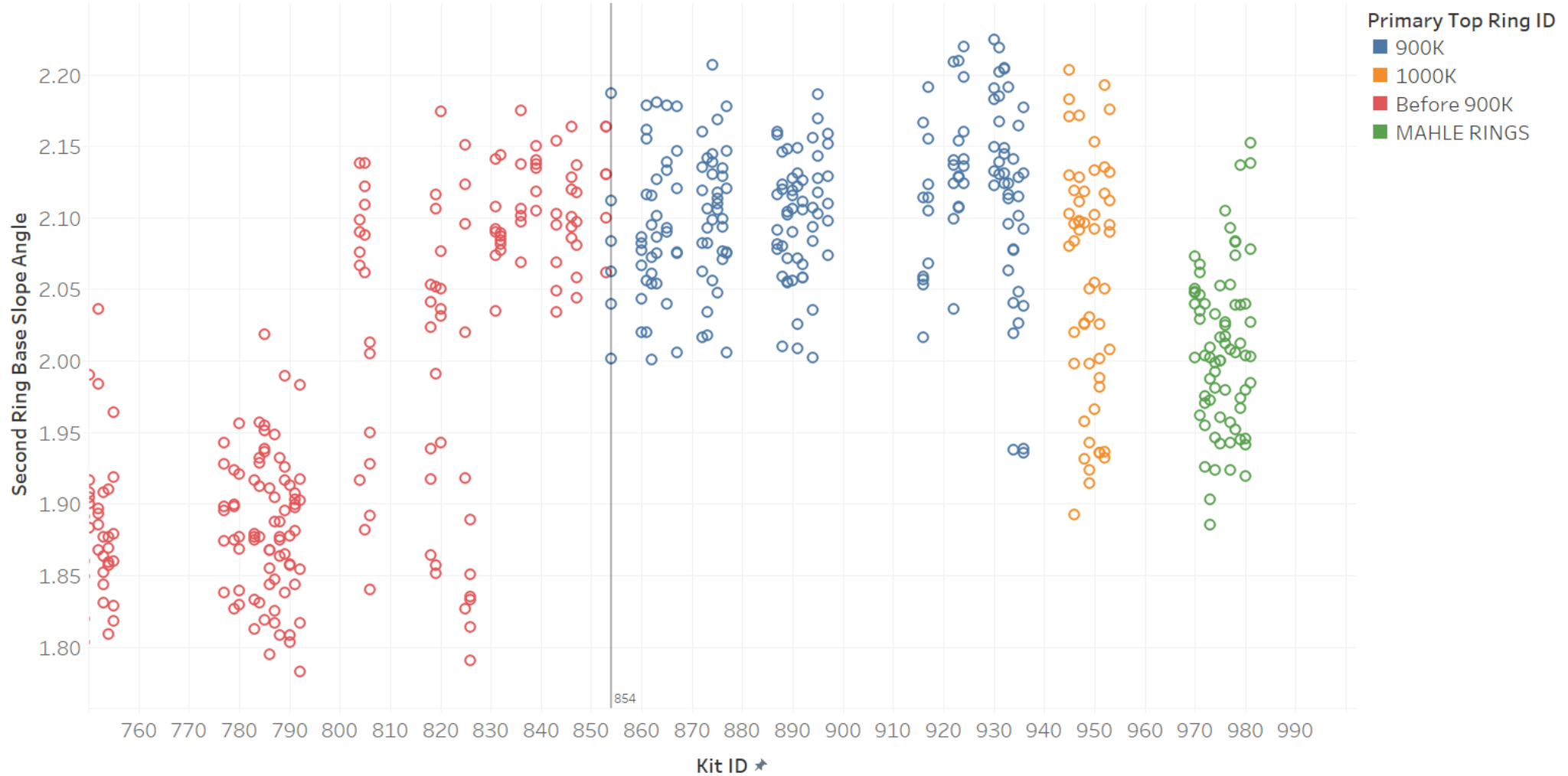
TEI Ring Measurement Comparison

Second Ring Witness Line Width (Average of 3 Locations)

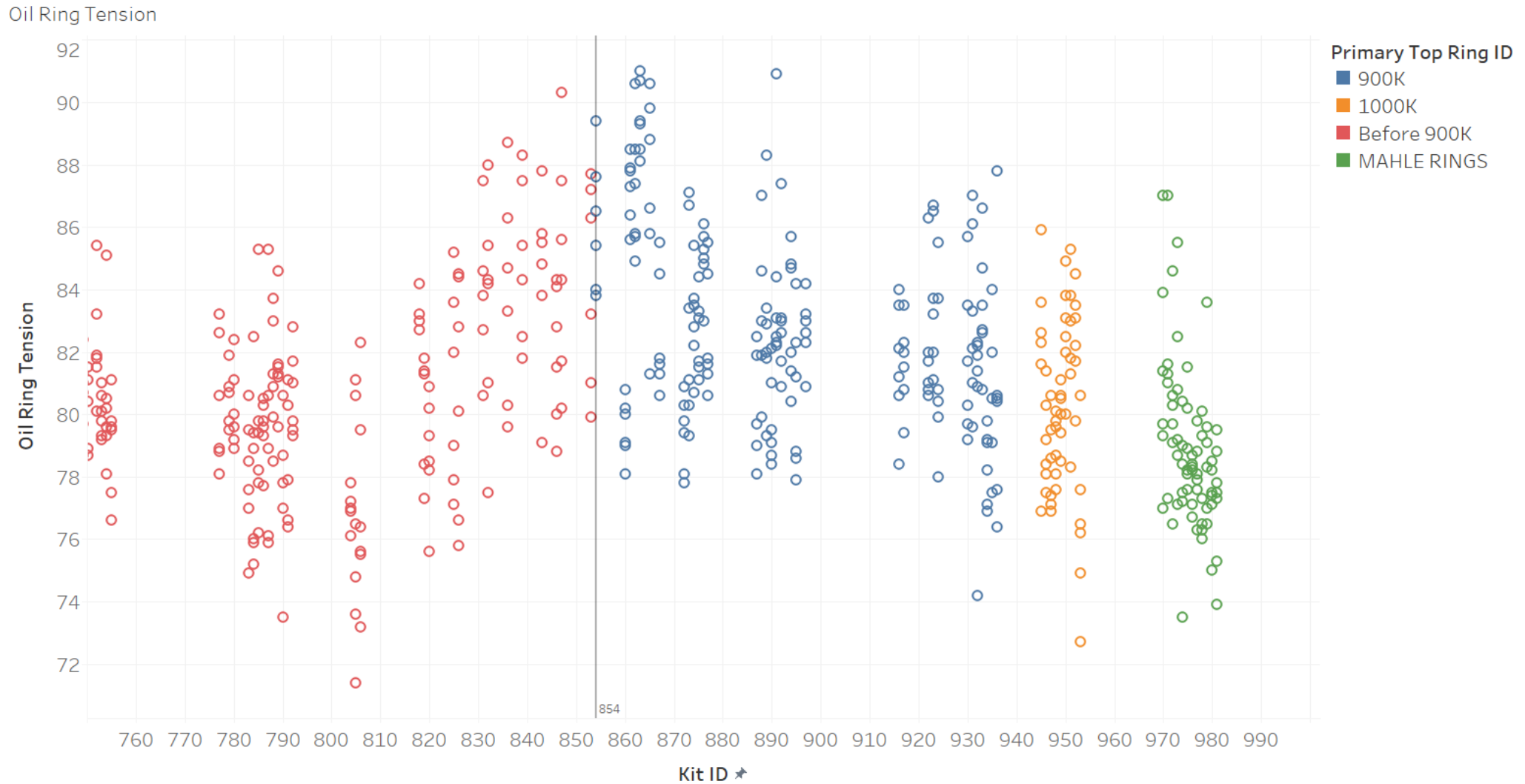


TEI Ring Measurement Comparison

Second Ring Base Slope Angle (Average of 3 Locations)



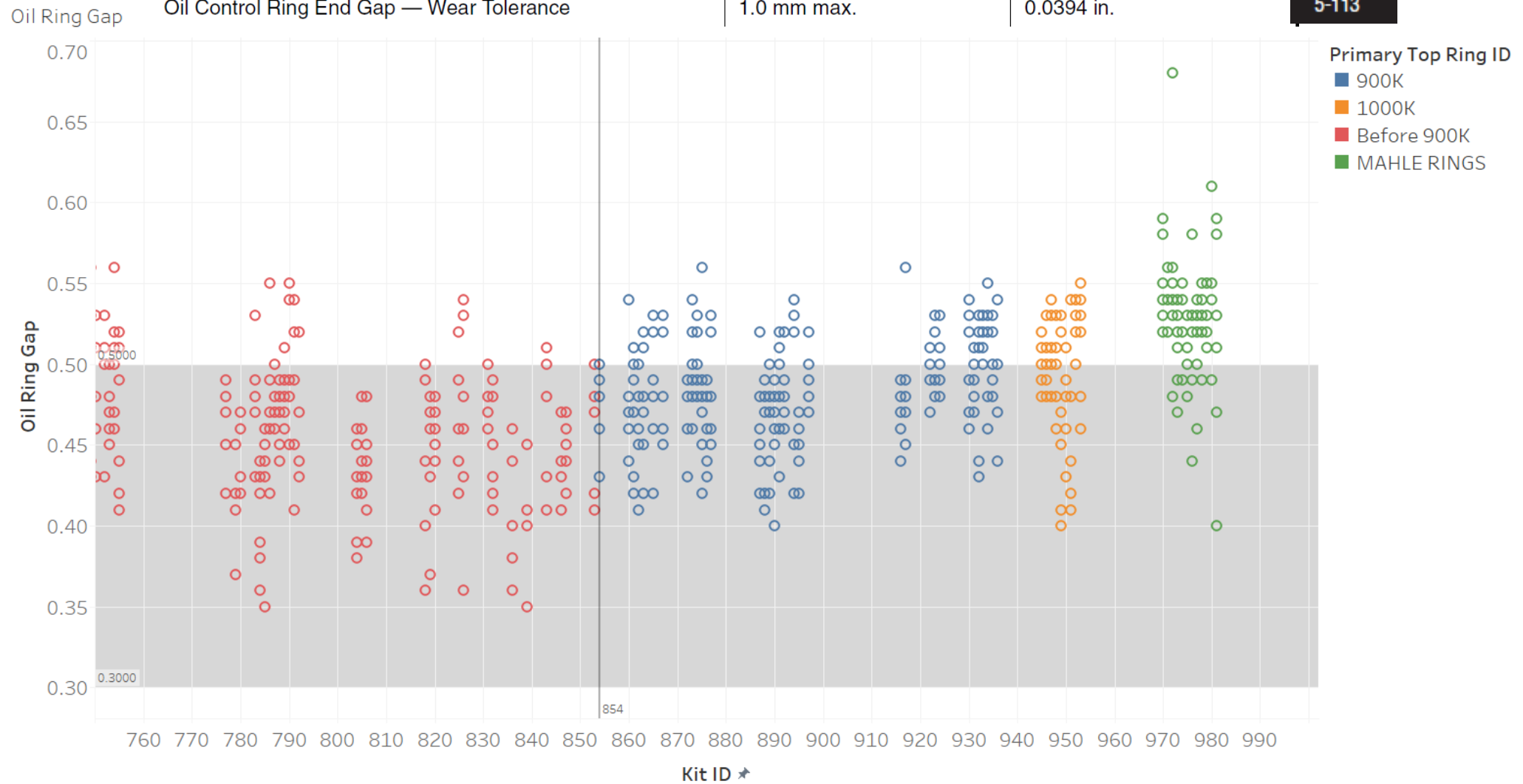
TEI Ring Measurement Comparison



TEI Ring Measurement Comparison

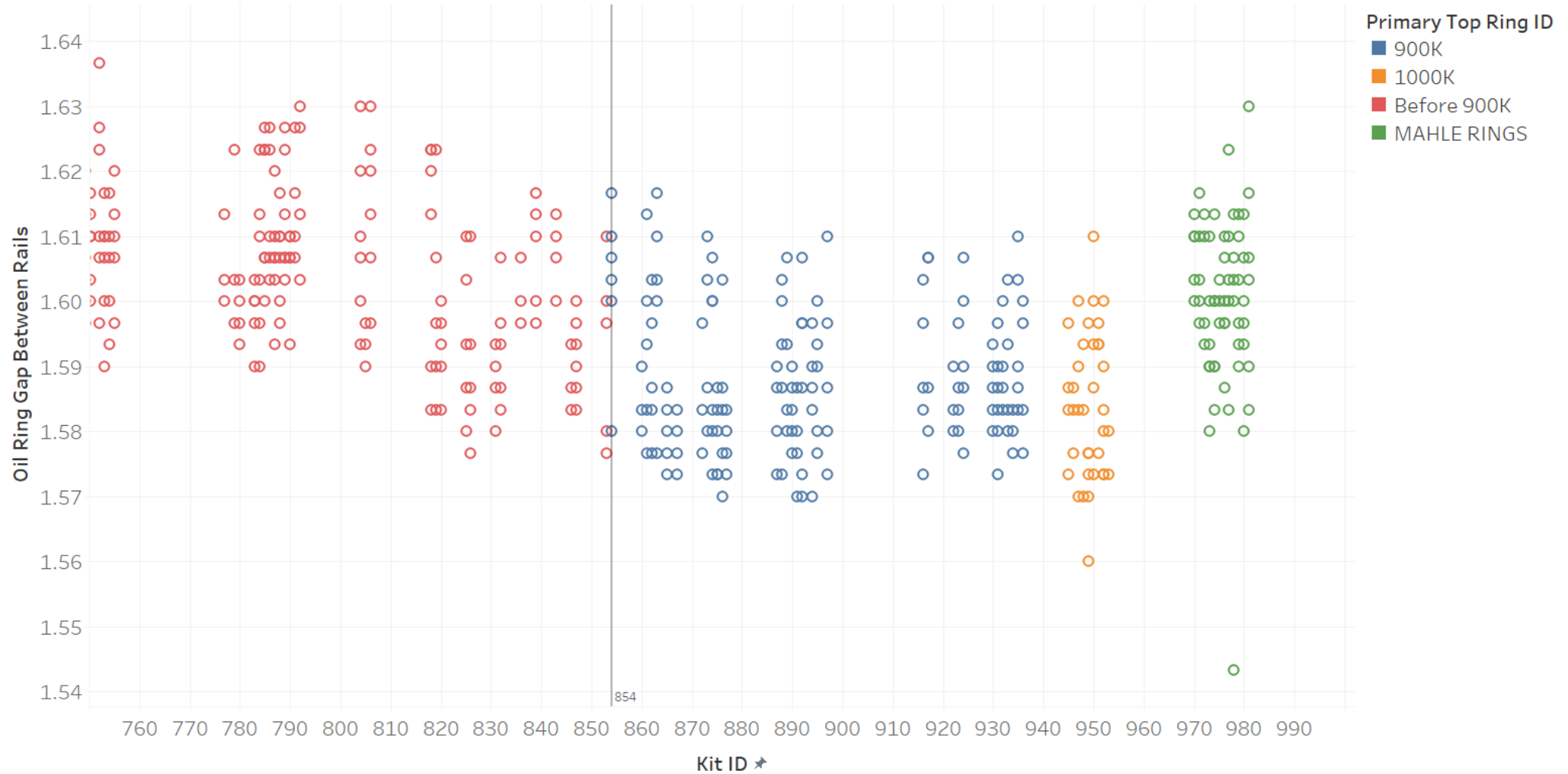
Oil Control Ring End Gap	0.30–0.55 mm	0.0118–0.0217 in.
Oil Control Ring End Gap — Wear Tolerance	1.0 mm max.	0.0394 in.

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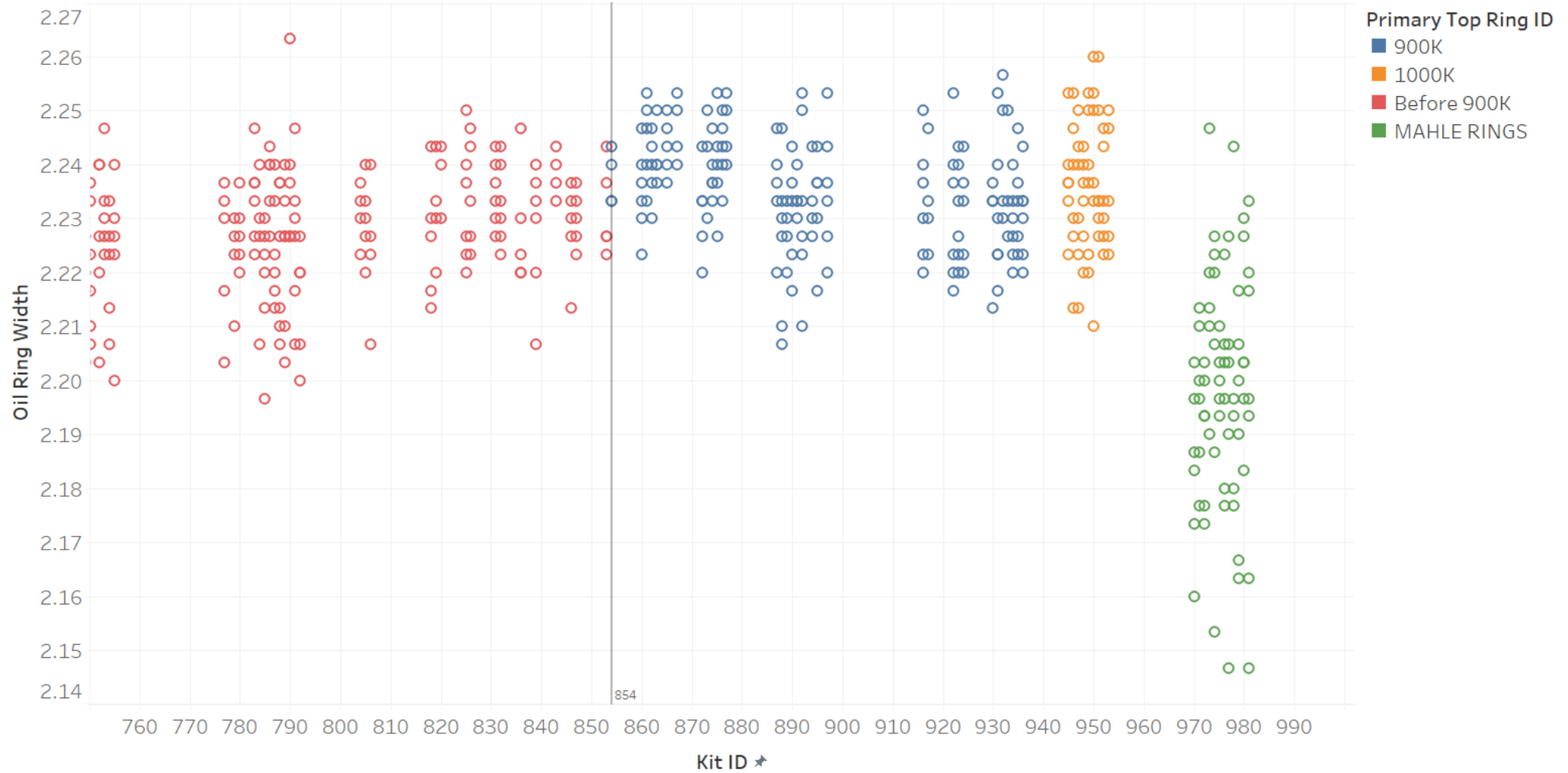
TEI Ring Measurement Comparison

Oil Ring Gap between Rails (Average of 3 Locations)



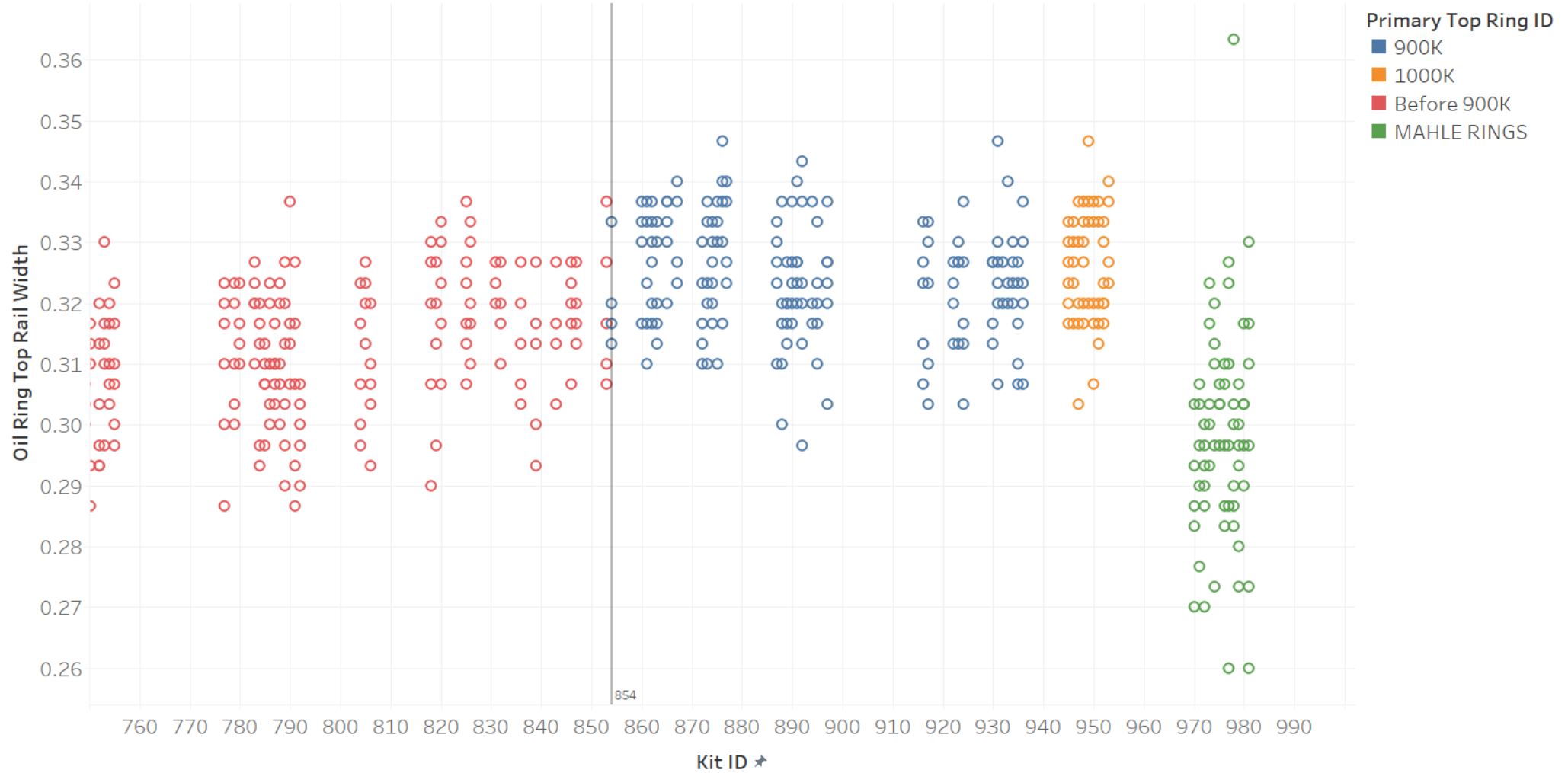
TEI Ring Measurement Comparison

Oil Ring Width (Average of 3 Locations)



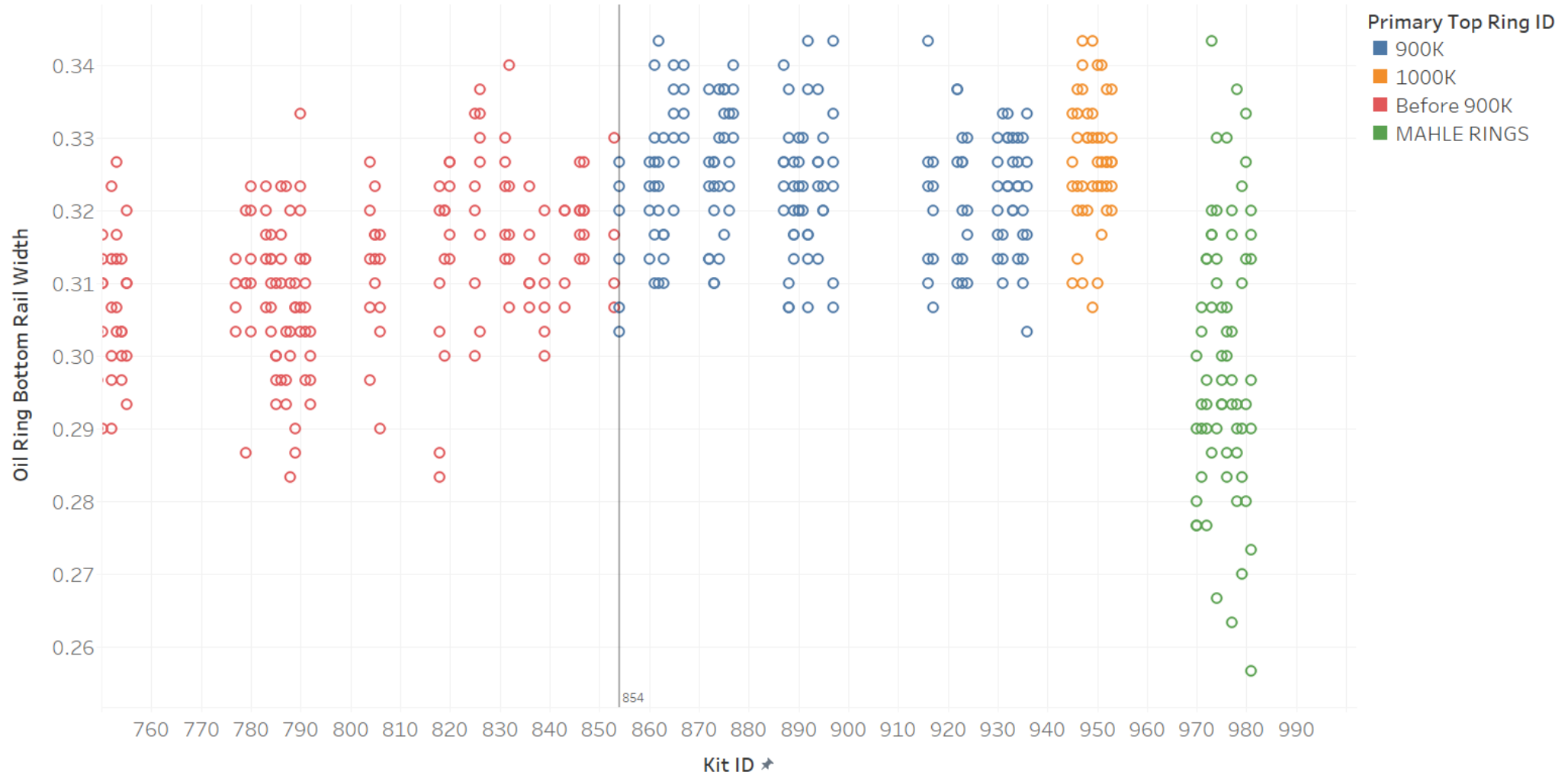
TEI Ring Measurement Comparison

Oil Ring Top Rail Width (Average of 3 Locations)



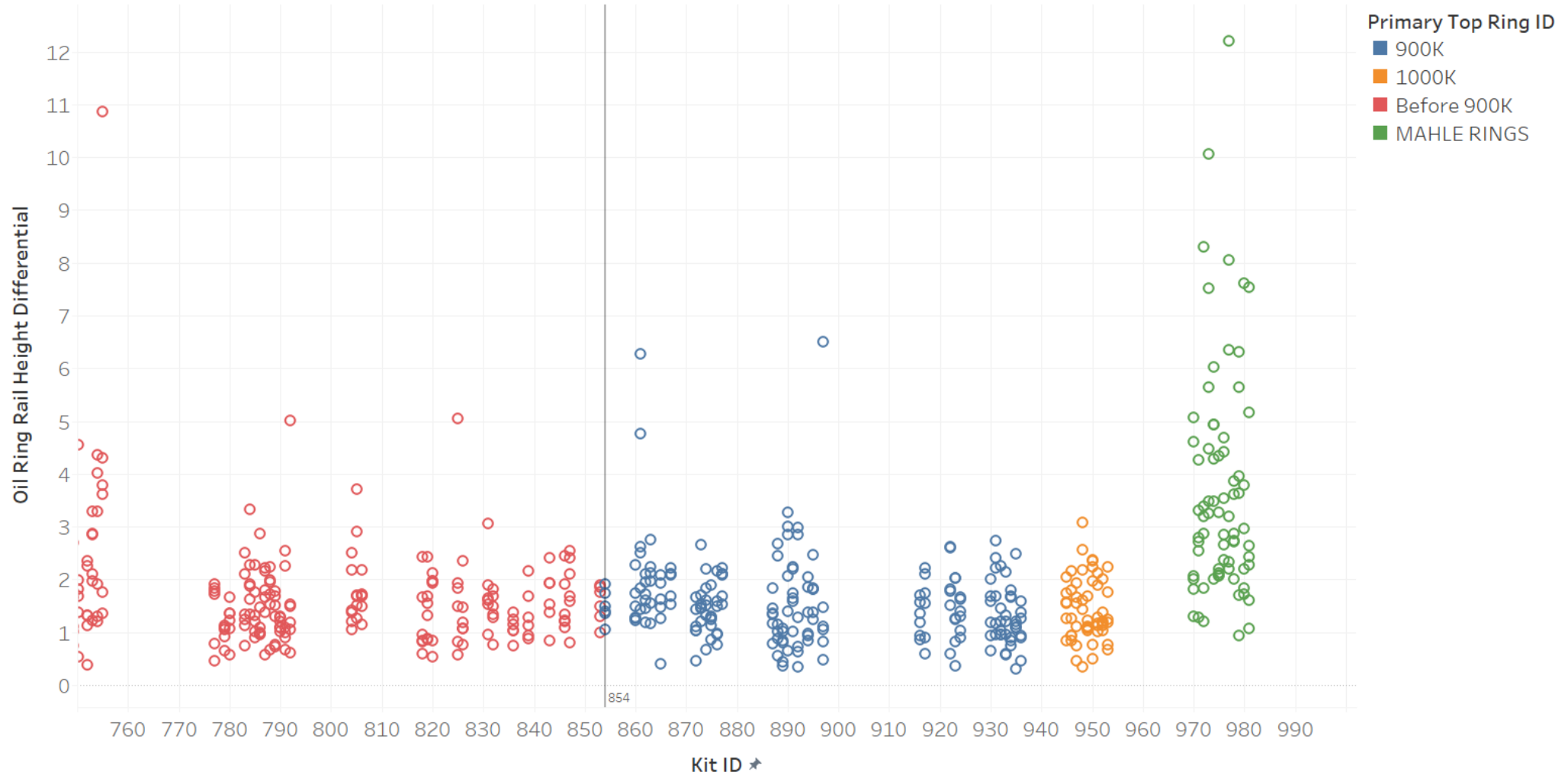
TEI Ring Measurement Comparison

Oil Ring Bottom Rail Width (Average of 3 Locations)



TEI Ring Measurement Comparison

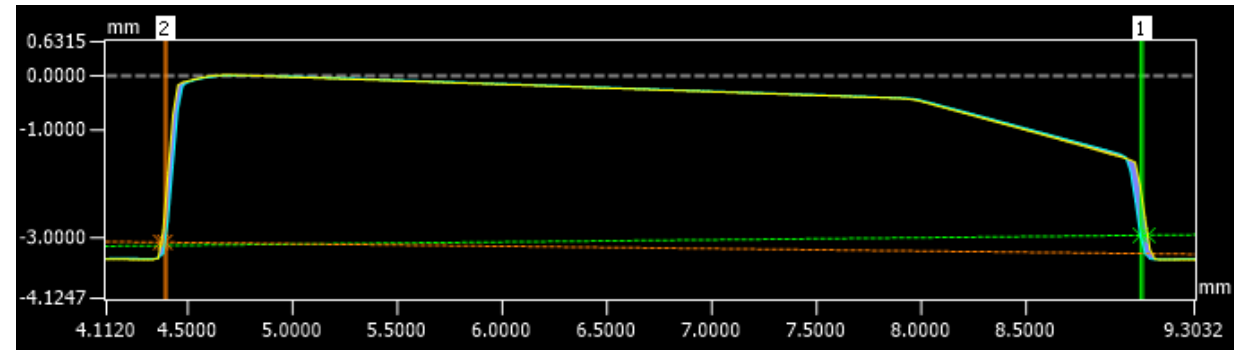
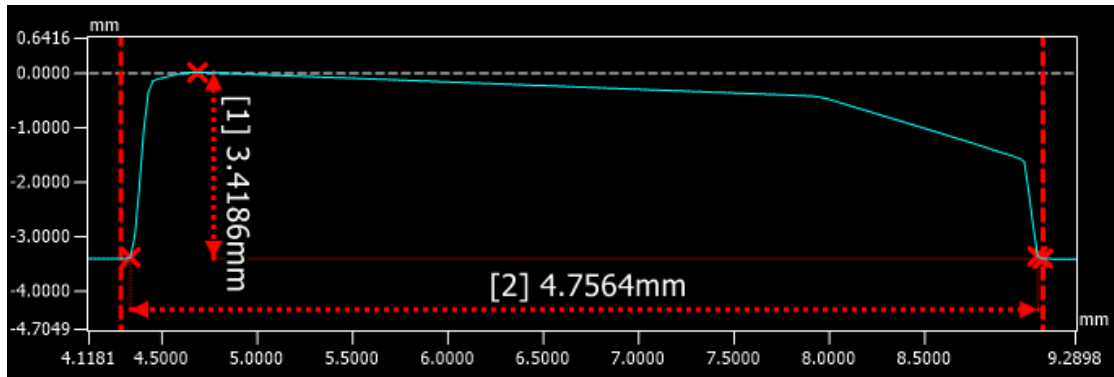
Oil Ring Rail Height Differential (Average of 3 Locations)



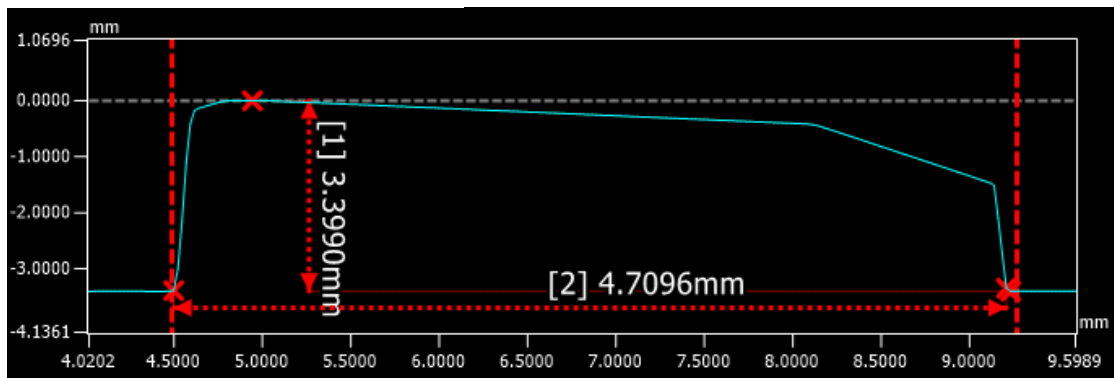
Top Ring Geometric Scans

Mahle Top Rings seem slightly larger, both in thickness (i.e. face width and overall thickness) and radially.

Mahle



Volvo 939252



Profile Overlaid:
Yellow = Mahle
Blue = Volvo

Top Ring Composition

Volvo

Mahle

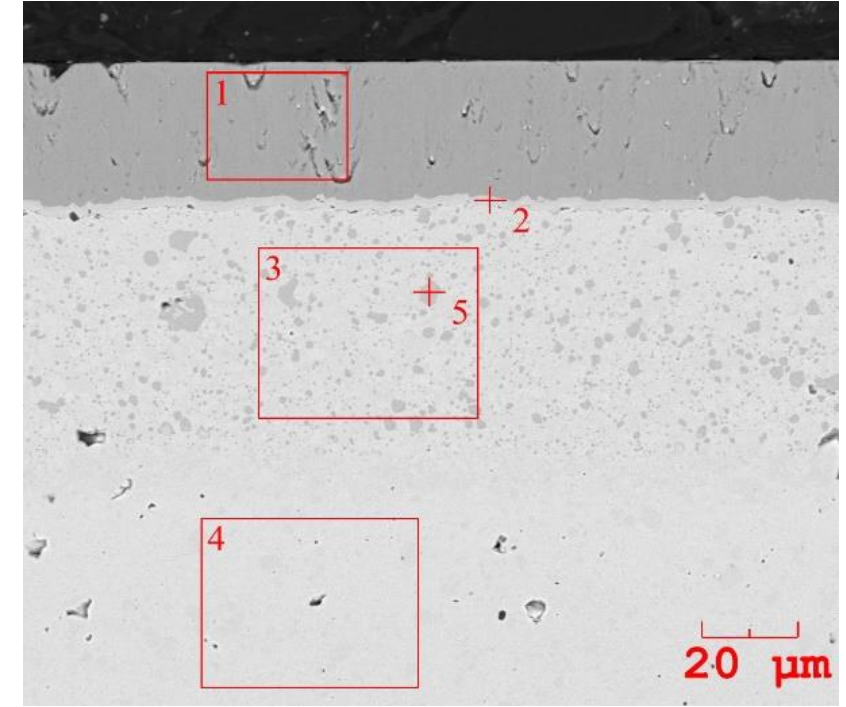
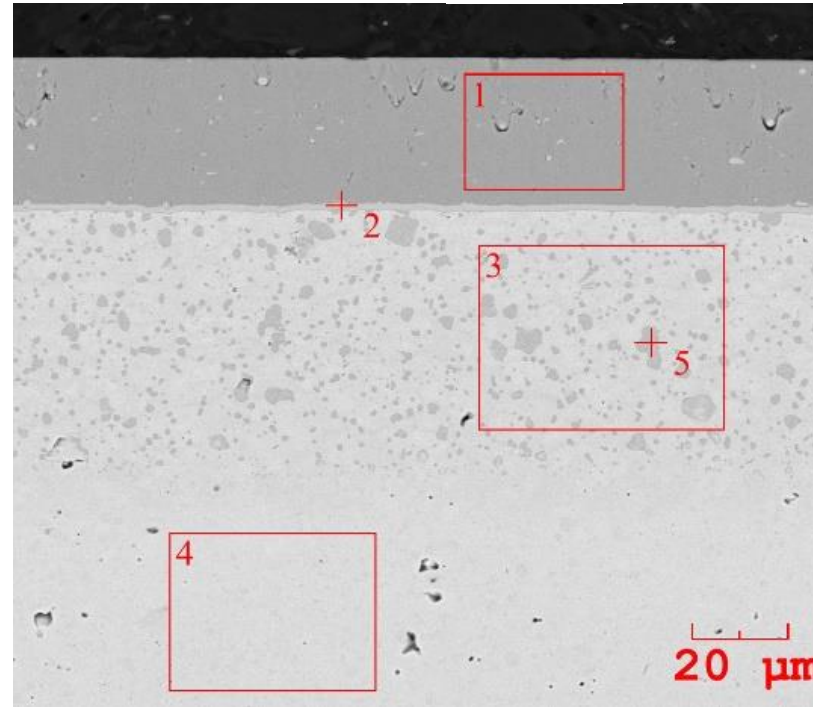
Area 1: Coating	Volvo Ring	Mahle Ring
Elt.	Conc %	Conc %
Cr	83.16	84.35
N	16.84	15.65

Point 2	Volvo Ring	Mahle Ring
Elt.	Conc %	Conc %
Cr	97.92	98.82
Fe	2.08	1.18

Area 3	Volvo Ring	Mahle Ring
Elt.	Conc %	Conc %
Fe	79.35	80.31
Cr	18.43	17.52
Mo	1.26	1.20
Si	0.68	0.72
Mn	0.28	0.25

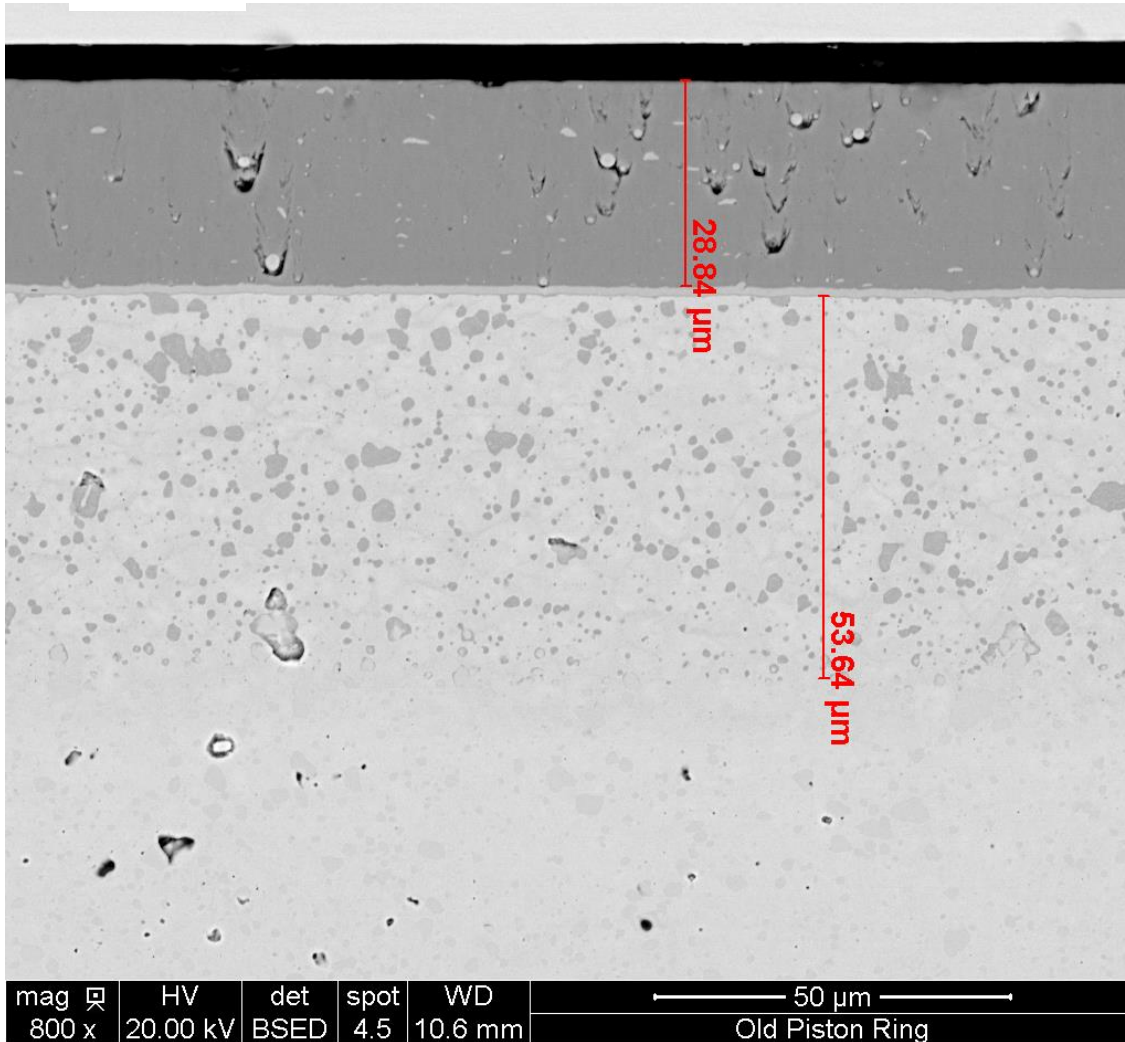
Area 4	Volvo Ring	Mahle Ring
Elt.	Conc %	Conc %
Fe	81.27	79.88
Cr	16.63	17.97
Mo	1.17	1.23
Si	0.63	0.66
Mn	0.30	0.26

Point 5	Volvo Ring	Mahle Ring
Elt.	Conc %	Conc %
Fe	31.94	37.12
Cr	63.35	58.80
Mo	4.00	3.30
V	0.41	0.41
Mn	0.30	0.37

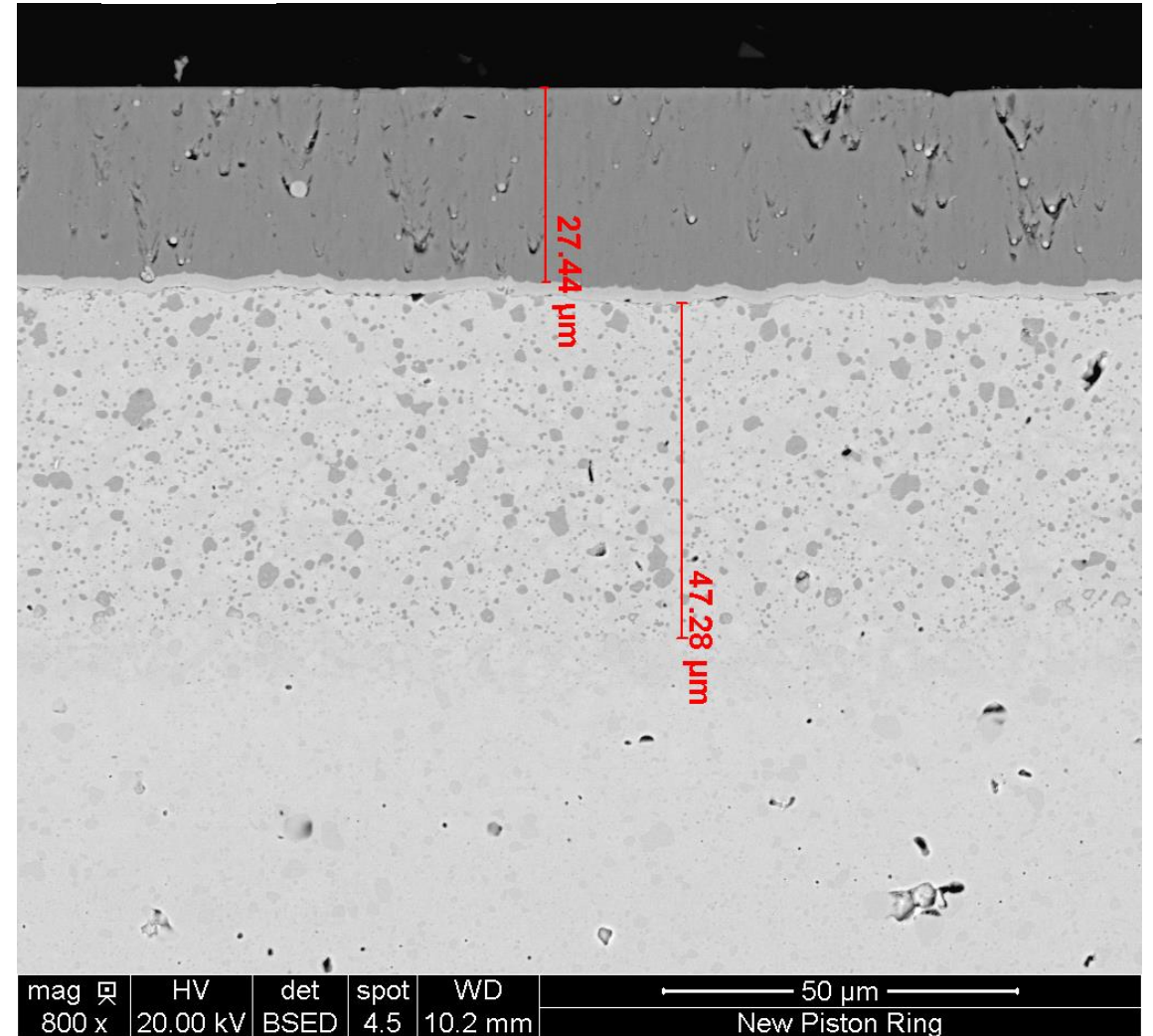


Top Ring SEM

Volvo

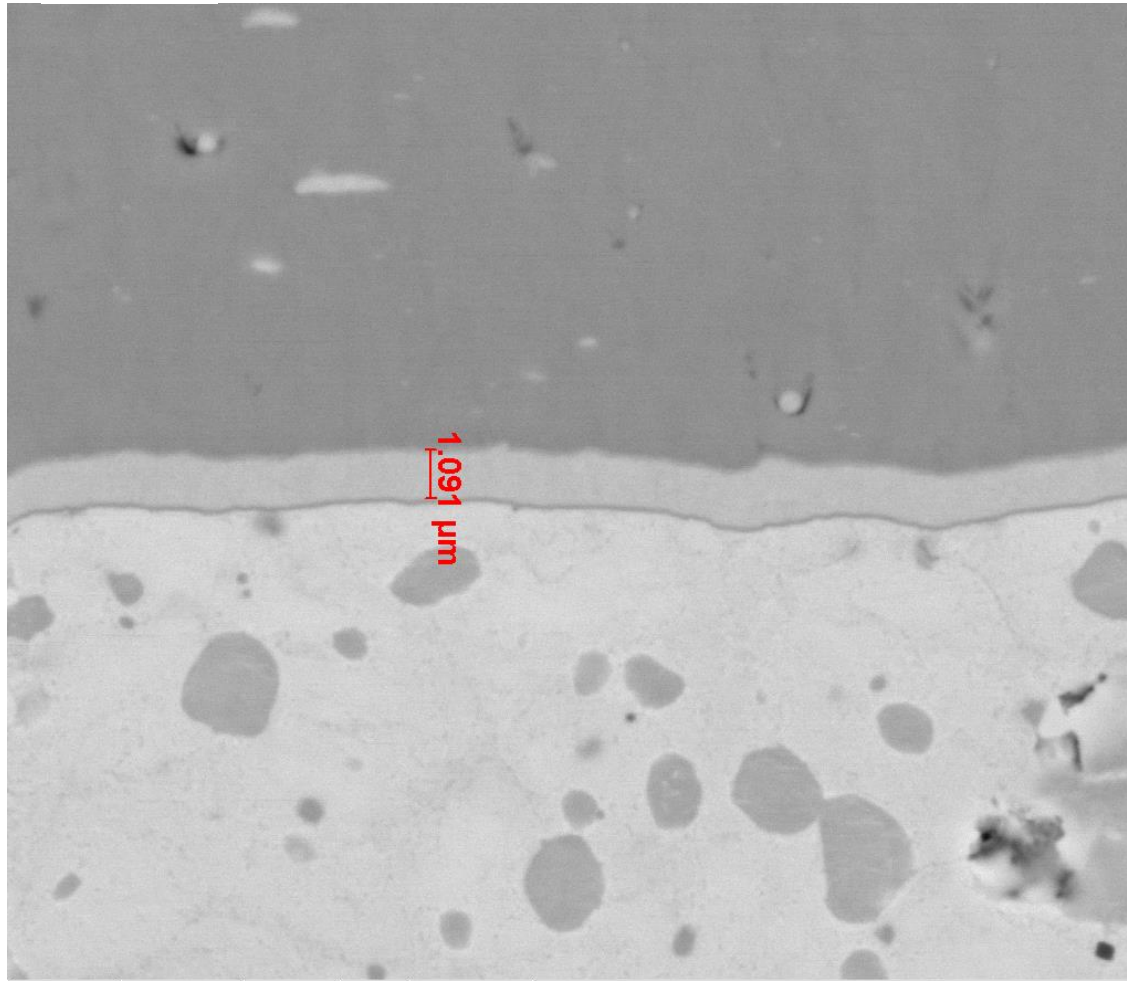


Mahle



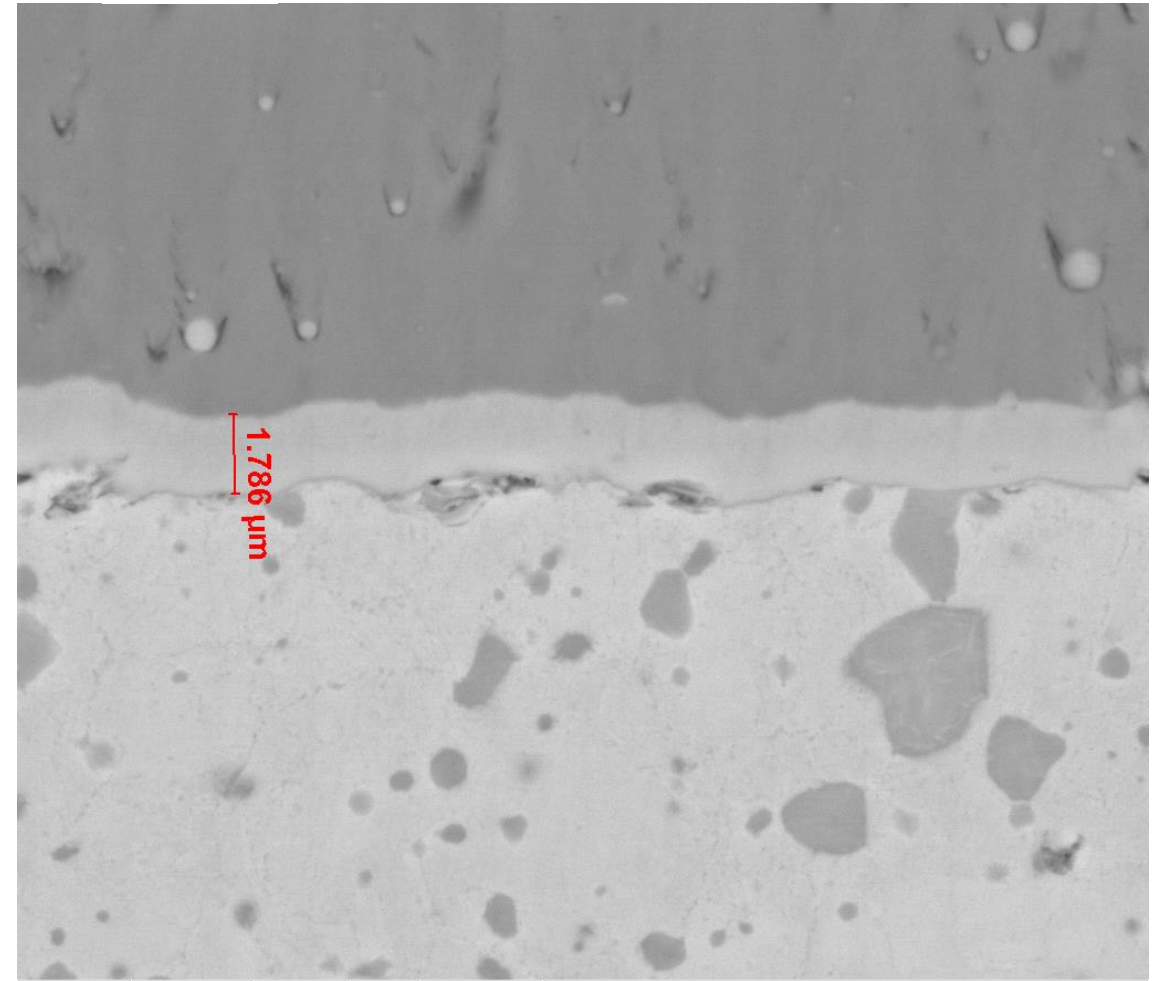
Top Ring SEM

Volvo



mag	HV	det	spot	WD	10 µm
5 000 x	20.00 kV	BSED	4.0	10.6 mm	Old Piston Ring

Mahle



mag	HV	det	spot	WD	10 µm
5 000 x	20.00 kV	BSED	4.0	10.3 mm	New Piston Ring