

DSR-PAV Test Improvement 3Q17 Status Update

AI TAC TF members:

Pavel Kriz (Imperial Oil/ExxonMobil)

Gerry Reinke (Mathy)

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Wes Cooper (Asphalt Institute)

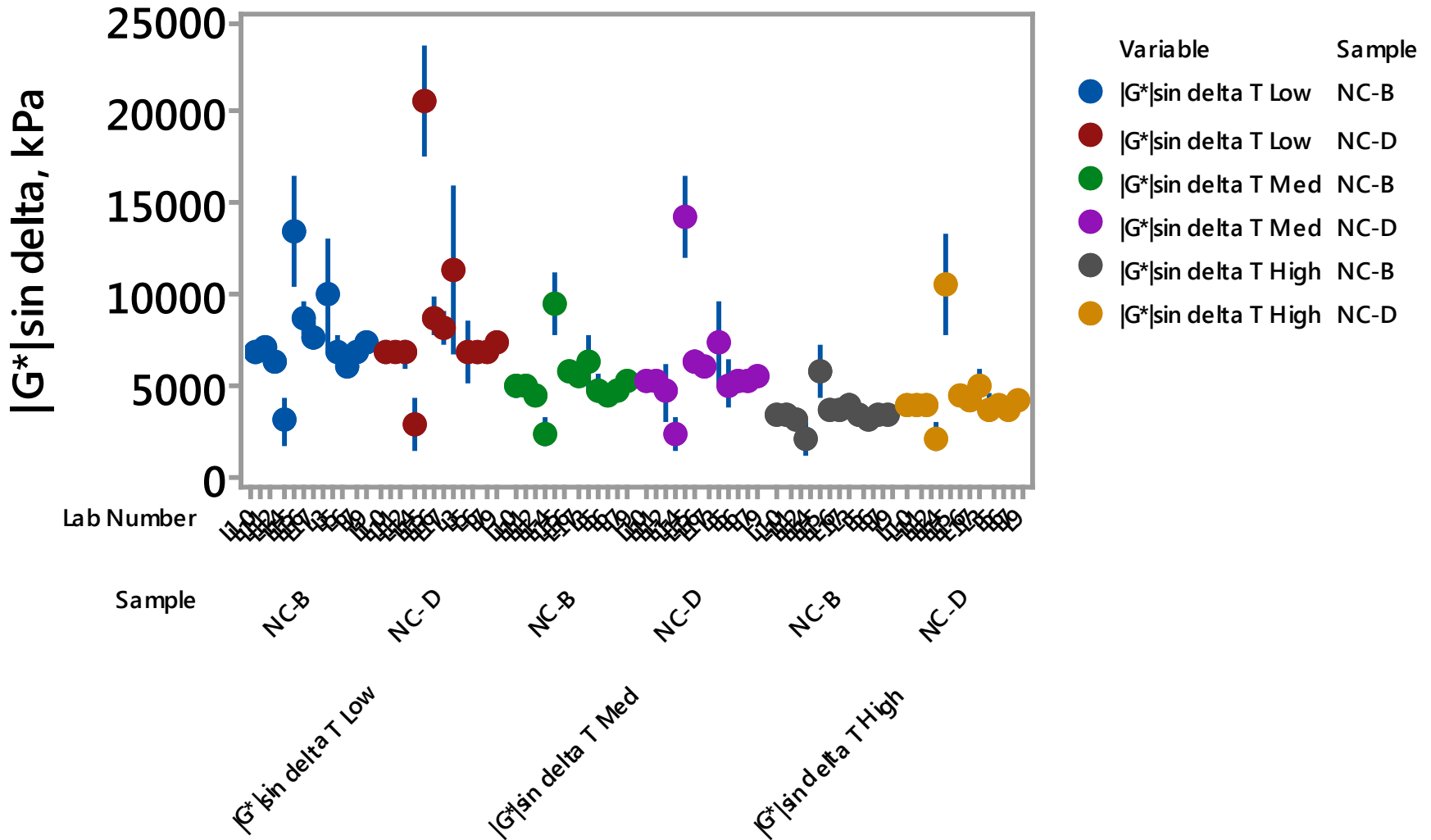
Dave Anderson (Consultant)

Expert Task Group Meeting, Bozeman, MT September 20, 2017

Development since May ETG

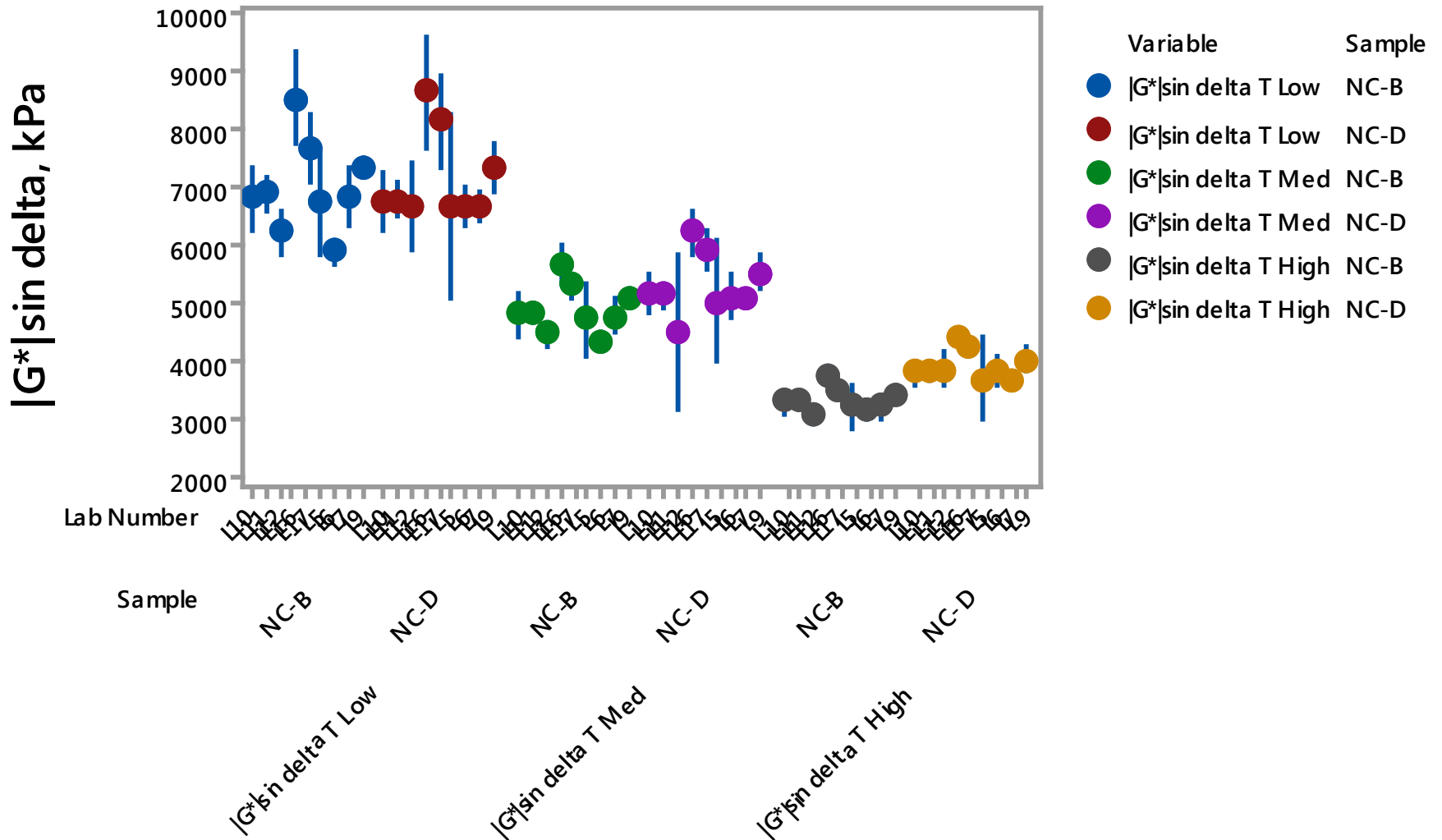
1. TF completed stage 1 → DSR equilibrium time
 - Time to equilibrium is not controlled among different DSRs the same, however its impact on data variability is not dominant
2. Stage 2: Testing an effect of strain & plate size on variability is completed (12 out of 17 Labs provided data – THANK YOU! (and thank you Mike))
3. Statistically analysis in progress – initial results presented herewith

DSR-PAV Phase 2: All Data (Mean, Std.)



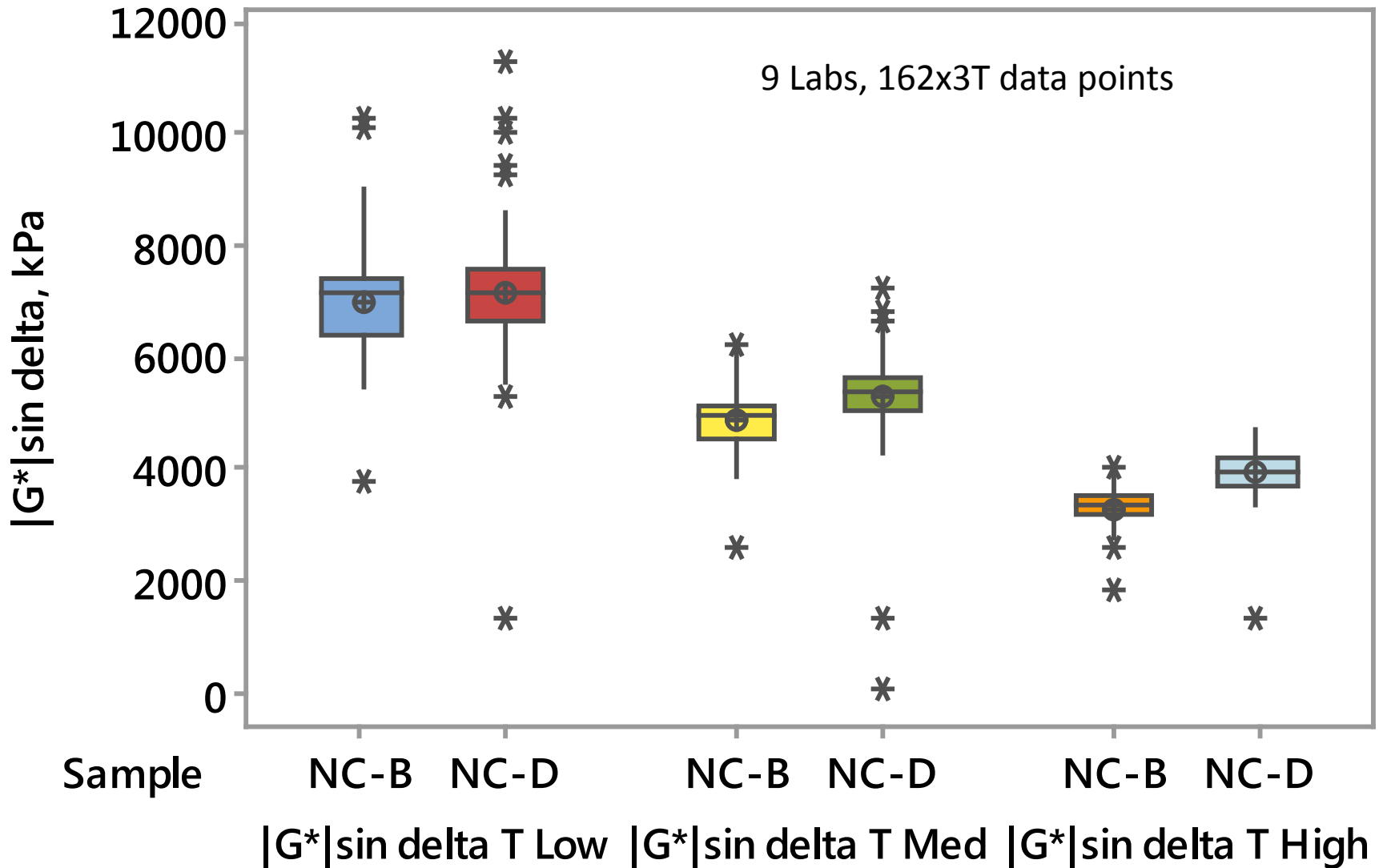
Individual standard deviations were used to calculate the intervals.

L3, L14 & L15 Removed from Dataset

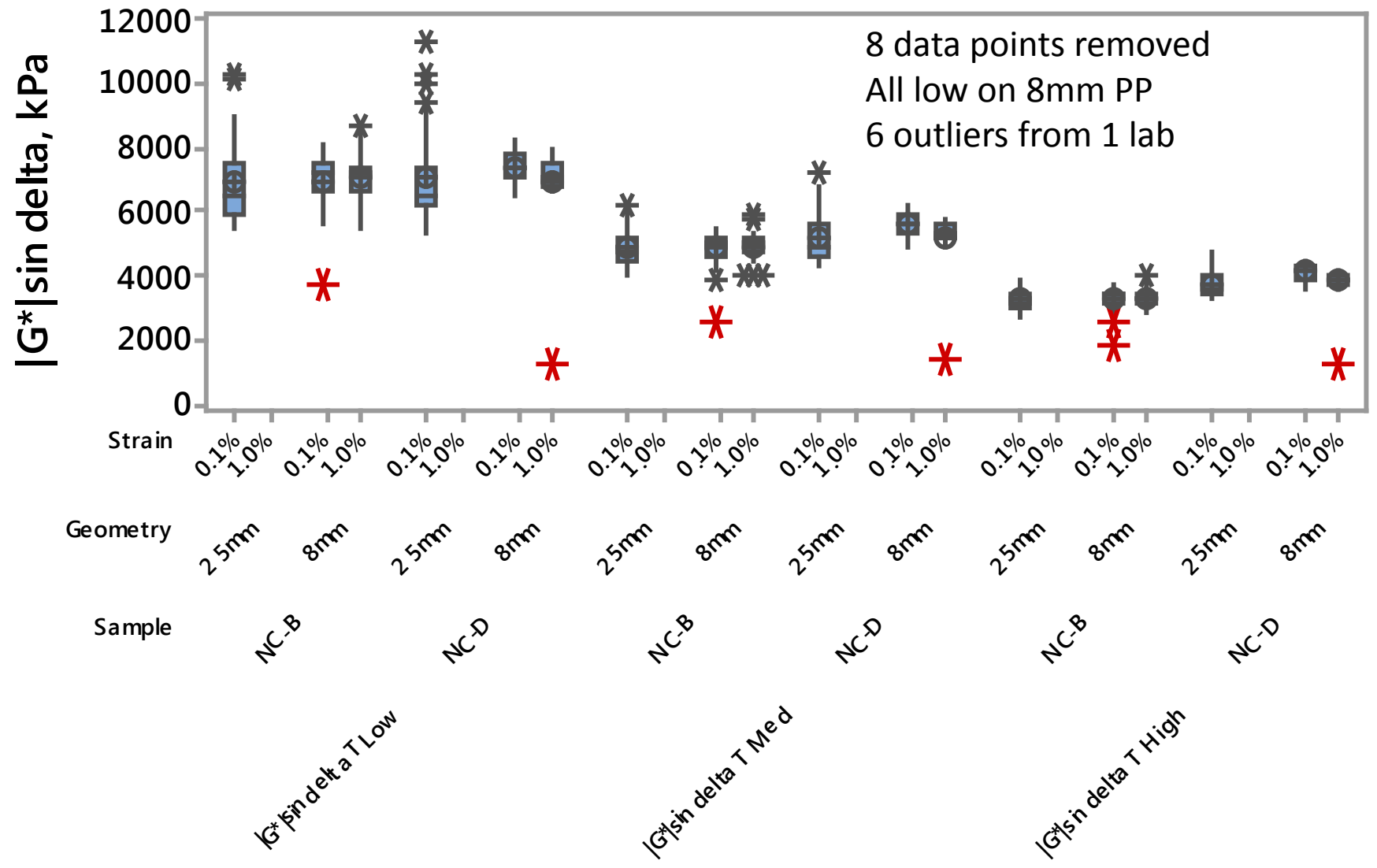


Individual standard deviations were used to calculate the intervals.

Higher Temperature, Better Data



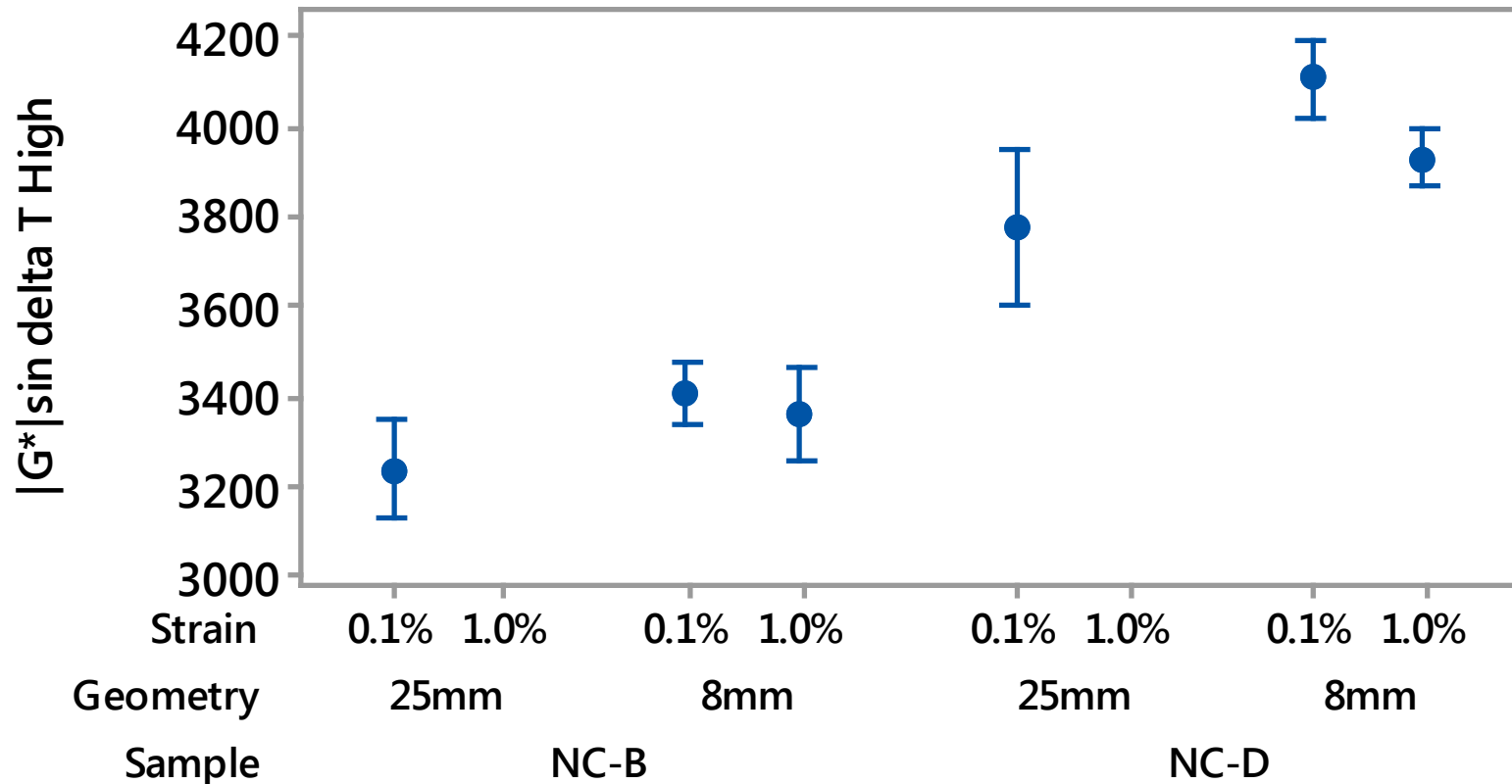
Outlier Mgmt. Grubbs ($\alpha=0.05$)



- In essence of time, let's focus at test results measured at highest (passing) DSR-PAV test temperature
- Analysis of results collected at temperature by 3 and 6 °C lower is in the Appendix

T High, 8mm lower StDev, Statistically Differ at 0.1% strain

Interval Plot of $|G^*| \sin \delta$ T High
95% CI for the Mean

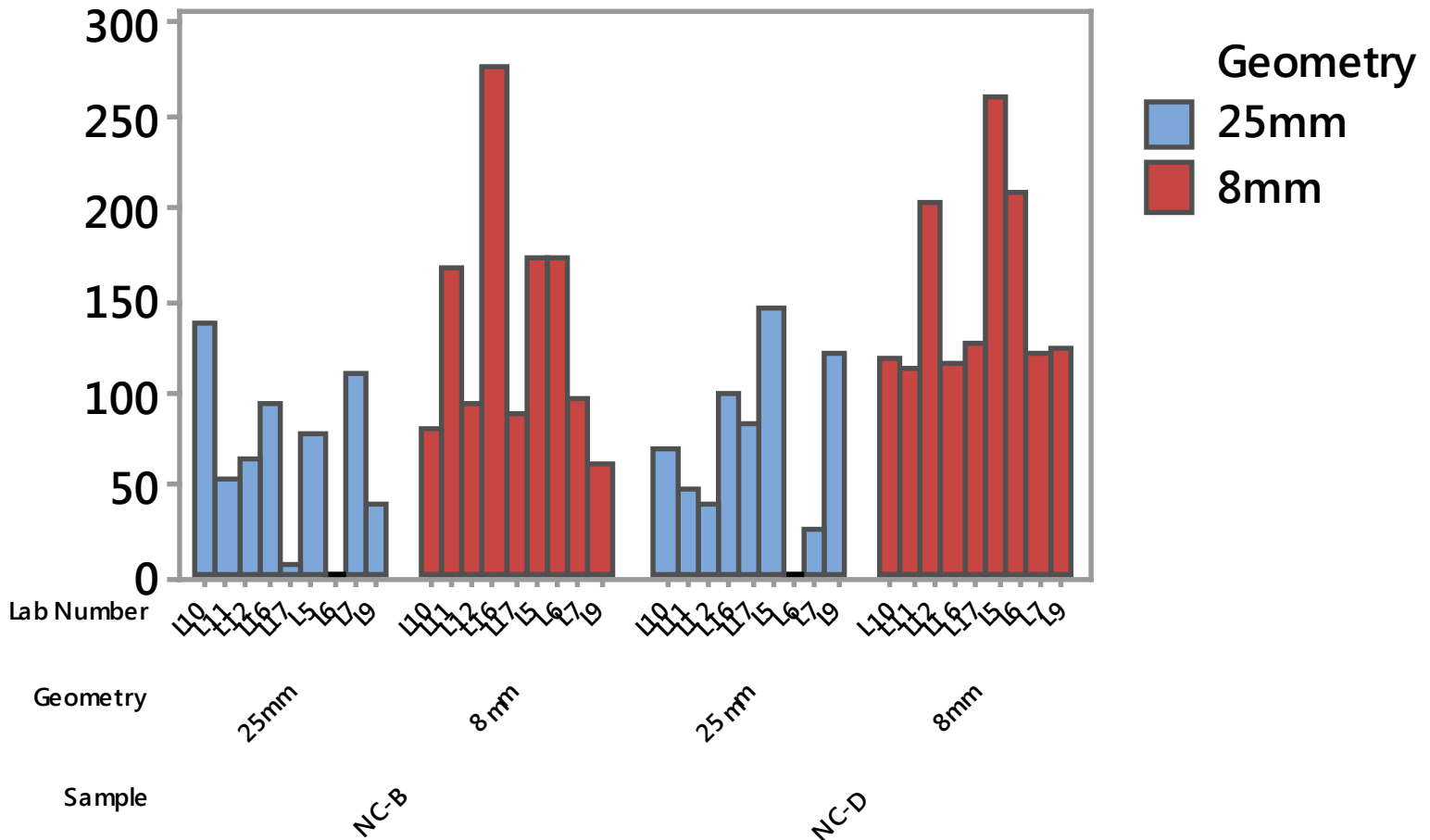


Individual standard deviations were used to calculate the intervals.

T High, 25mm Better Precision than 8mm but Poorer Accuracy

Standard Deviation of $|G^*| \sin \delta$ T High

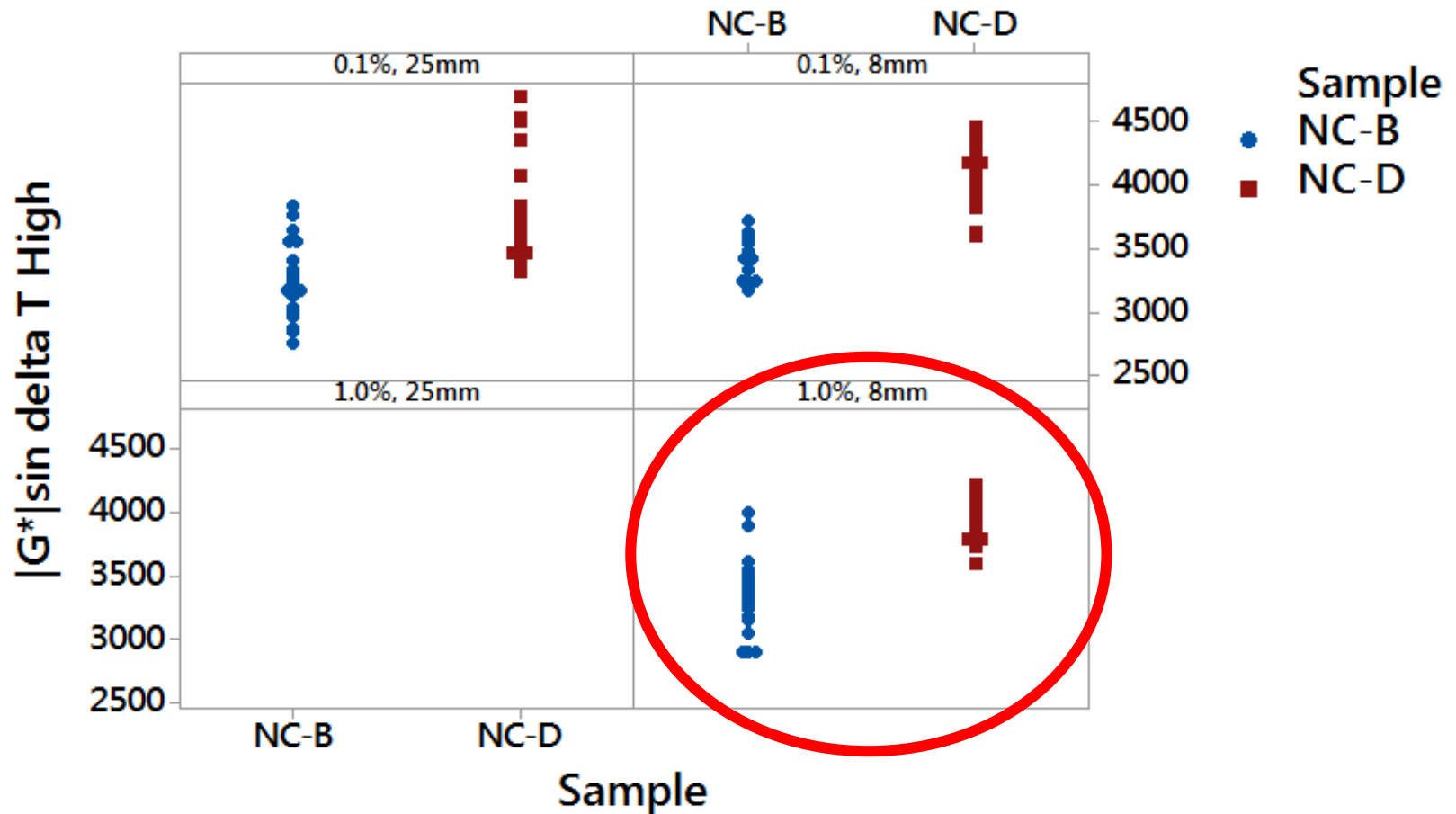
Chart of Stdev($|G^*| \sin \delta$ T High)



Reality of DSR-PAV Measurement

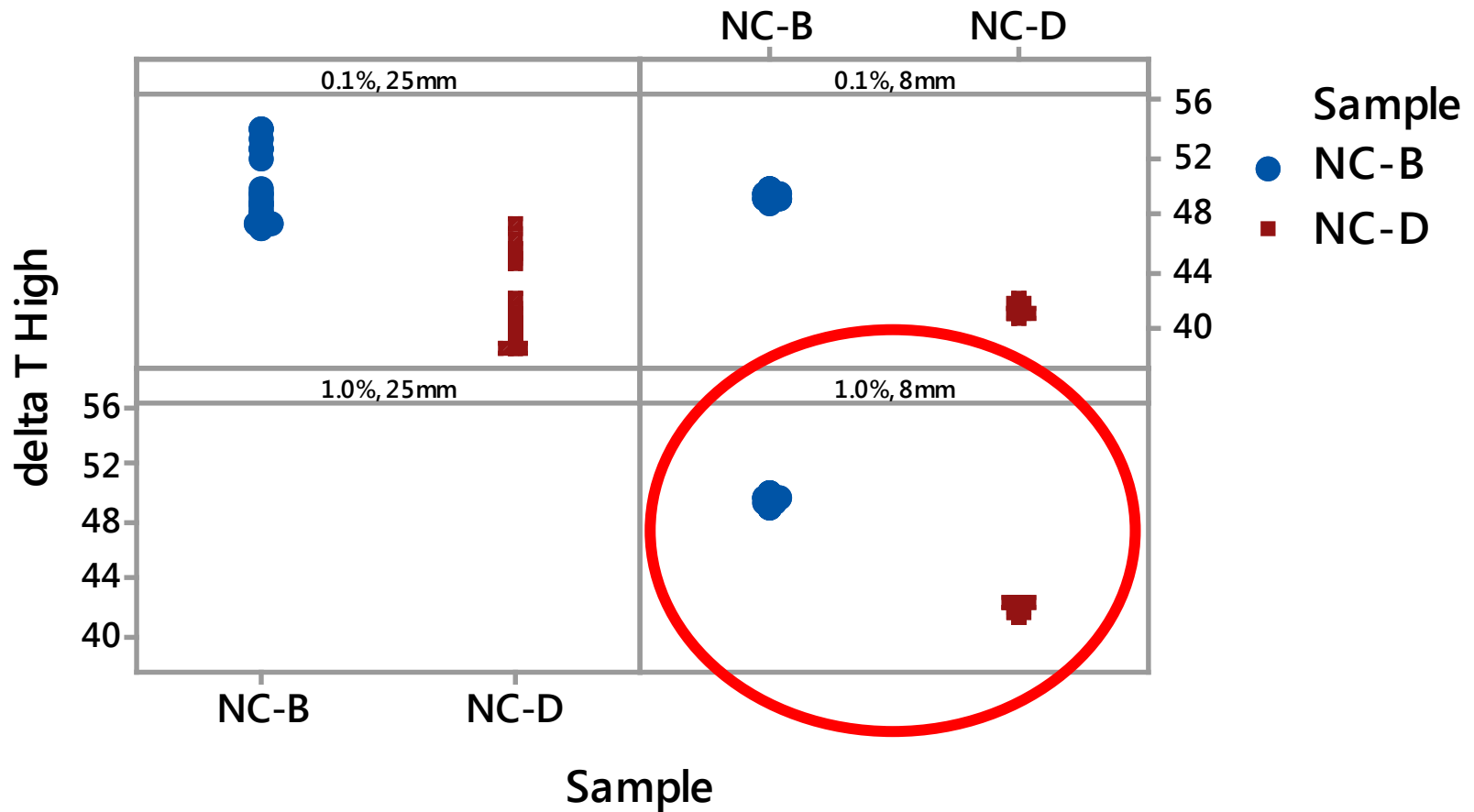
Variability is too high to discriminate

Individual Value Plot of $|G^*|\sin \delta$ T High



Phase Angle on 8mm Very Reliably Measured

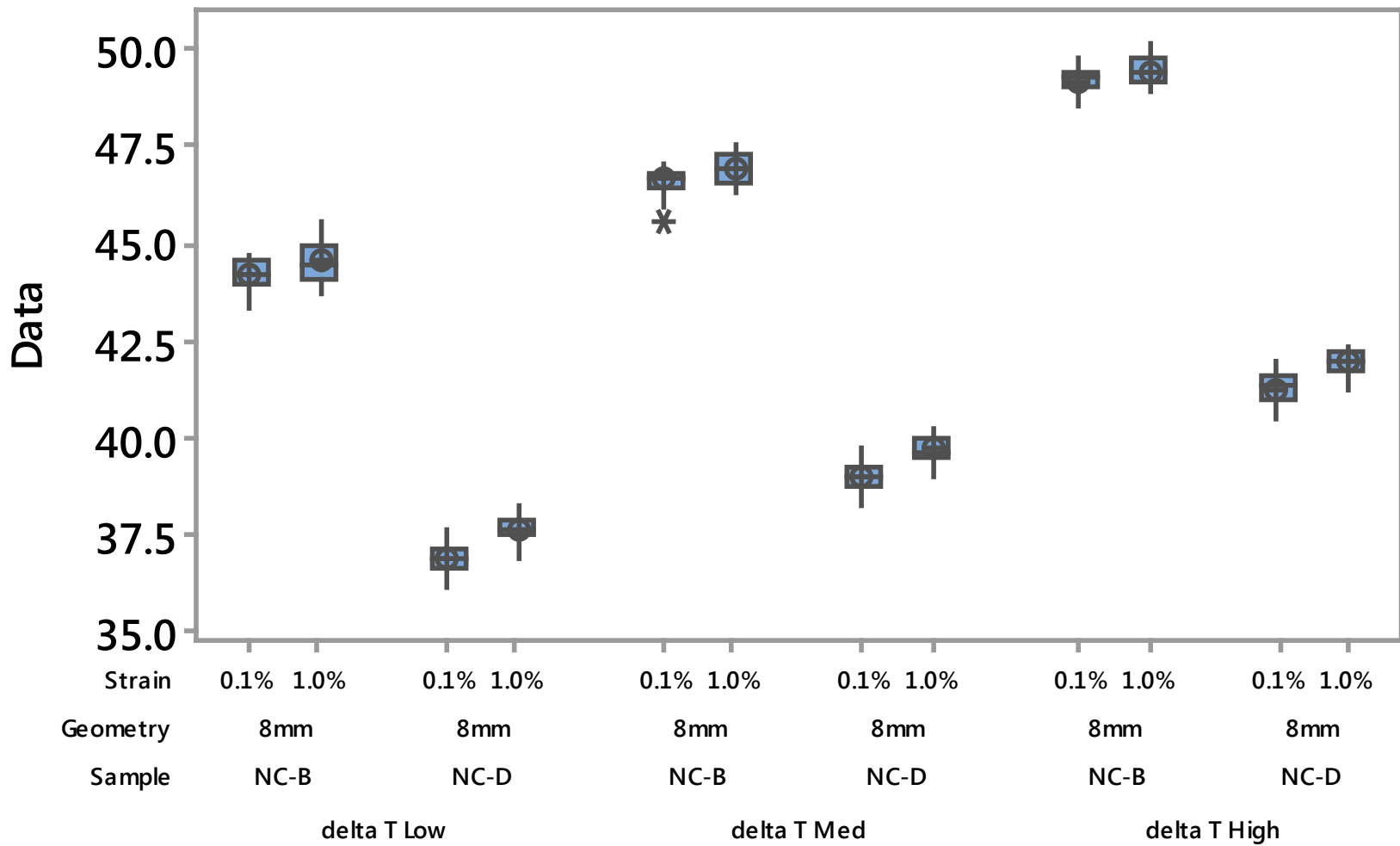
Individual Value Plot of delta T High



Panel variables: Strain, Geometry

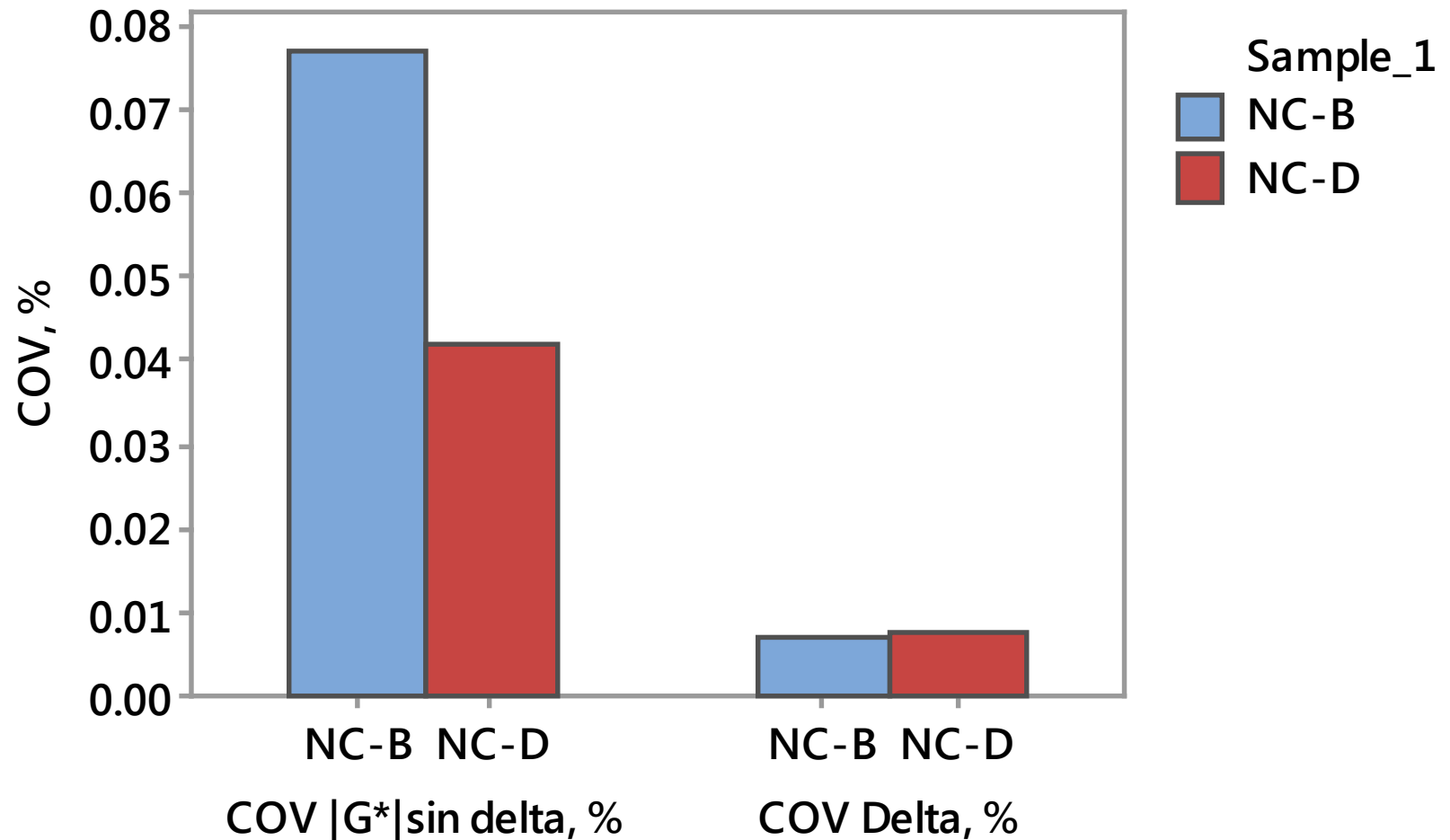
Phase Angle VERY Reliably Measured by Current Setup – Discriminate Samples & Temperatures

Boxplot of delta T Low, delta T Med, delta T High

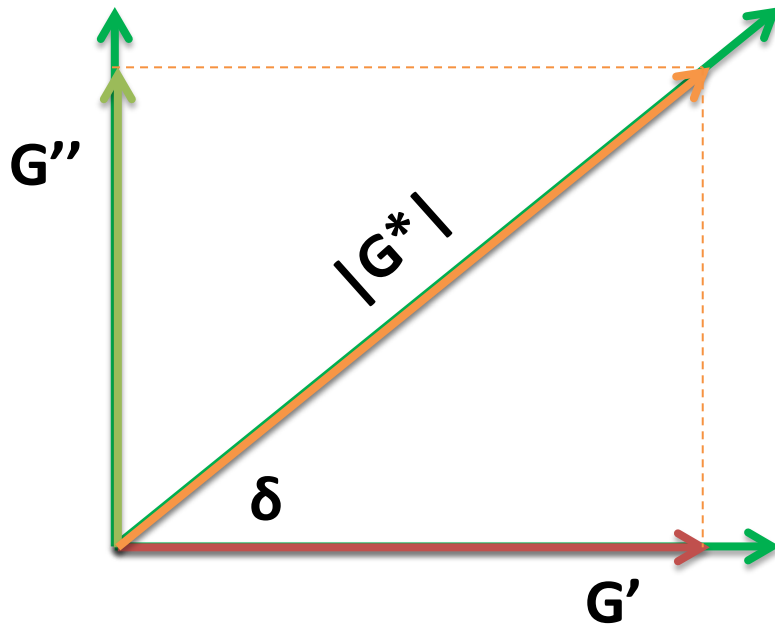


COV for Phase Angle about 10x lower

Chart of COV $|G^*| \sin \delta$, %, COV Delta, %



Phase Angle Measurement is Less Variable



$$|G^*| \cdot \sin \delta = G''$$

Over a narrow range of temperature, G' & G'' change relatively proportionally, thus a change in phase angle would be much less significant than a change in $|G^*|$

Observations from DSR-PAV RR Phase 2

- 3 Labs excluded as clear outliers
- 25 mm plate although relatively precise in individual labs is not suitable at the modulus levels observed in typical DSR-PAV test
- Level of strain (0.1 or 1.0%) insignificant with regards to test result and variability
- No setup able to reliably discriminate the two binders in terms of modulus
- Phase angle showed as very reliable parameter any lab can measure, and which can discriminate asphalts and temperature changes

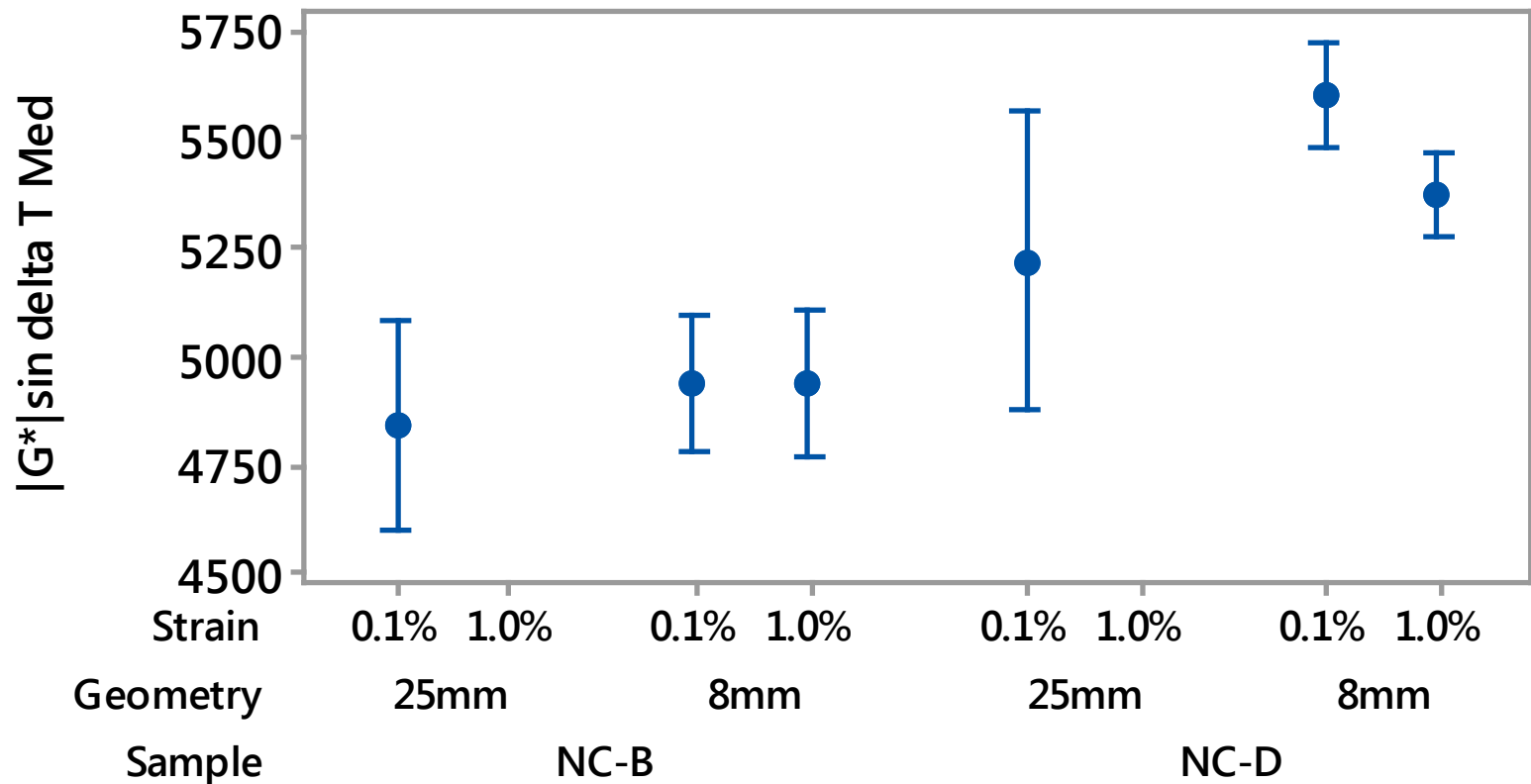
Open to Inputs & Discussion

- Thank you for your time

Appendix

T Med, 8mm lower StDev, Statistically Differ at 0.1% strain

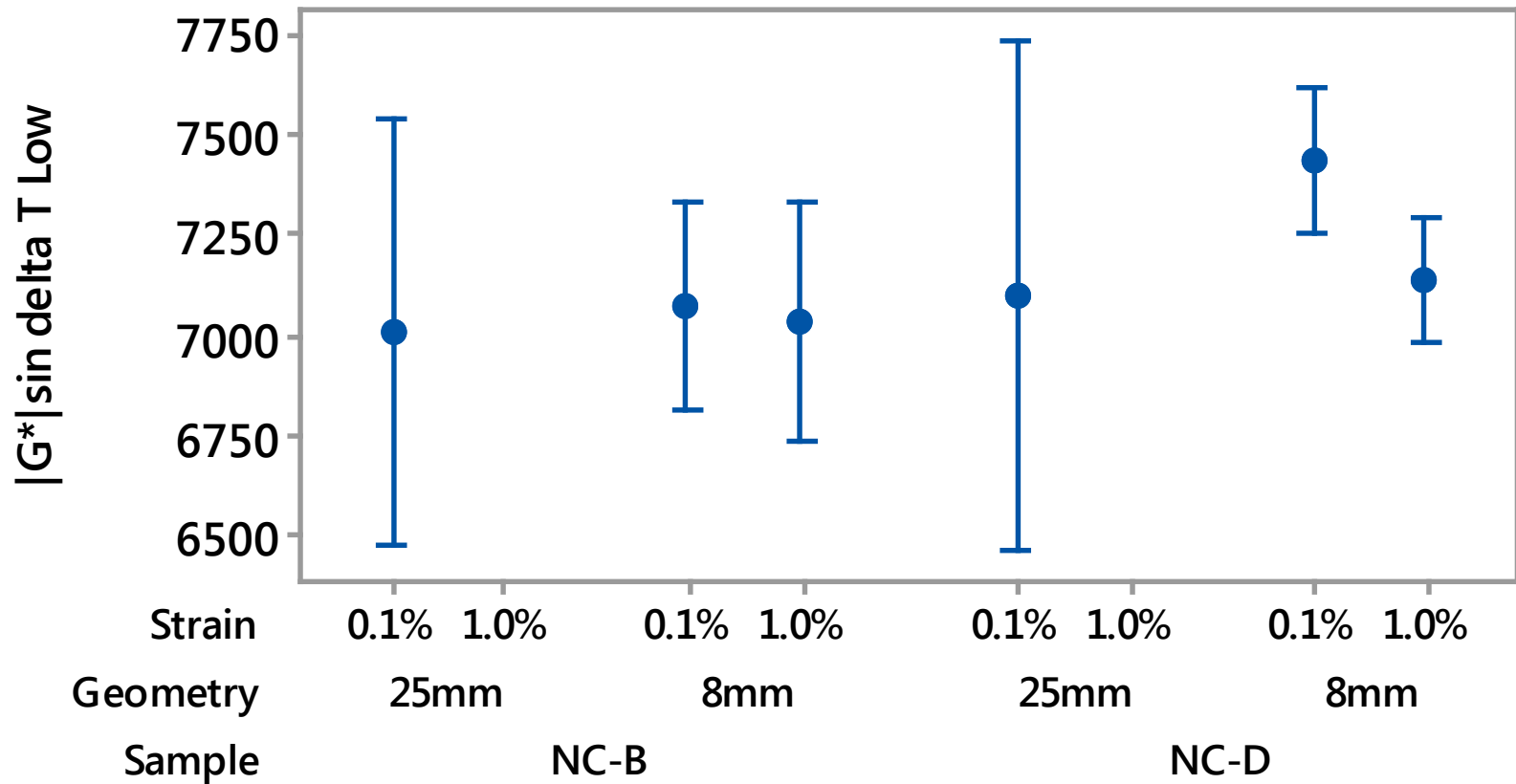
Interval Plot of $|G^*| \sin \delta$ T Med
95% CI for the Mean



Individual standard deviations were used to calculate the intervals.

T Low, 8mm lower StDev, 25mm not useful

Interval Plot of $|G^*| \sin \delta$ T Low
95% CI for the Mean

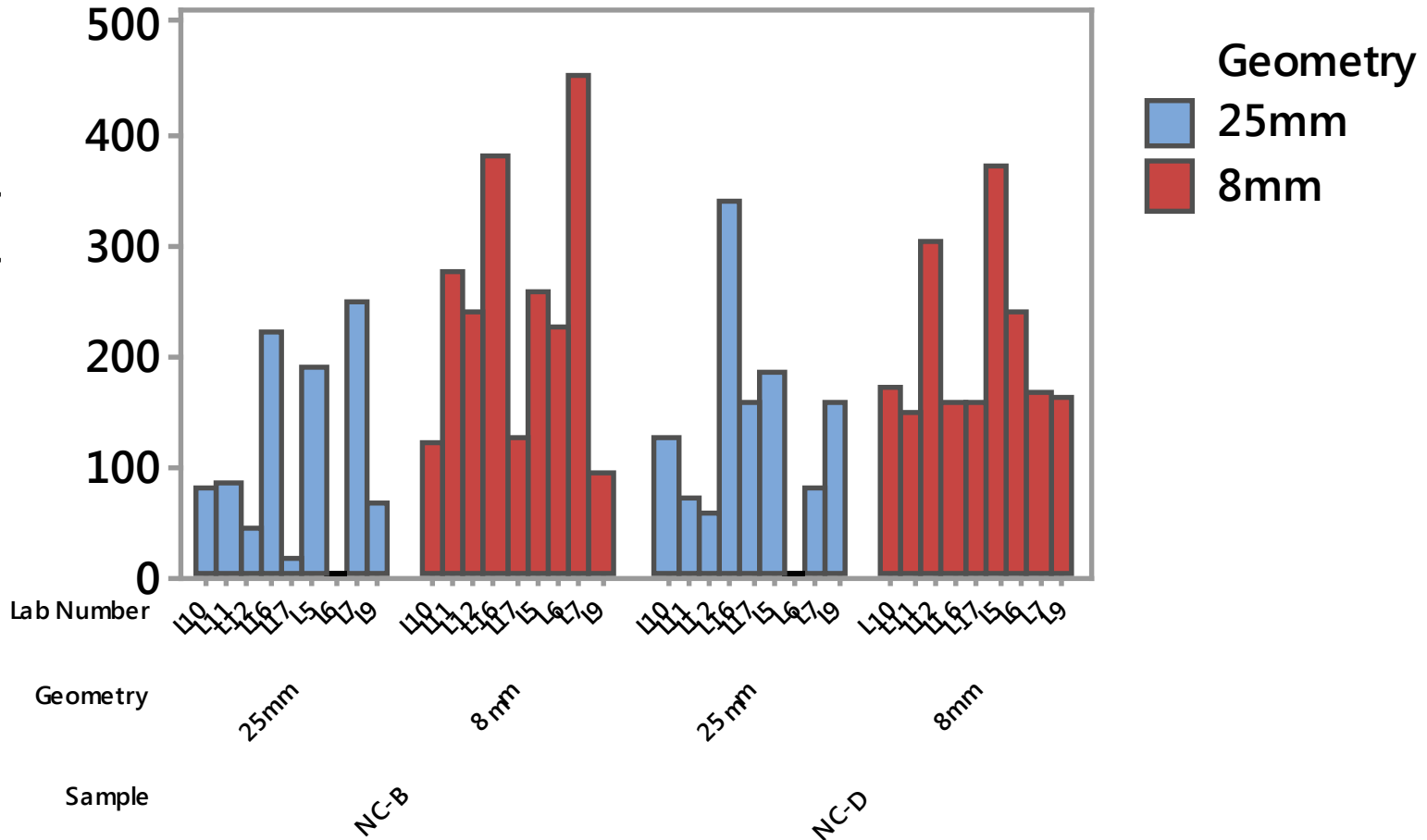


Individual standard deviations were used to calculate the intervals.

T Med, 25mm Better Precision than 8mm but Poorer Accuracy

Chart of Stdev($|G^*| \sin \delta$ T Med)

Standard Deviation of $|G^*| \sin \delta$ T Med



T Low, 25mm Unreliable

Standard Deviation of $|G^*| \sin \delta$ T Low

Chart of Stdev($|G^*| \sin \delta$ T Low)

