GT Conference: Valve Train Validation for New Engine Program

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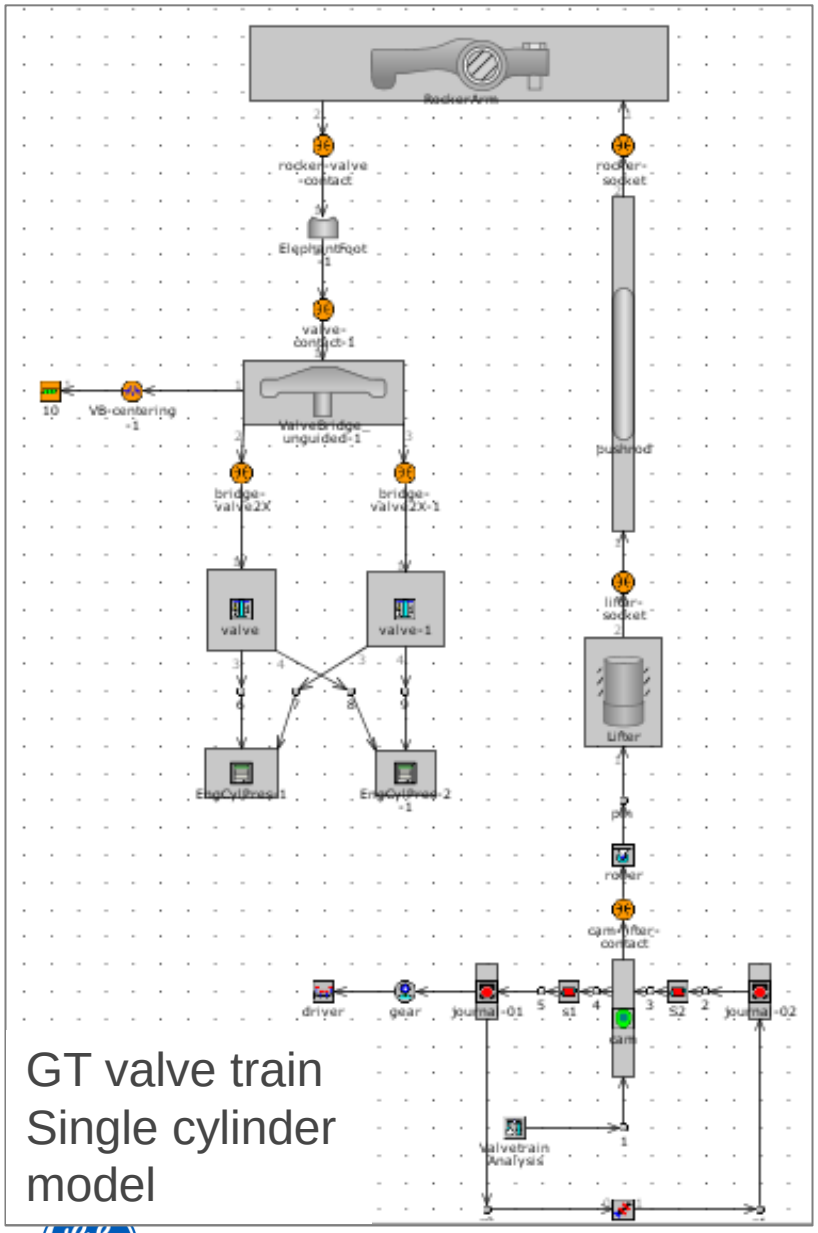
Imagination at work.

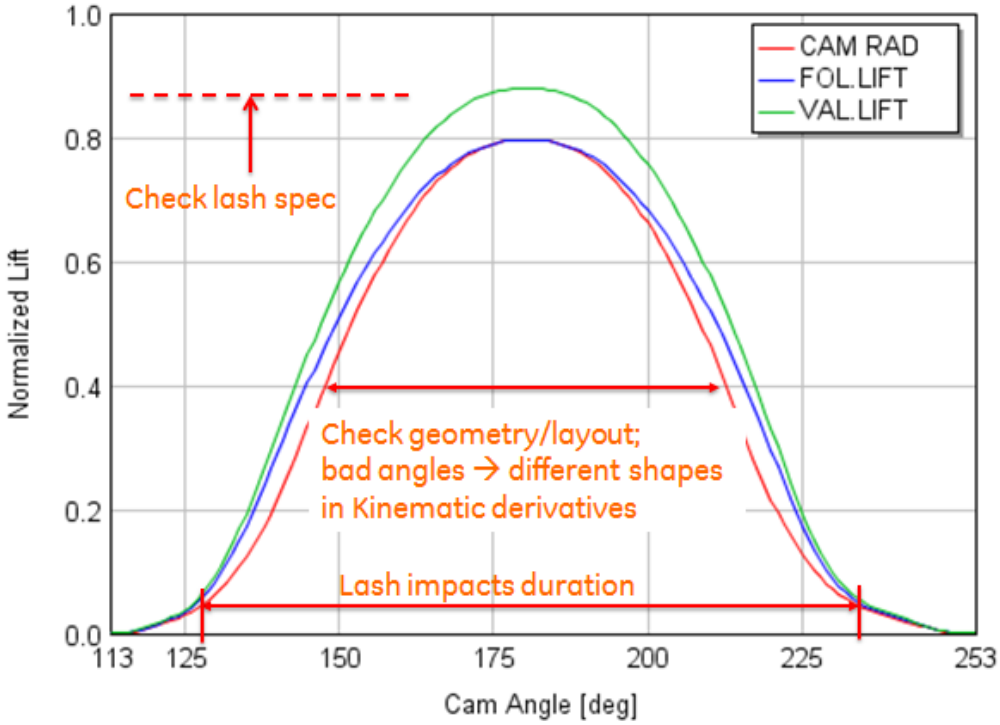
Agenda

- GT Model
- Schematic of measurement locations
- Calibration of Valve and seat stiffness using test data
- Influence of Rocker Pivot stiffness on Valve closing
- Valve displacement validation
- Valve seating velocity Validation
- Pushrod force dynamics influencing parameters
- Influence of lash on Pushrod force
- Pushrod force validation
- High Lash Valve Displacement
- Summary

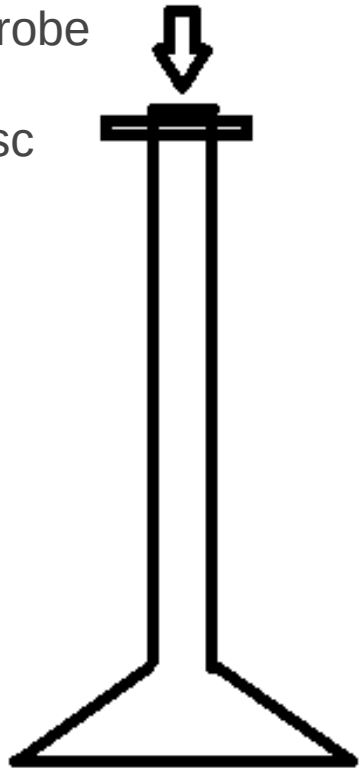
Valve train Dynamic model

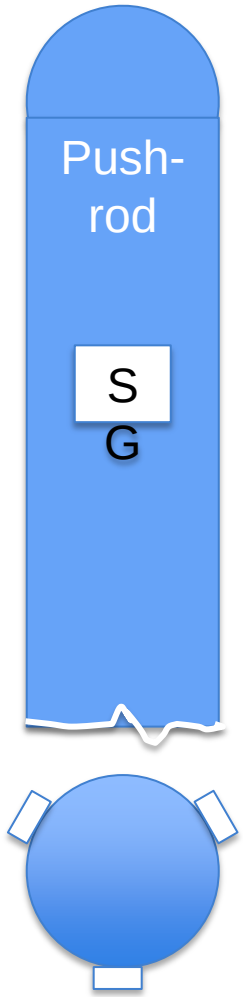


GT valve train Single cylinder model



Schematic of Valve displacement & Pushrod force measurement



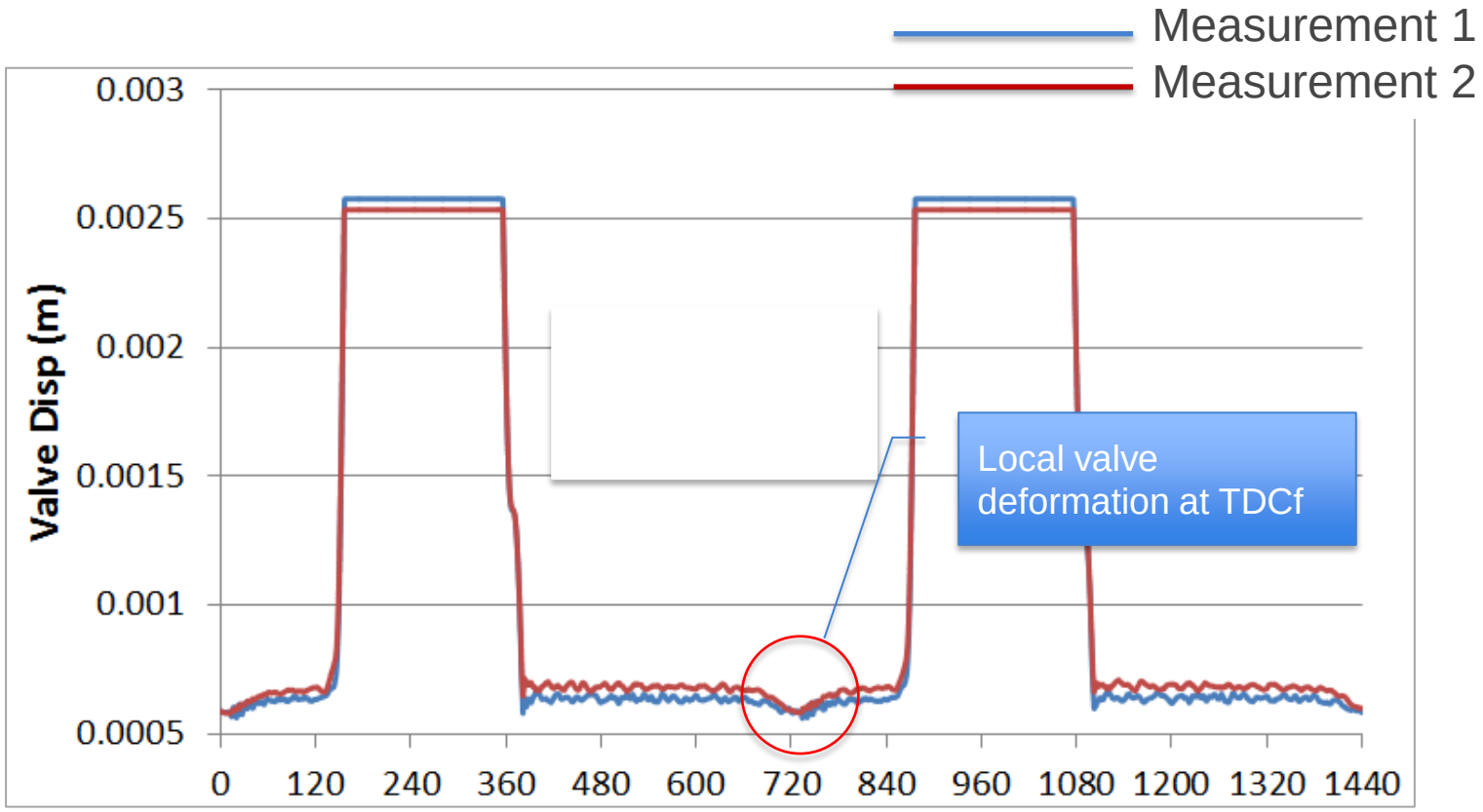


- Proximity probe used to measure displacement of the valve
- Valve seating velocity calculated by differentiating the measured valve displacement

Valve

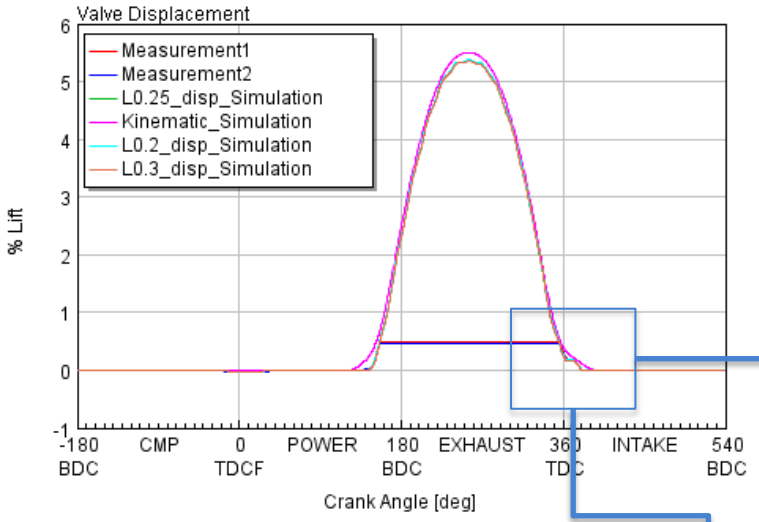
- Measured by 3 equally spaced (theta direction) strain gages
- Measured strains are converted into force

Calibration of Valve and seat stiffness with test data

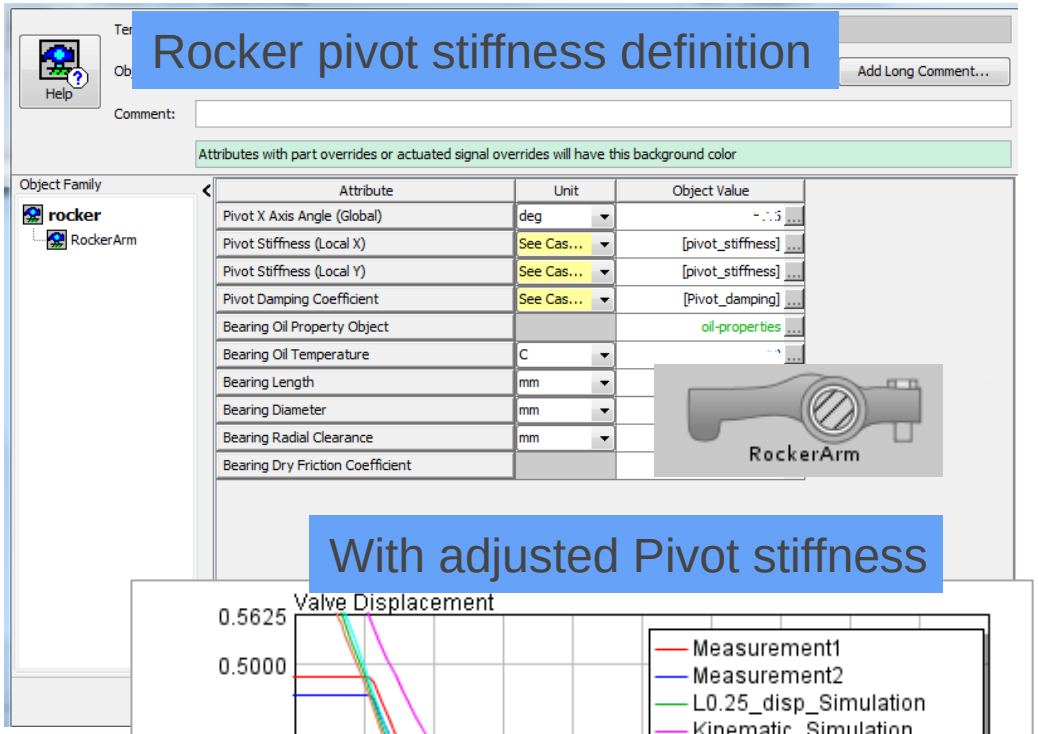


- Valve & seat Stiffness calibrated to observed local deformation of Valve at Firing TDC

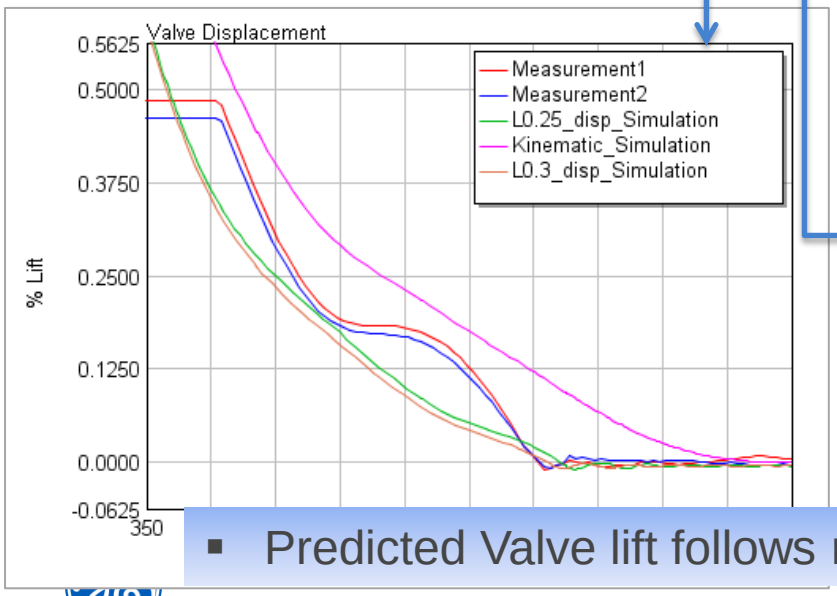
Influence of Rocker Pivot stiffness on Valve closing



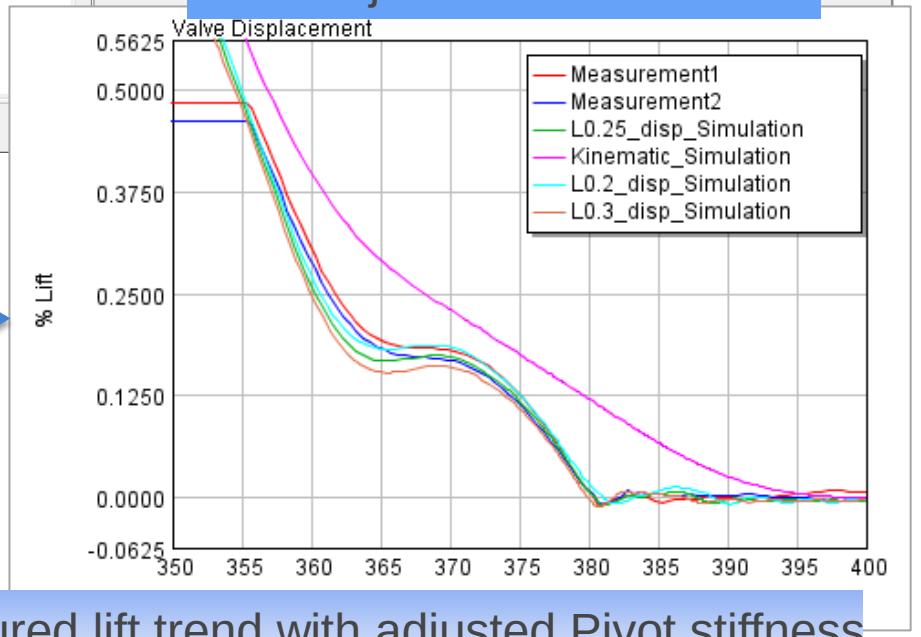
Rocker pivot stiffness definition



With default Pivot stiffness

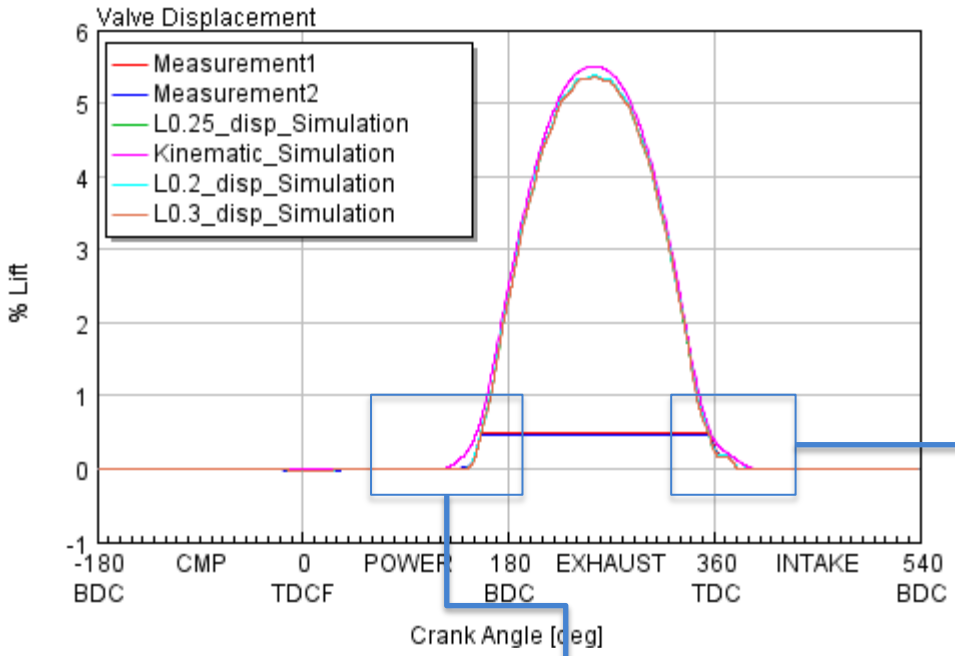


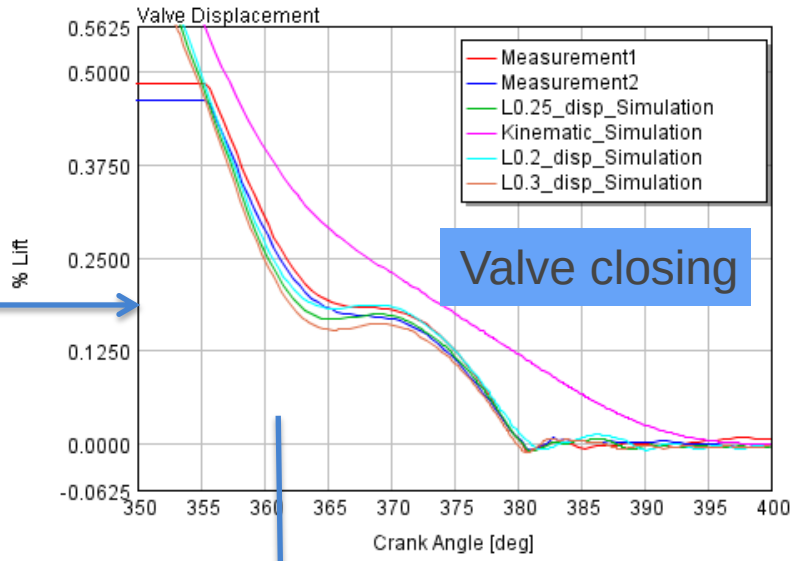
With adjusted Pivot stiffness

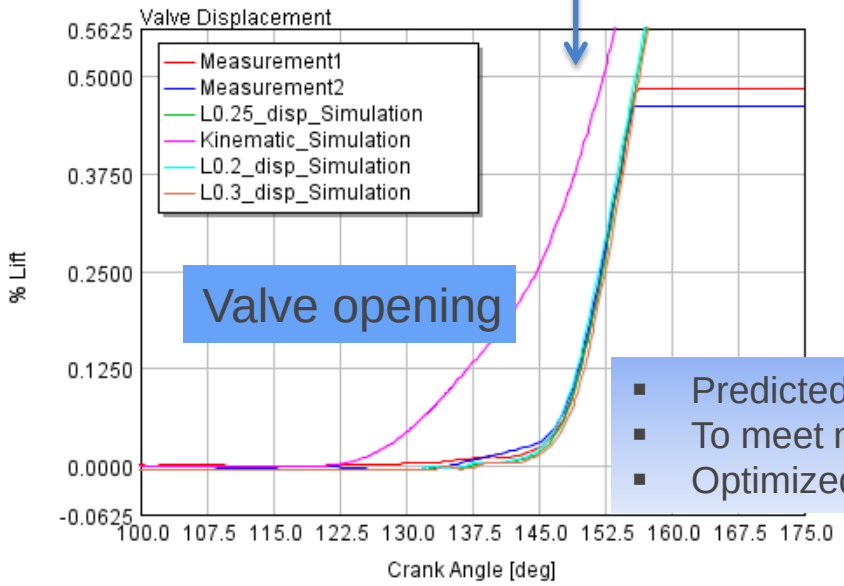


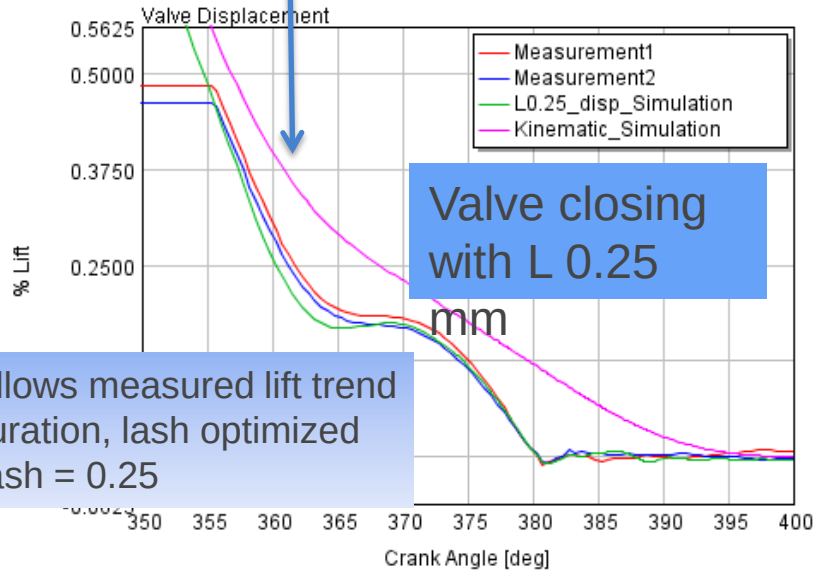
- Predicted Valve lift follows measured lift trend with adjusted Pivot stiffness

Valve displacement validation



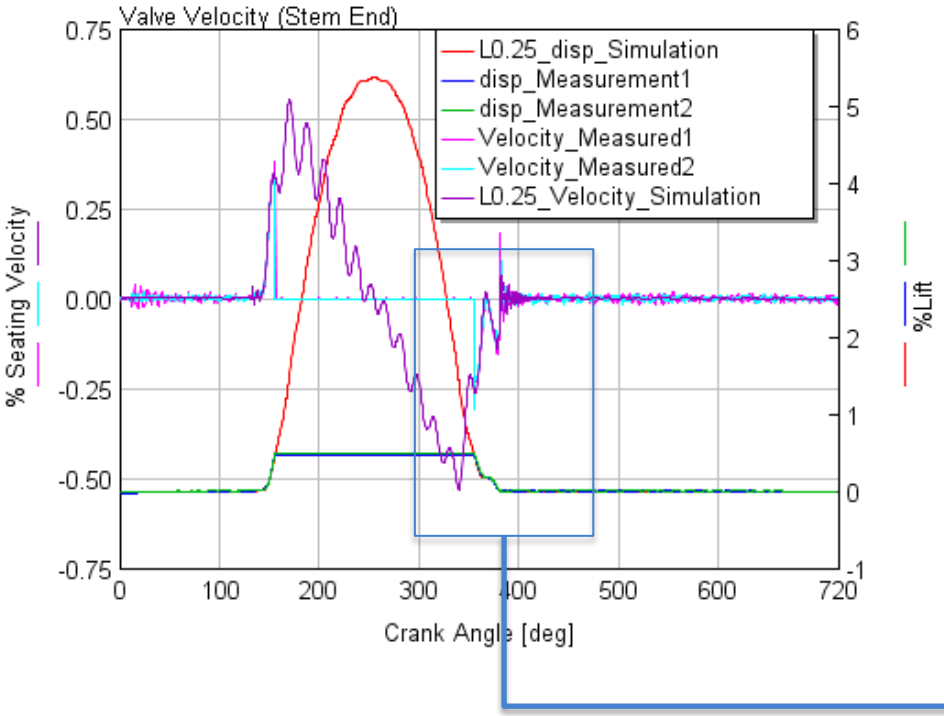


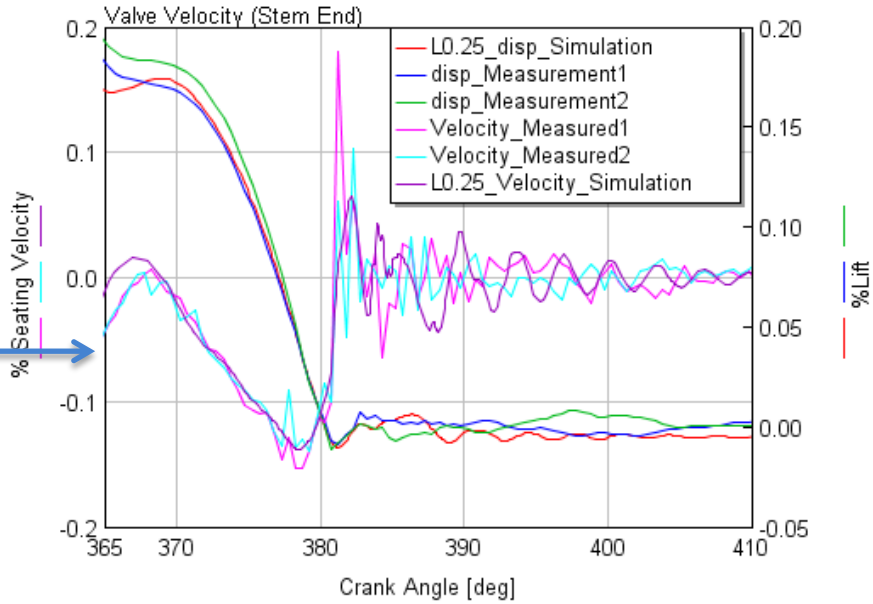




- Predicted Valve lift follows measured lift trend
- To meet measured duration, lash optimized
- Optimized dynamic lash = 0.25

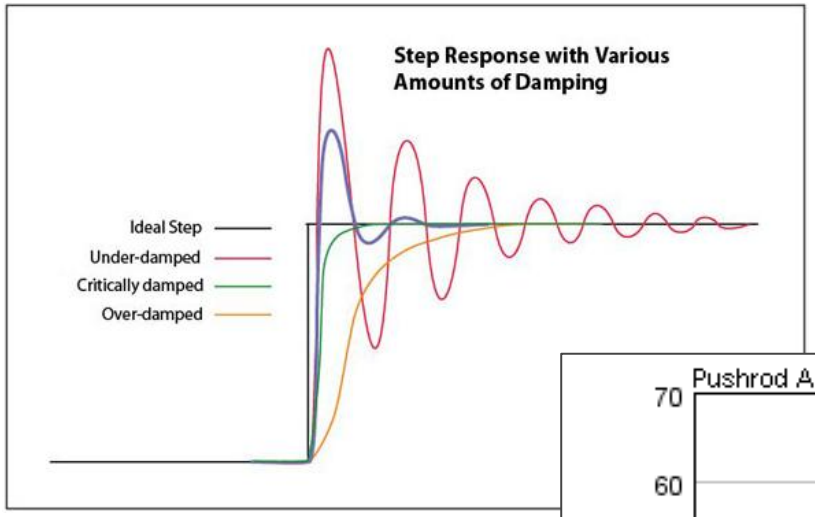
Valve seating velocity Validation

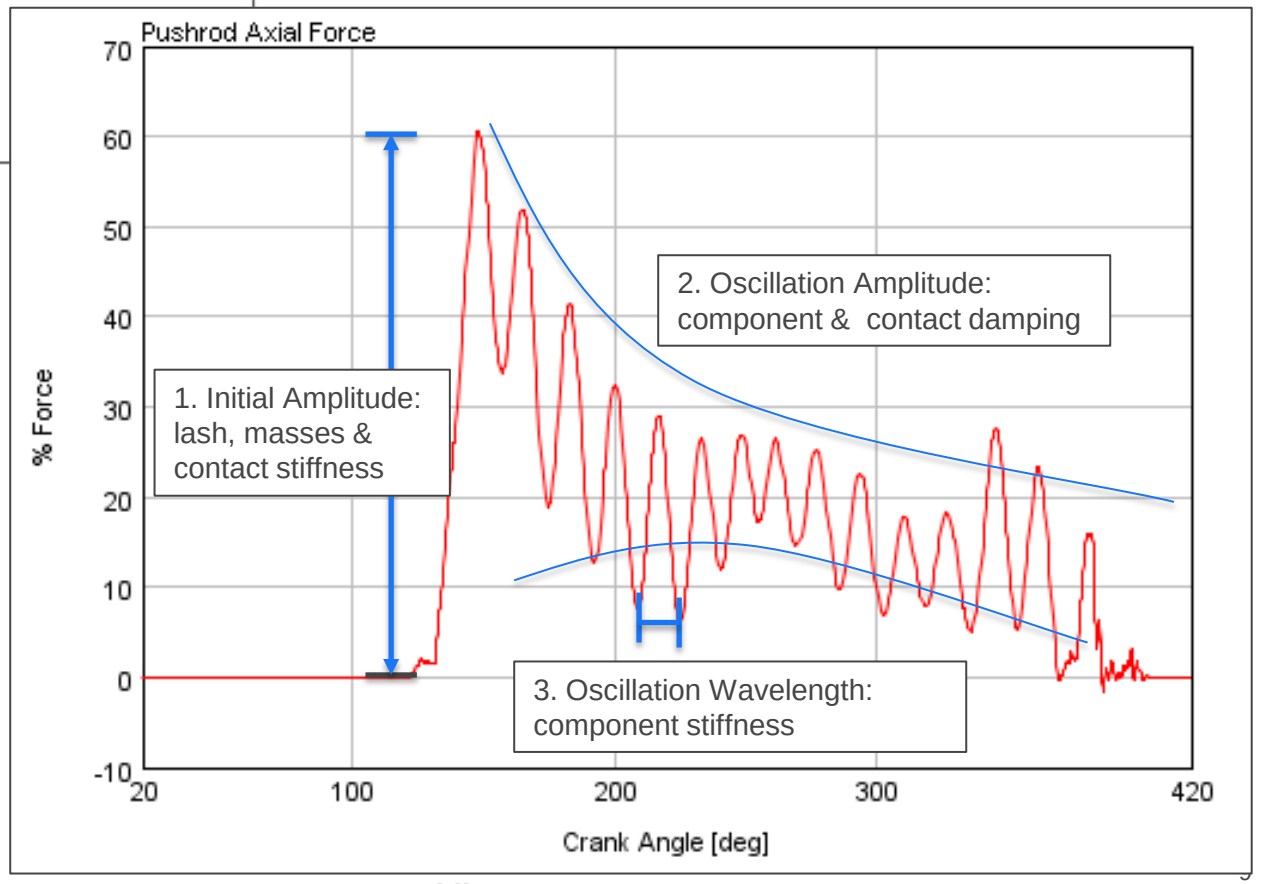




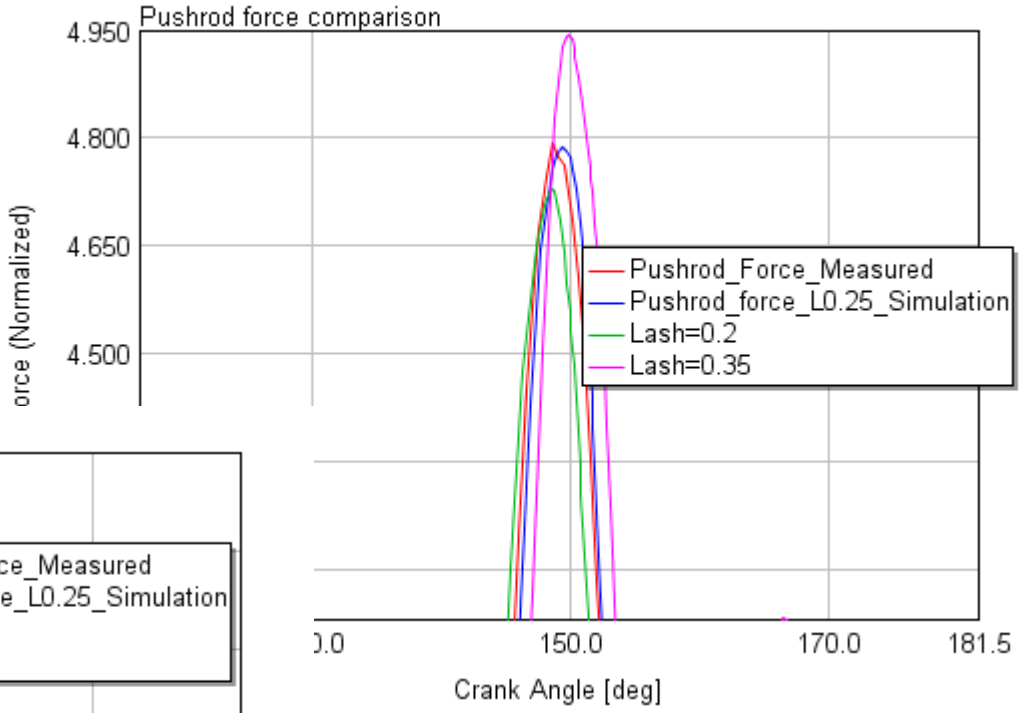
- Seating velocity trend exactly followed
- Values within measurement variation

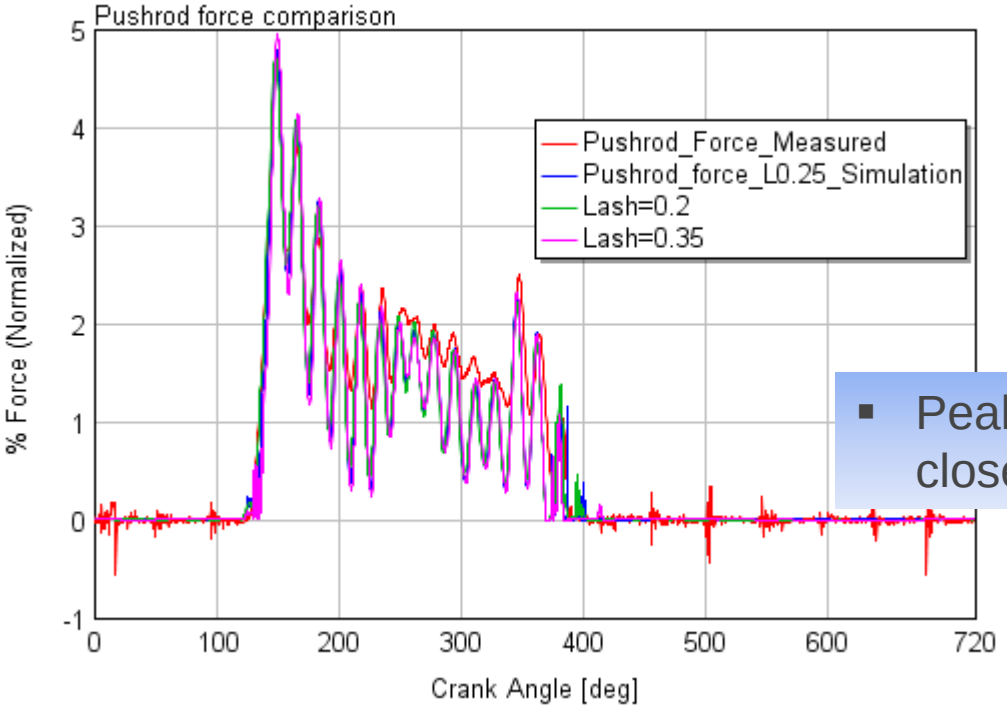
Pushrod force dynamics influencing parameters





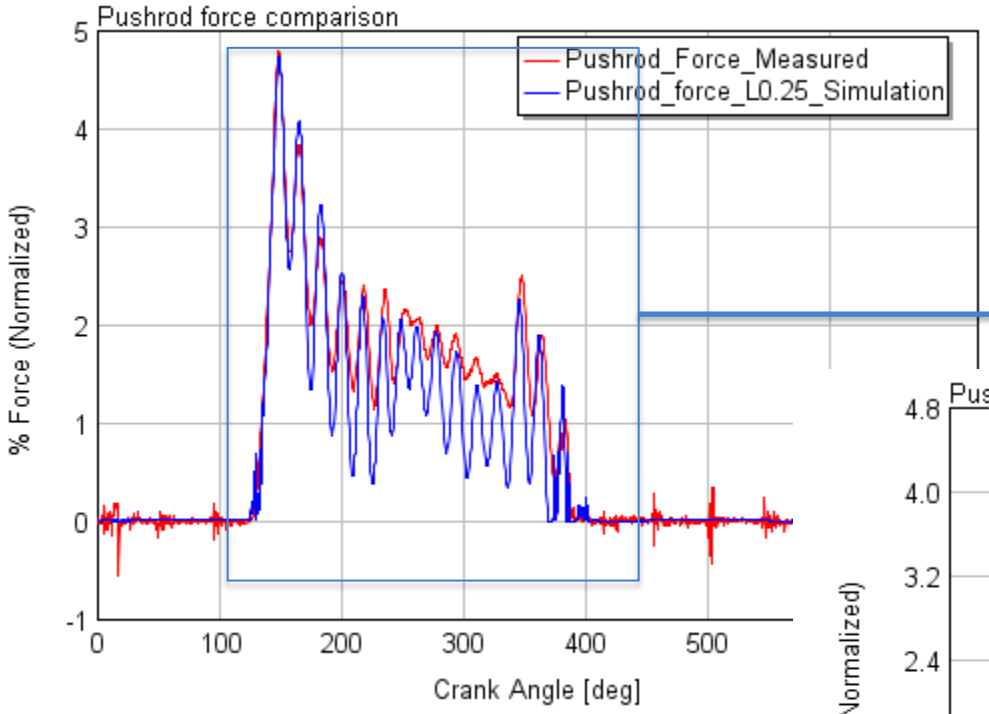
Influence of lash on Pushrod force

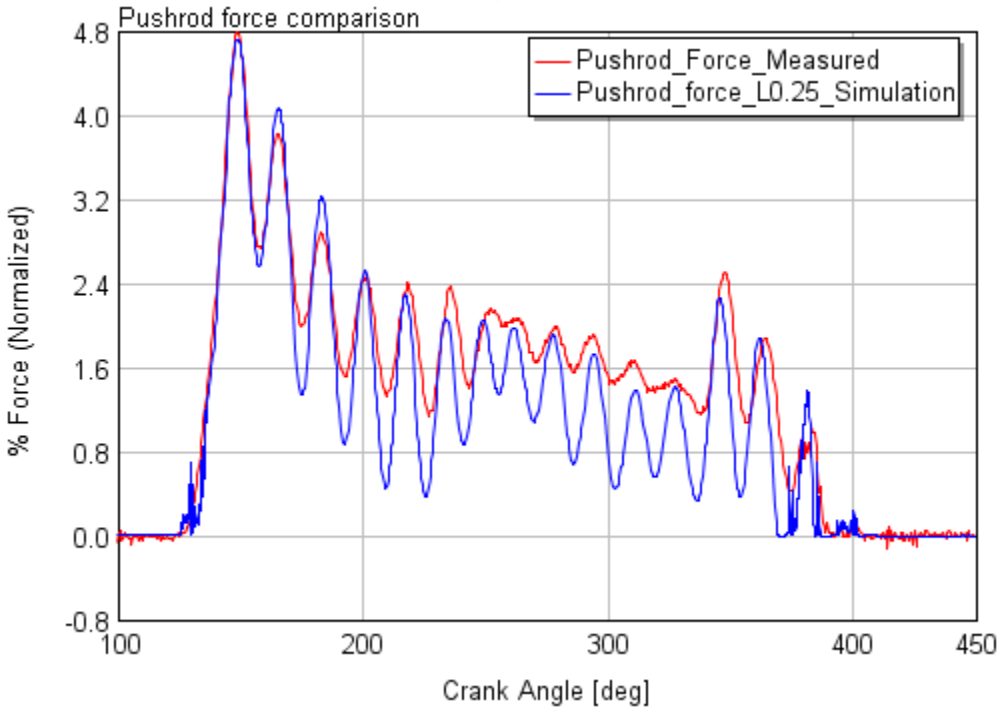




- Peak pushrod force with L 0.25 mm in close agreement with test data

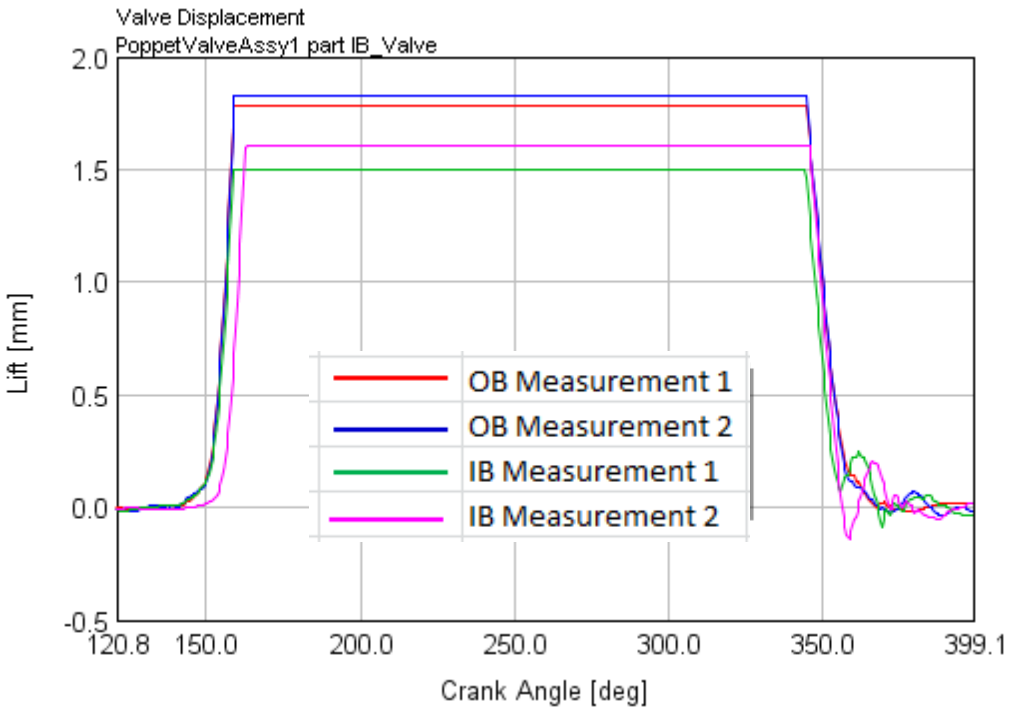
Pushrod force validation



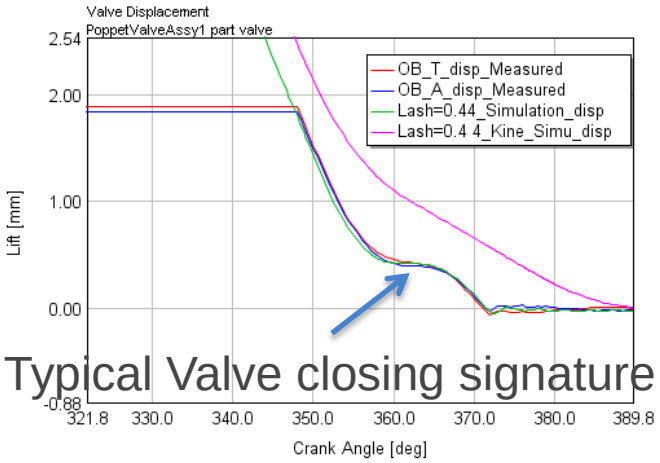


- Simulation Pushrod force frequency matches well with measurement frequency
- Max Pushrod force matches well within measurement variation ~ 100 N

Discrepancy in high Valve lash condition



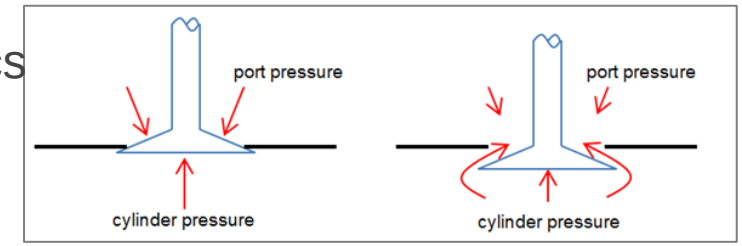
Nominal lash Valve displacement



Typical Valve closing signature

- Not seen typical Valve closing signature and
- Lift difference between OB & IB ~ 0.28 mm → may indicate Valve bridge rotation

Local port pressure for IB/OB valve is not available, which may drive observed dynamics



Summary

- Completed Validation for nominal and high lash condition
- GT Simulation shows good correlation for valve displacement, seating velocity and Pushrod force for measurement trend, magnitude and frequency of oscillations except for below load cases
- High lash over-speed condition test data shows significant difference in trend and magnitude of OB vs IB valve lift. This may be possibly due to Valve bridge rotation. OB/IB Port pressure data is required to capture phenomenon
- Efforts are on to capture it defining large arc contact & other virtual means