The X-Tracker™ Wheel Bearing Family

Vehicle Dynamics Expo 2008

Presented By:

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Outline

- Market Trends
- Case Study Background
- Increased demands of a HP Vehicle
- Quantification and root cause
- Brake Knock back explanation
- Analytical Assessment
- Design Solution
- Confirmation results
- Summary of benefits

Market Trends

- Use of larger wheels and tires
- Use of larger brake components
- Use of SUV and light trucks as family vehicles
- Increase of performance without changing chassis architecture
- Use of identical components on multiple vehicle platforms
- Increased vehicle warranty coverage

Case Study Background

- High performance vehicles developed from production platforms

- Very significant change to an existing vehicles performance targets resulting in more demanding component requirements

  - Structural loading conditions are significantly effected
    - Acceleration (hp, torque, mass)
    - Braking (specific torque, mass)
    - Cornering (taller/stiffer tire, more grip, mass)
    - Application (performance driving, track usage)

- Design solutions were required to resolve these forces

- Vehicle architecture/component interface must remain common with the base vehicle

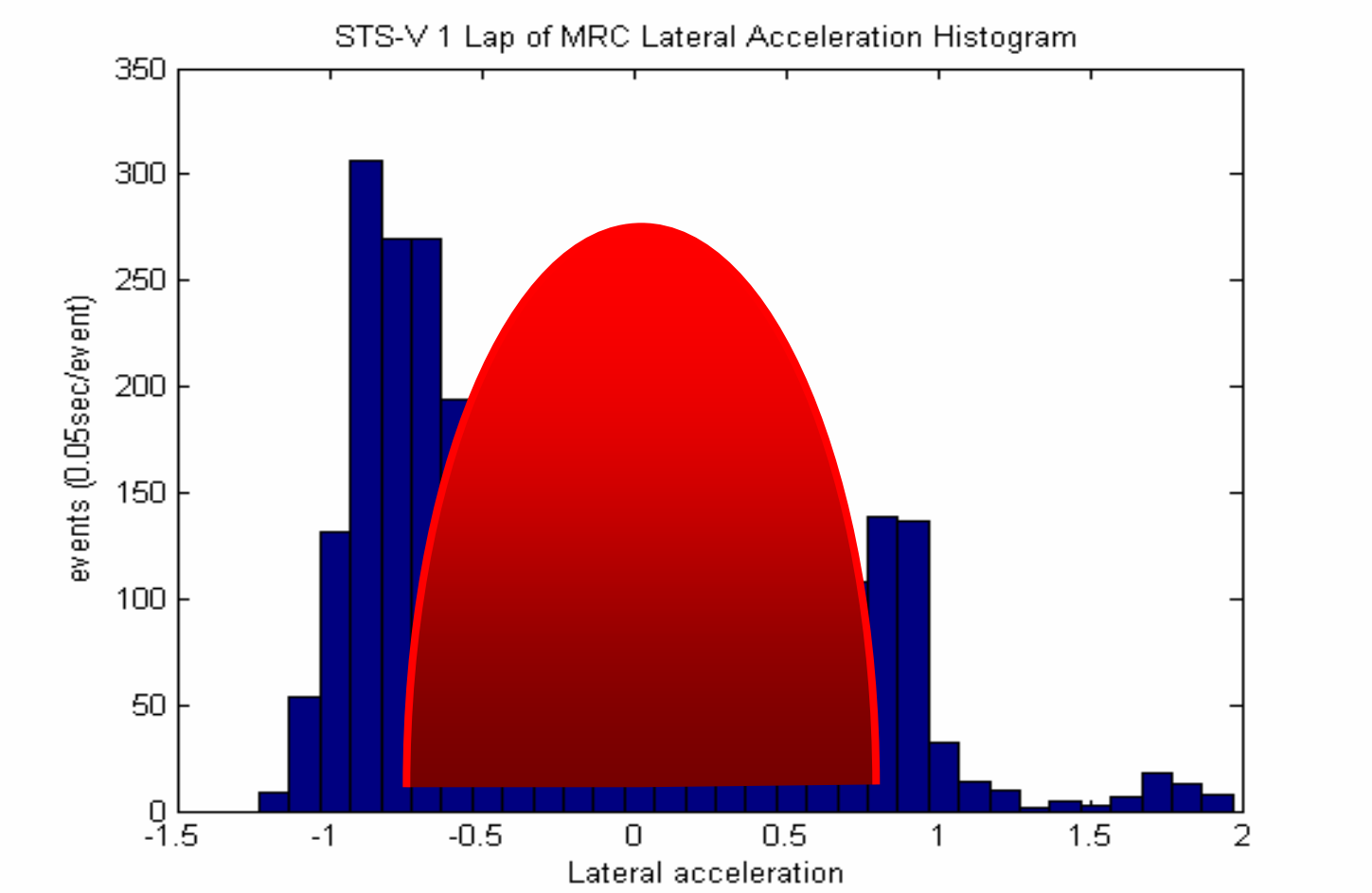
Vehicle Modifications

Horsepower increase of ~32%

Torque increase of ~28%

	Base Vehicle	Performance Version
Tire (Front)	225/50/R17	255/45/R18
Tire Rear	255/45/R17	275/40/R19
Horsepower	320 @ 6400 rpm	469 @ 6400 rpm
Torque	315 lb-ft @4400 rpm	439 lb-ft @ 3900 rpm
Powertrain	4.6l V8	4.4 l V8 (Supercharged)
0 to 60	6.0 seconds	<5.0 seconds
Top Speed	120 mph	167 mph

Lateral Acceleration on Test Track



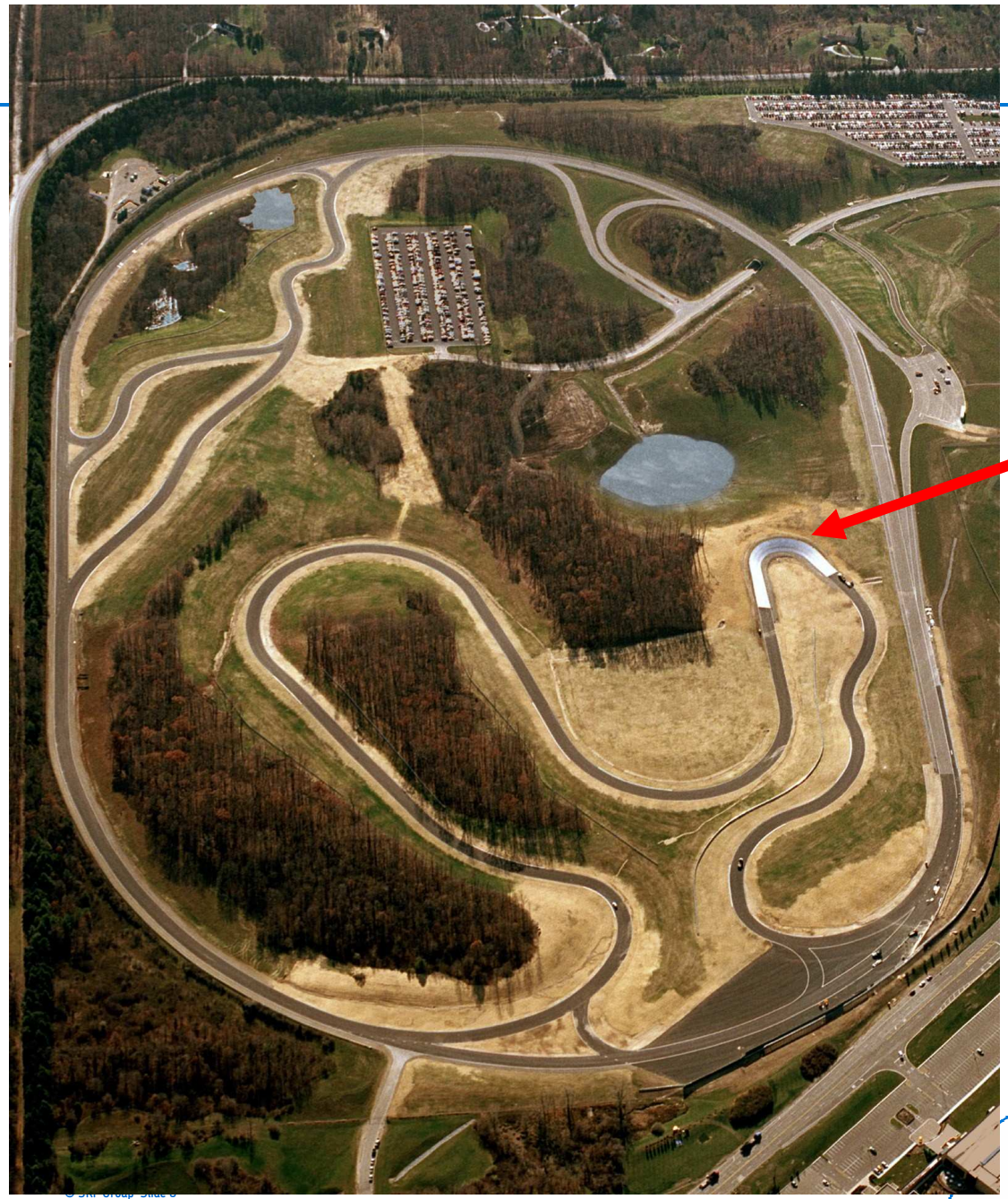
Track Requirements

- The vehicle was required to have excellent performance both on road and on track

- General Motors tests and validates all HPVO products on the Milford Road Course located at the GM Milford Proving Grounds

- Tests were also conducted at the famous Nurburgring in Germany

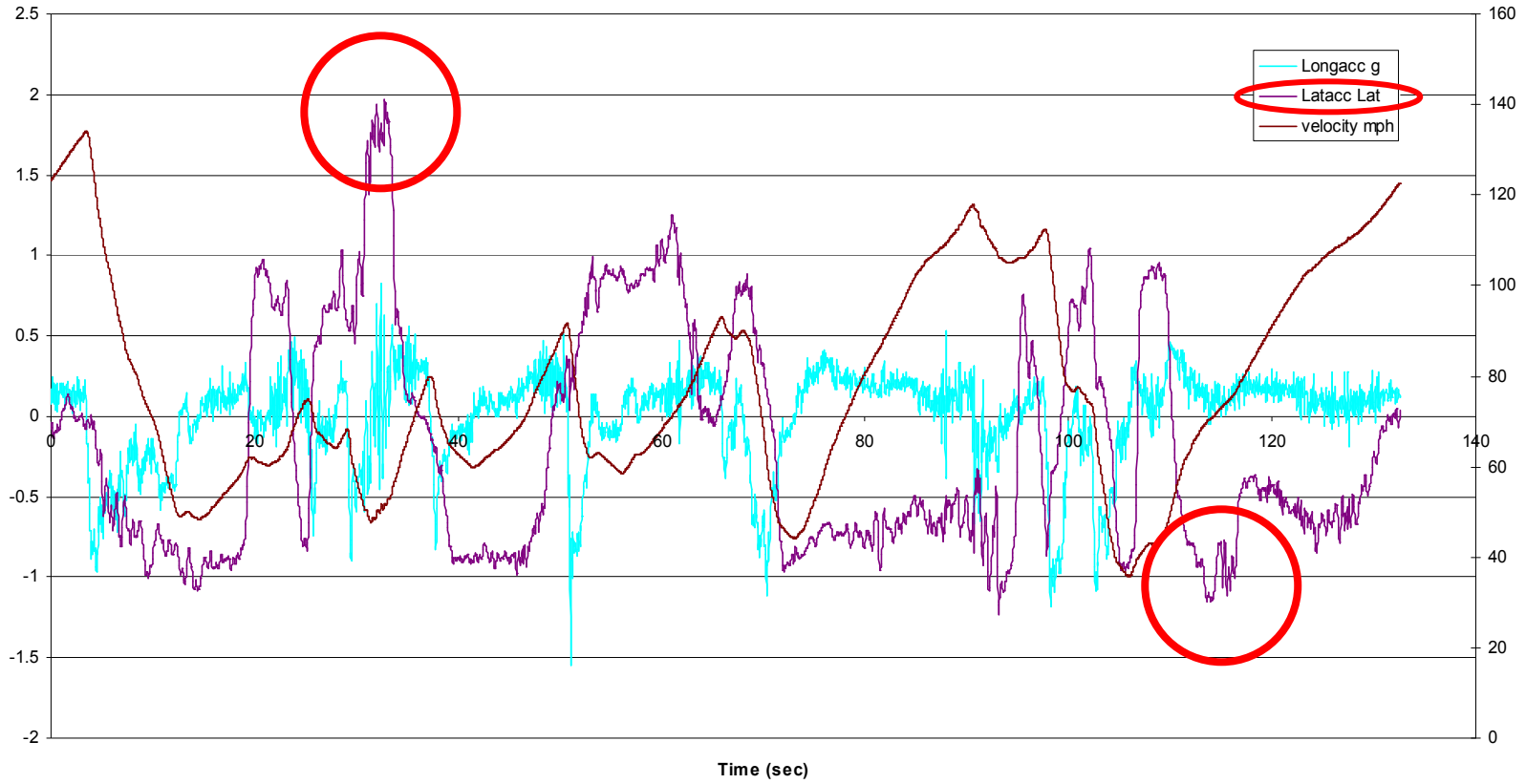
M.R.C.



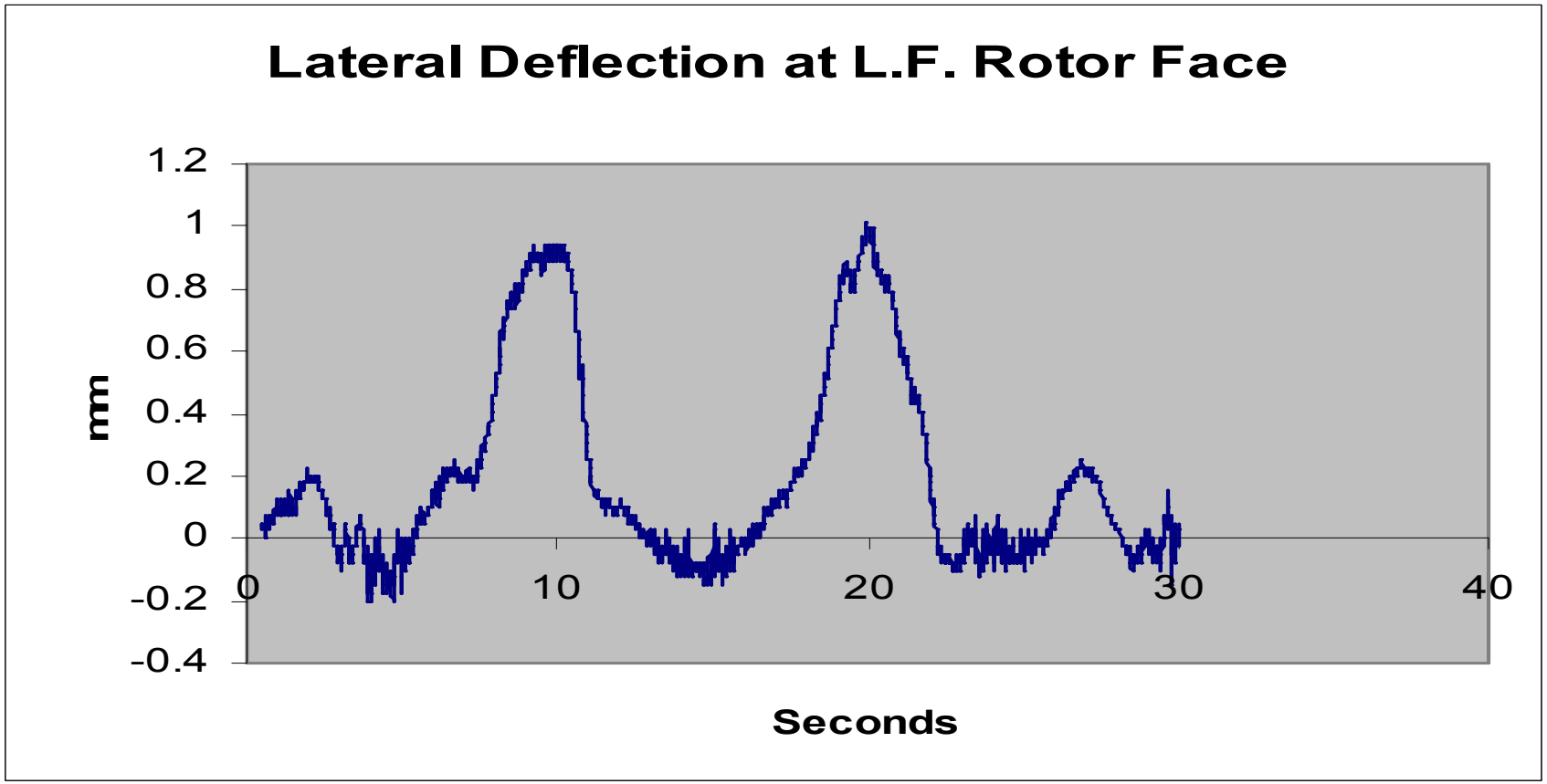
Peak lateral loads
>1.5g

Lateral Acceleration and Racing

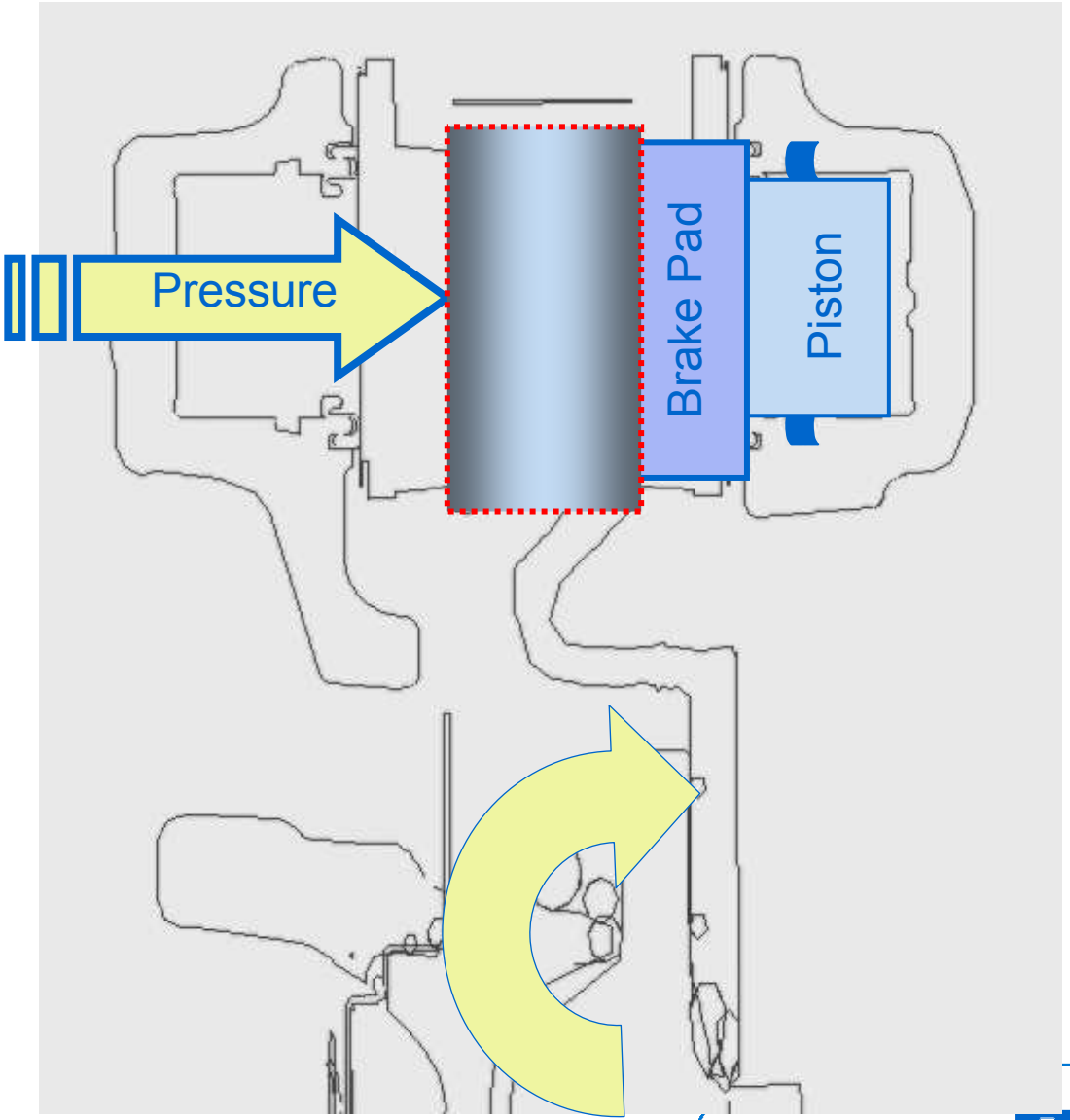
Driving the vehicle at the limit generates lateral loads significantly higher that those generated in typical passenger car (<0.7g)



Lateral Rotor Deflection Due to Bearing Deflection

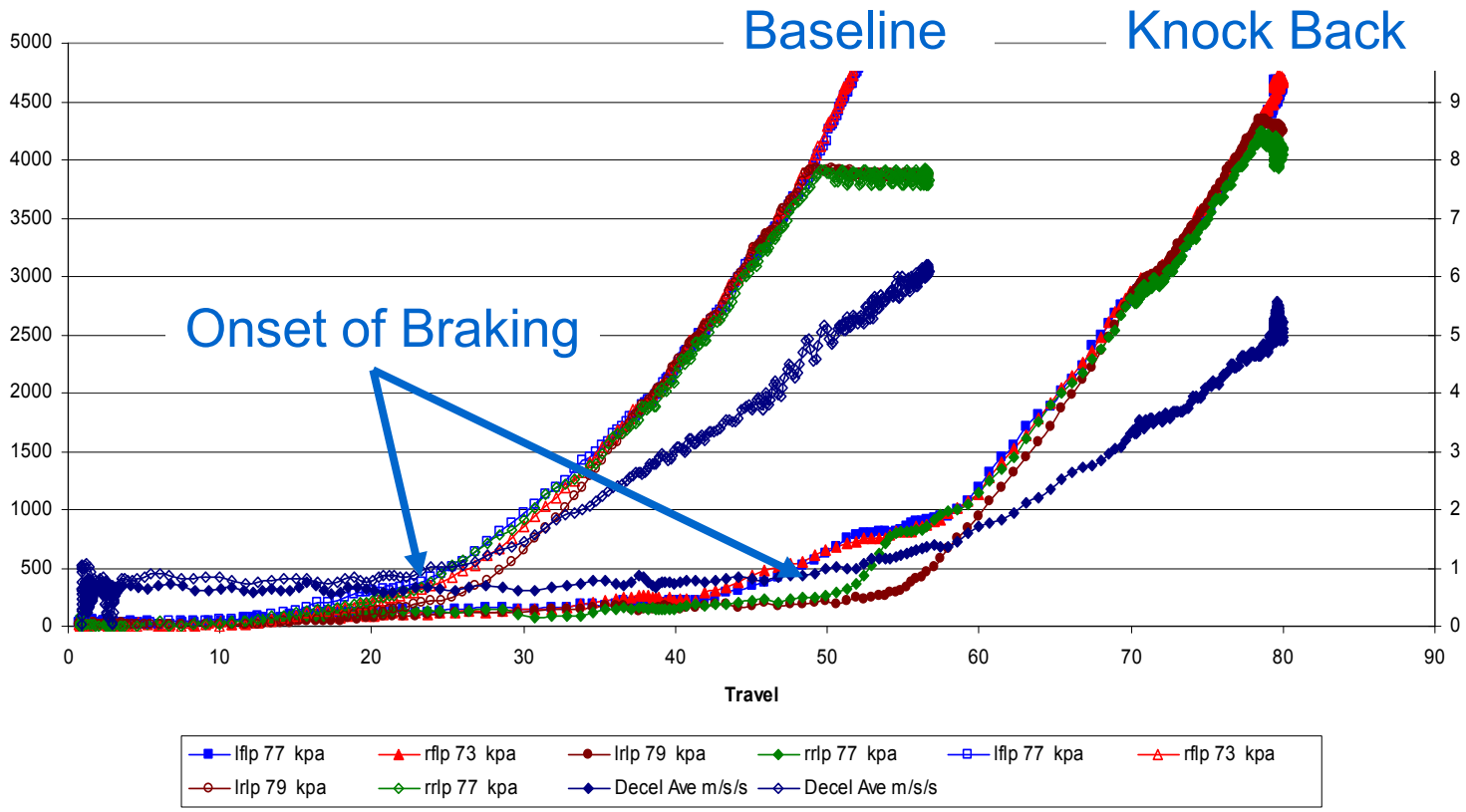


Problem Description

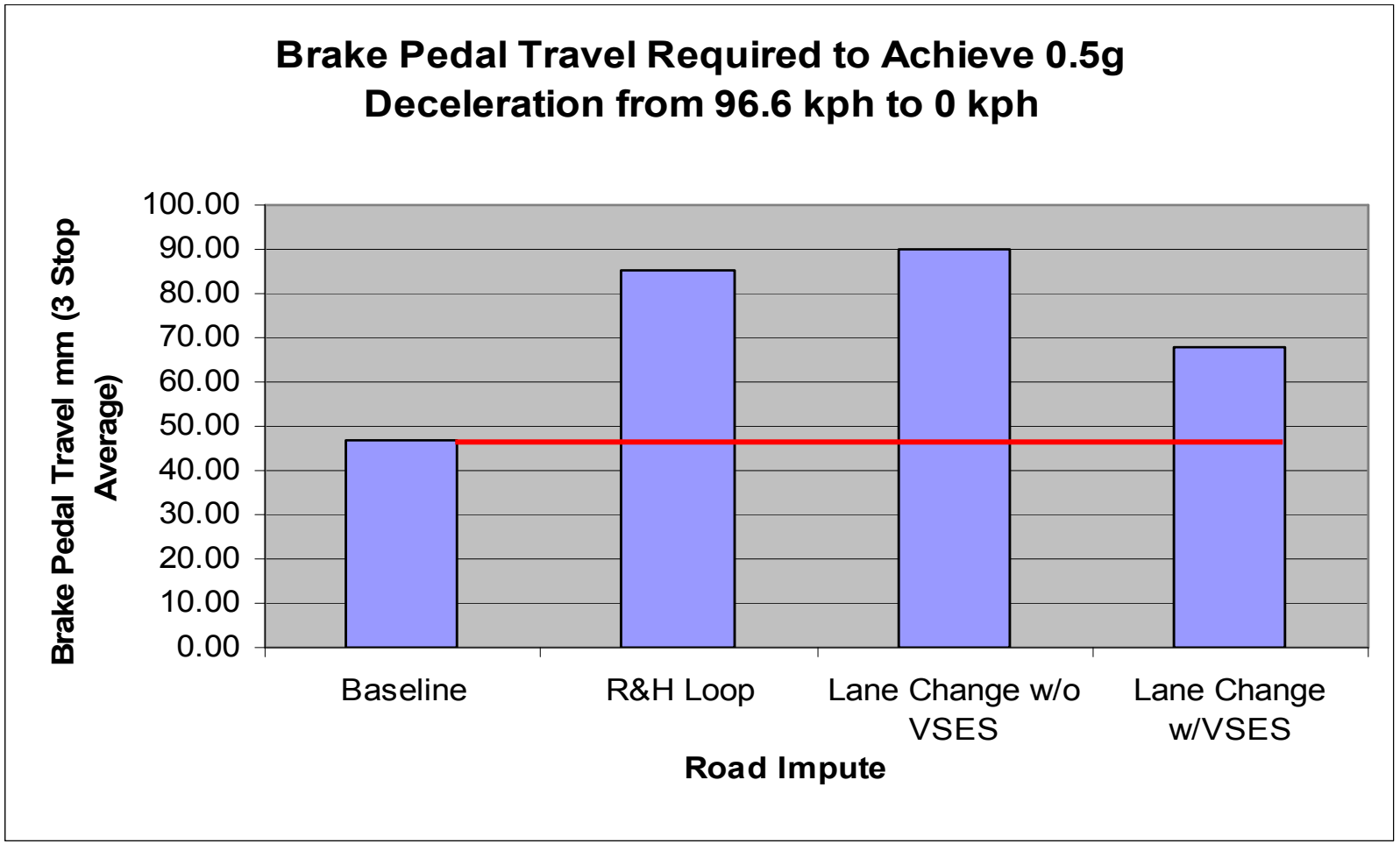


Displacement vs. Line Pressure

(One Lap Ride and Handling Loop 0.5 g Ramp Apply)



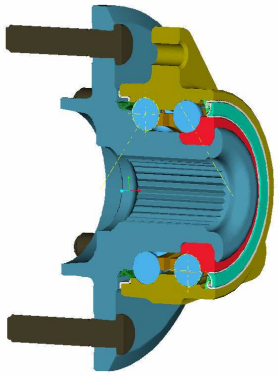
Pedal Travel



Typical Design Criteria For Hub Units

- Bearings typically designed given a specific loading, packaging and environment requirements
- Designed for life, endurance and strength
- Typically symmetric rows for manufacturing considerations

HBU3



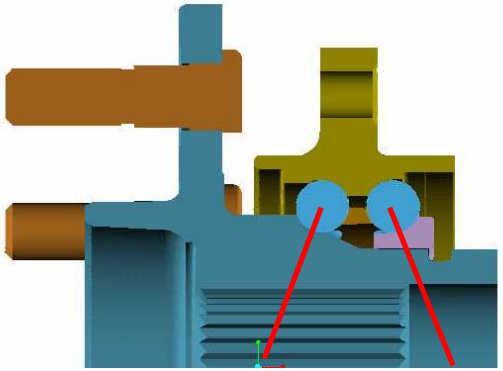
Design Improvement

(A)Increase hub flange thickness

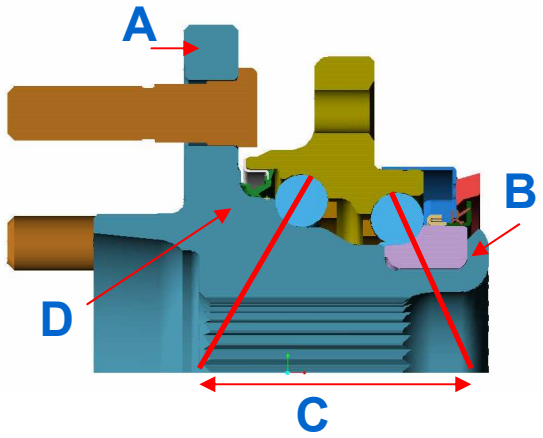
(B) Move from preload retention by snap rings to orbital forming

(C) Increase the row to row distance and stance

(C & D) Increase pitch circle diameter and number of balls on the outboard row to reduce hub bending and further stance increase

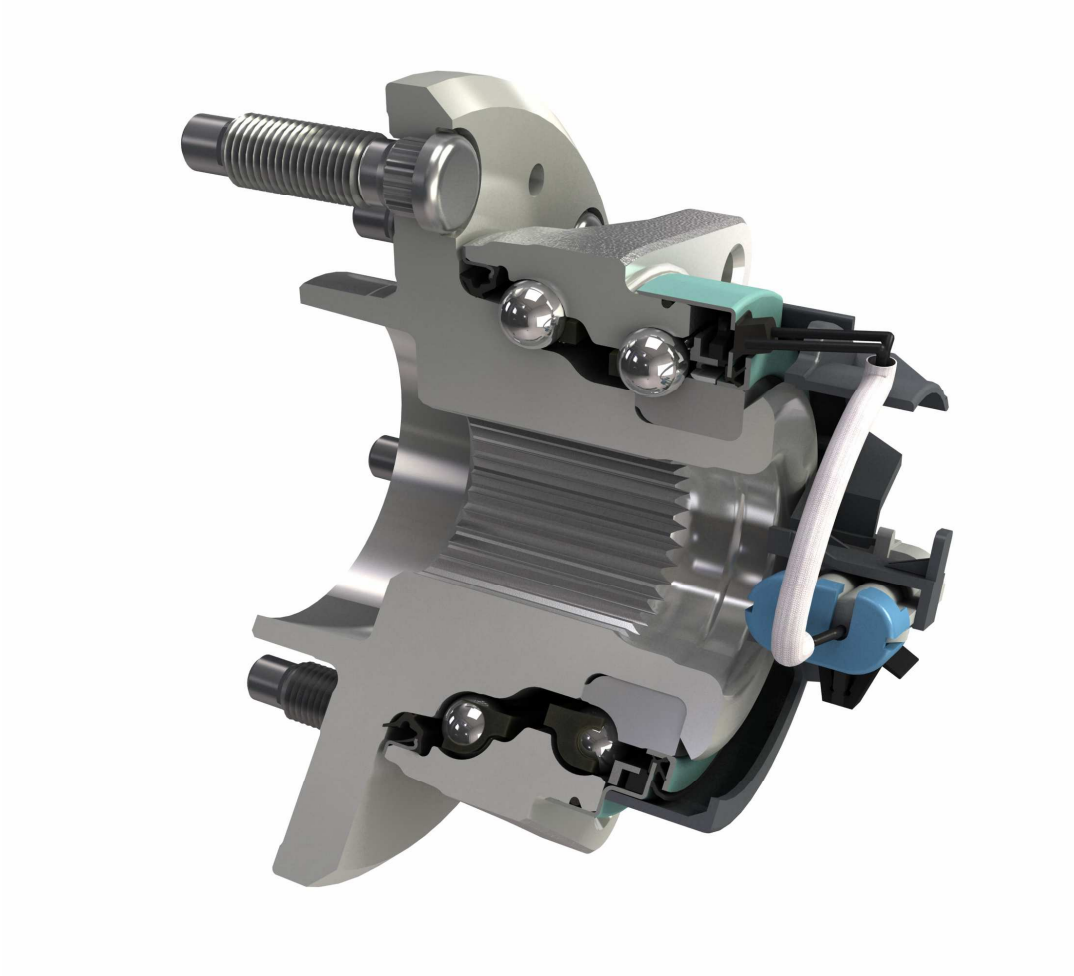


Current Design

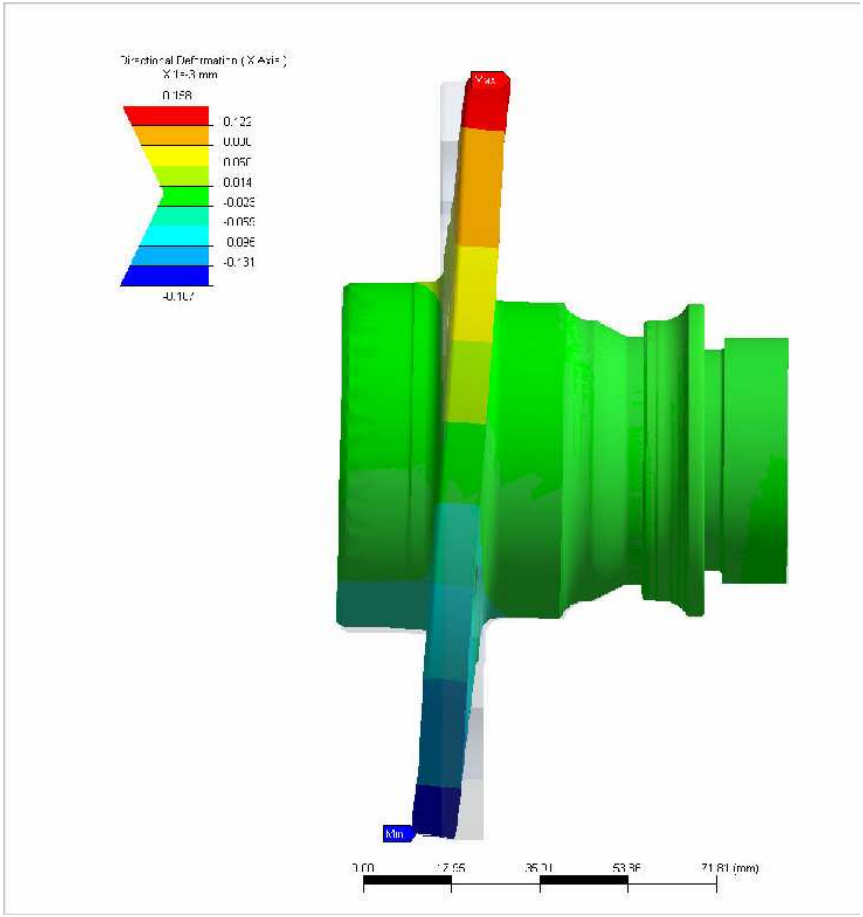


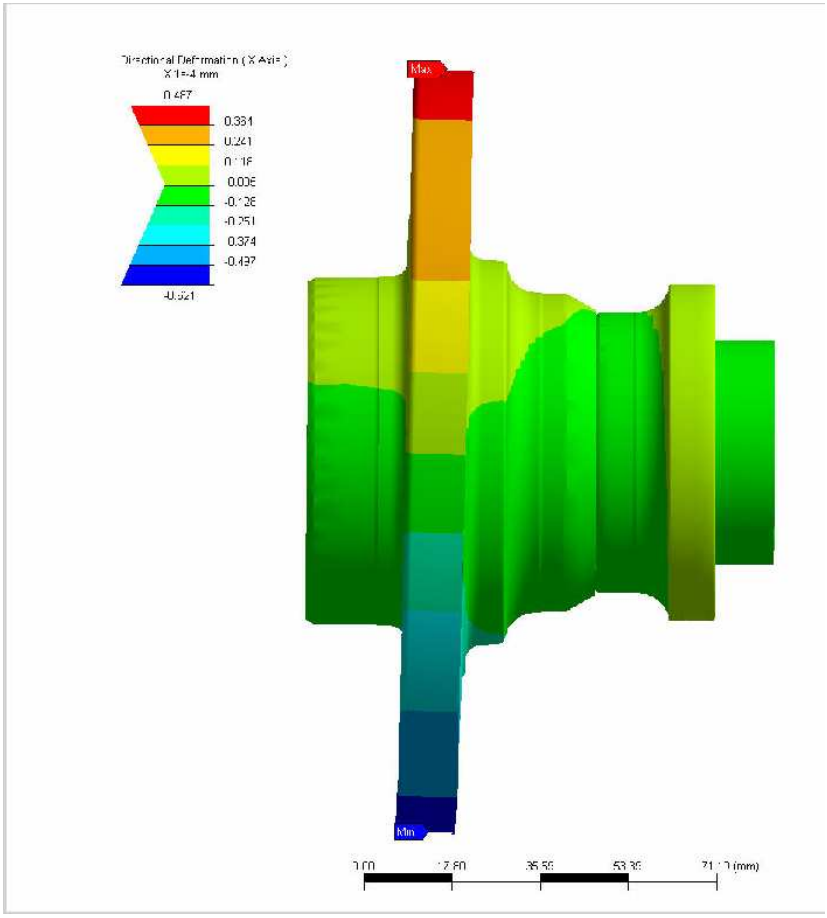
New design

X-Tracker™ Asymmetric Ball Row HBU3

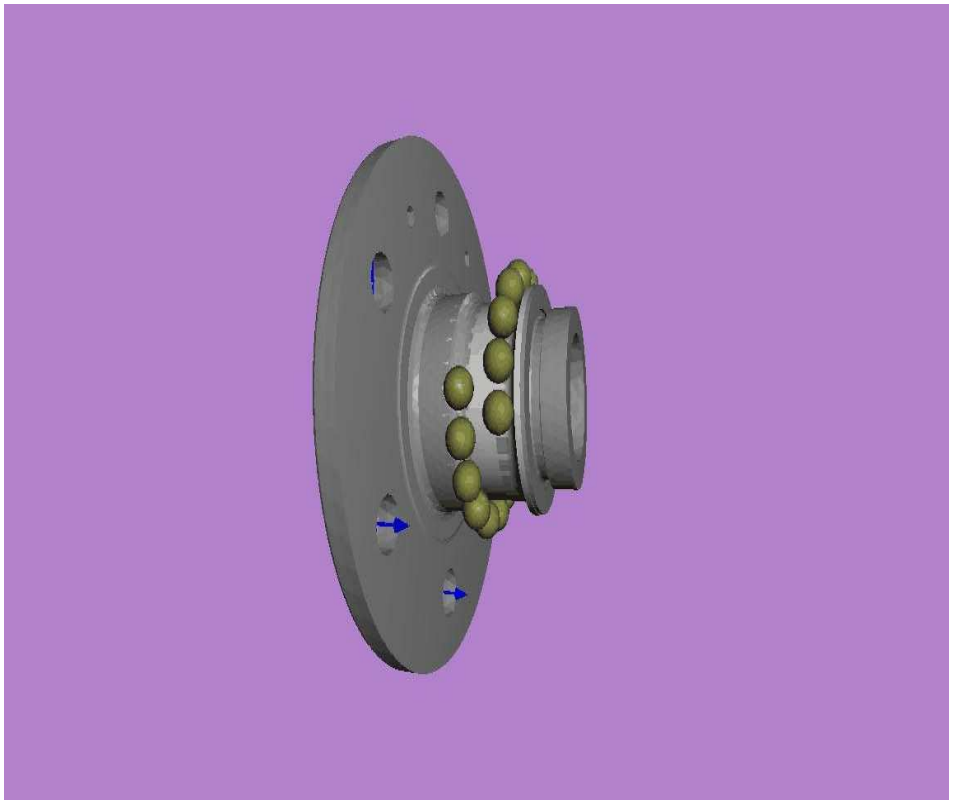


Component FEA (Wheel Hub)

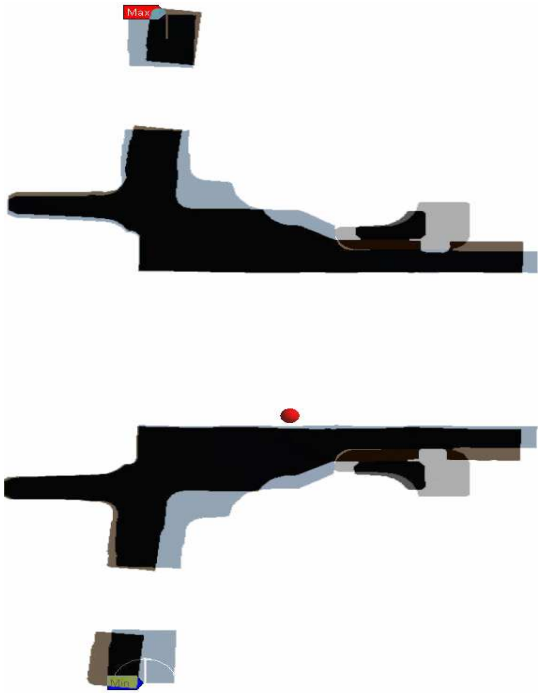




Hub Unit System Modeling

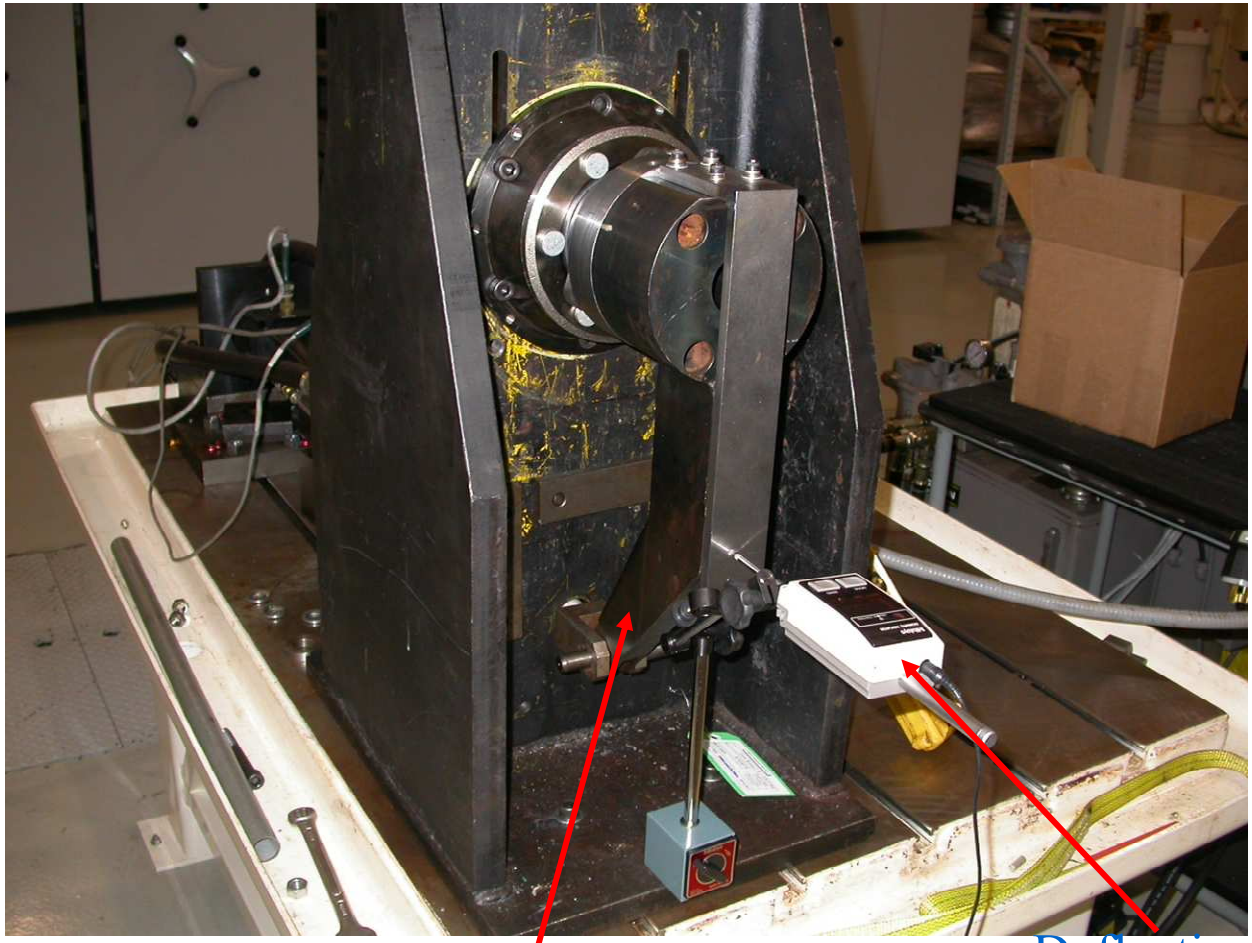


SKF Orpheus Model



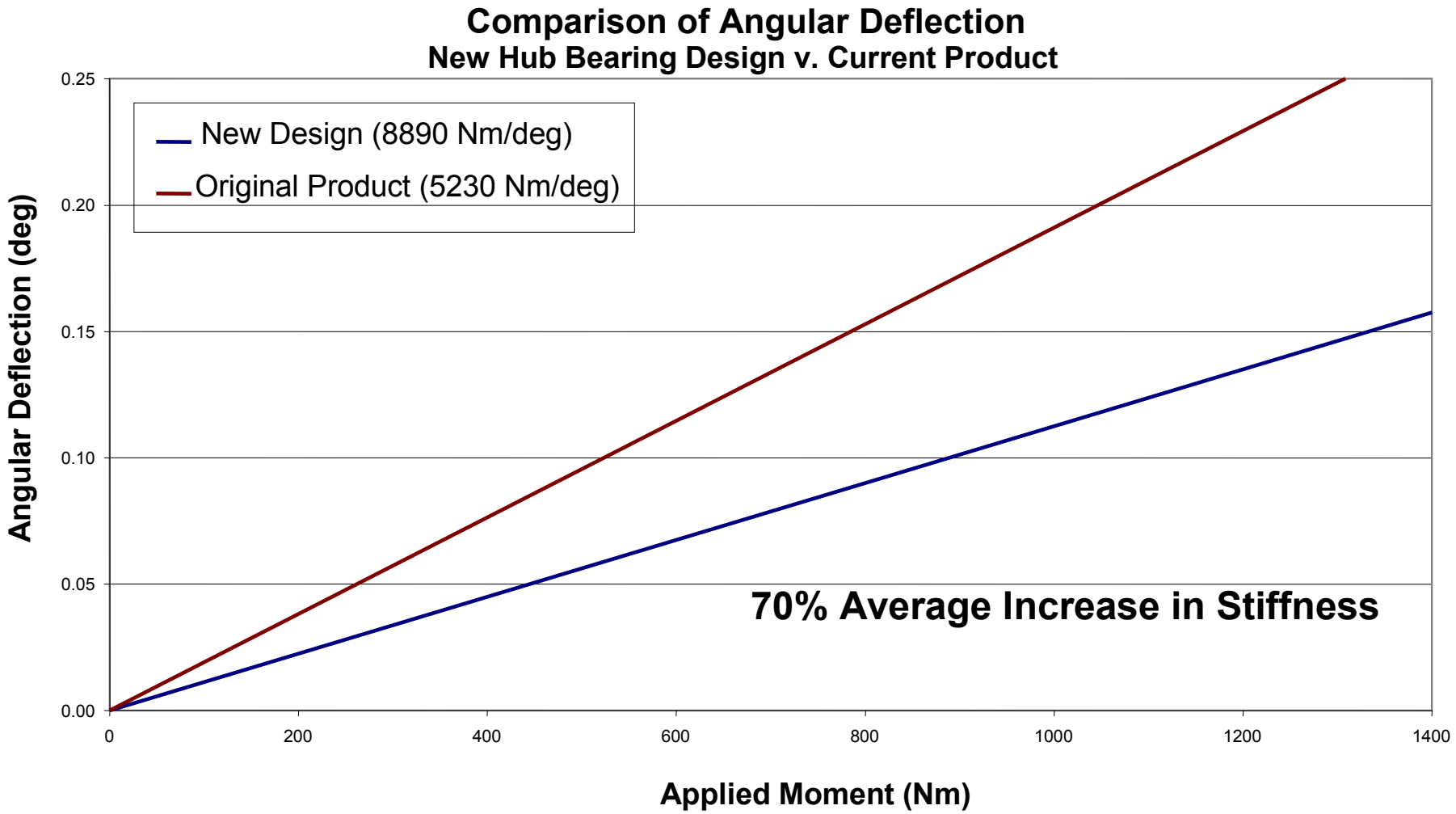
Original vs.
Design Solution

Rig Setup for Stiffness Comparison

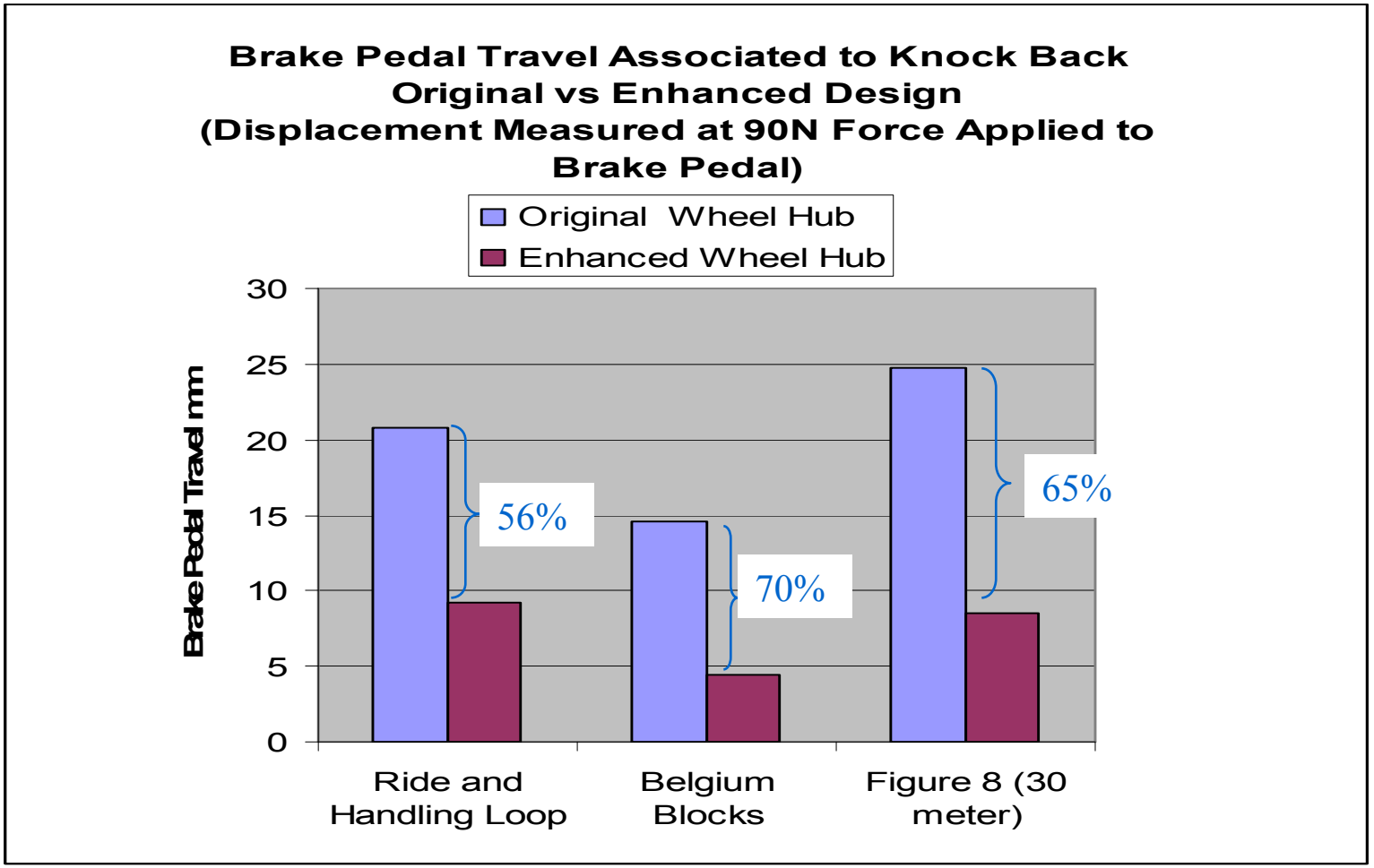


Bench Test Results

(averages of regressed data)



Verification on Vehicle



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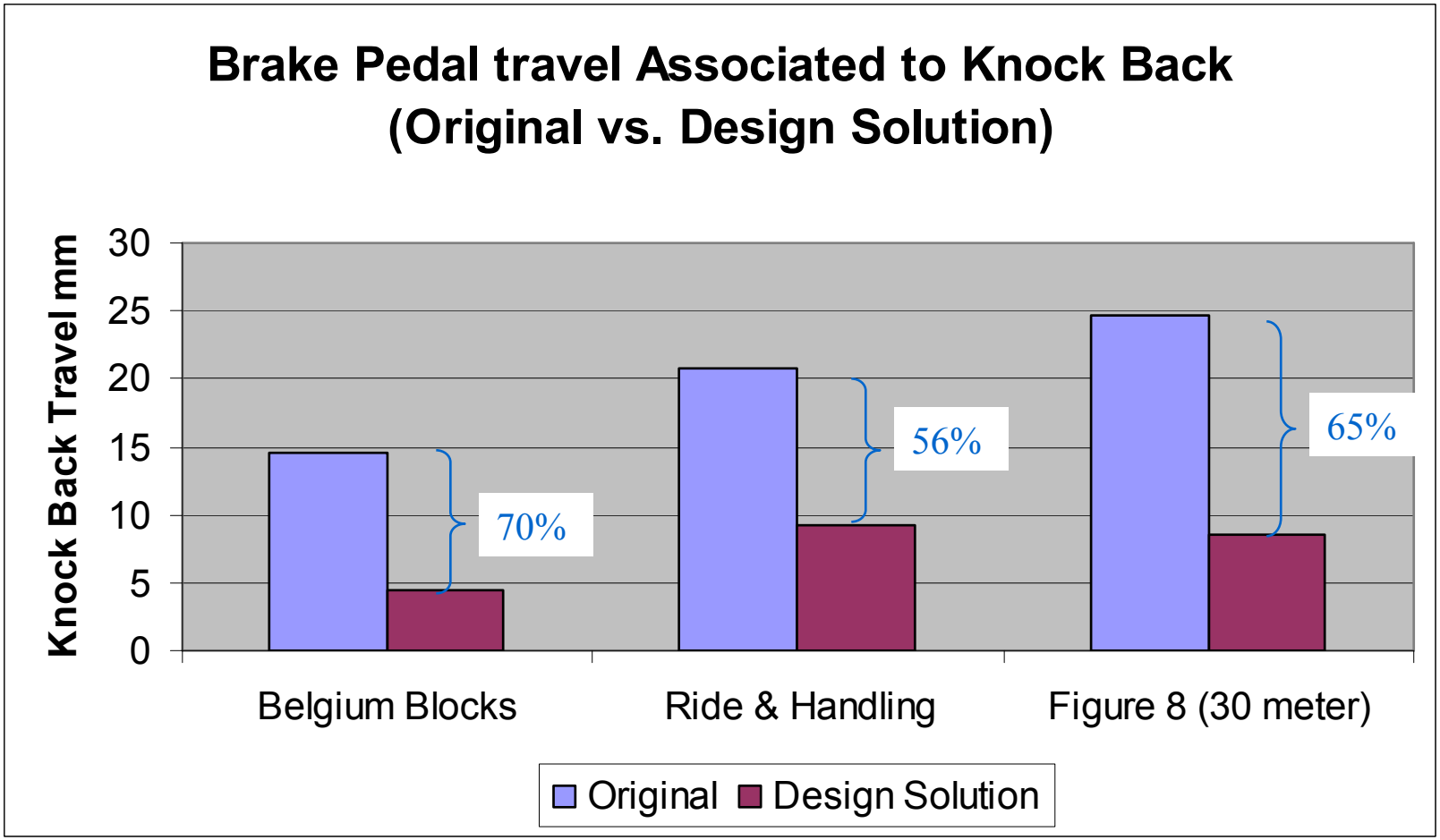
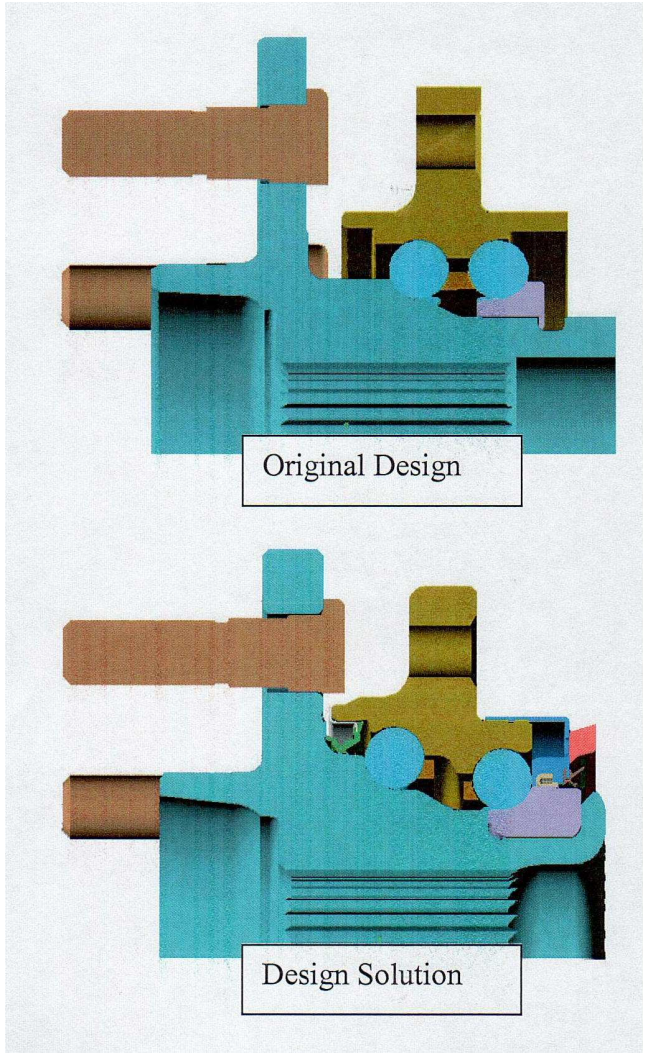


Results

- Challenge:
  - Improve brake caliper piston knock back
  - Maintain bearing preload

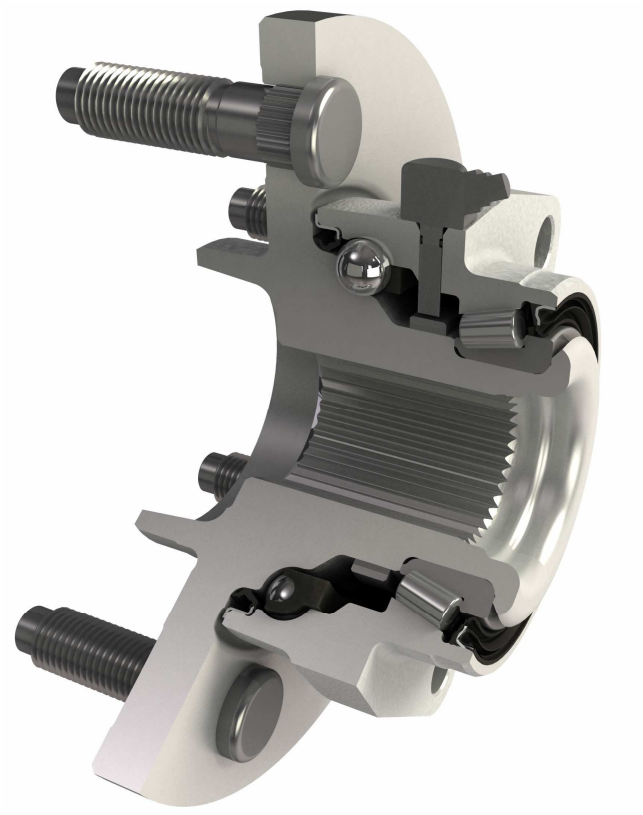
- Result:
  - Up to 70% more camber stiffness
  - Significant reduction of knock back and pedal travel issues (56%-70%)
  - Permanent stiffness improvement



Project Conclusion

- Project team has succeeded in resolving the caliper piston knock back issue by employing a system solution approach
- Vehicle testing defined the problem
- Modeling was used to simulate the problem and predict effectiveness of design solution
- Lab testing was utilized to verify the design solution
- Vehicle testing confirmed the results

X-Tracker™ Hybrid and Asymmetric Roller



Benefits of X-Tracker™ Hub Units

Brakes:	
NVH Reduction:	Reduced brake disc wear
Safety improvement:	Reduced brake pedal travel
Performance:	Improved lap times in racing
Vehicle:	
Flexibility:	Flexibility in wheel offset use (OE & VSM)
Safety:	Robust hub flange for large wheel upgrades (VSM)
Performance:	Improved bearing life in same package (OE & VSM)
Fuel Efficiency:	Preload optimization and brake drag reduction

SKF®