be certain.

MTS

Standards and Approaches for Ball Joint Durability Testing

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Stuttgart, Germany






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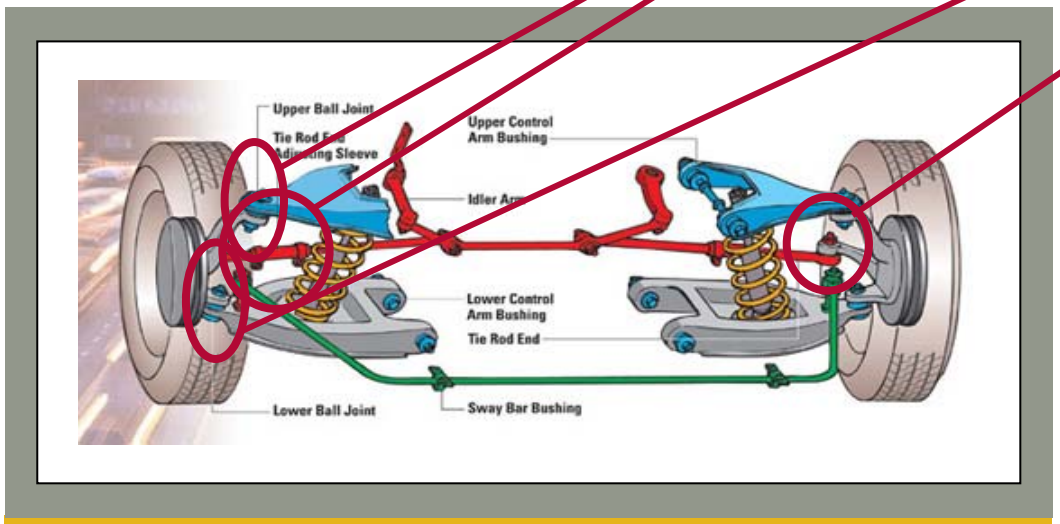
Ball Joint Overview

Ball Joint Basics

- Common ball joint applications
- Types of ball joints



Ball Joint Components

Types of Ball Joints

SAE J193 Ball Joint Tests

In general, J193 tests are uni-axial . . .

. . . except for Assy Fatigue/Heat Treat.

J193 Ball Joint Tests	MTS Capabilities
Impact Strength	✓
Yield	✓
Tensile Load	✓
Rotation & Oscillation Torque	✓
Axial End Movement	✓
Cam-Out Strength	✓
Assy Fatigue and Heat Treat	✓
Pull-Out/Push-Out Strength	✓

A multi-axial test system is required.

J193 Endurance Load Requirements

5.2.4 Ball Stud and Socket Assembly Fatigue and Heat Test

5.2.4.1 Objective – To determine fatigue and wear characteristics of ball stud and socket assemblies.

5.2.4.2.2 Phase II Test – Endurance Load: "To ***correlate*** the cycle life of the assembly for the ***average load*** to which the assembly will be subjected in application and environment, with life ***in actual use*** . . ."

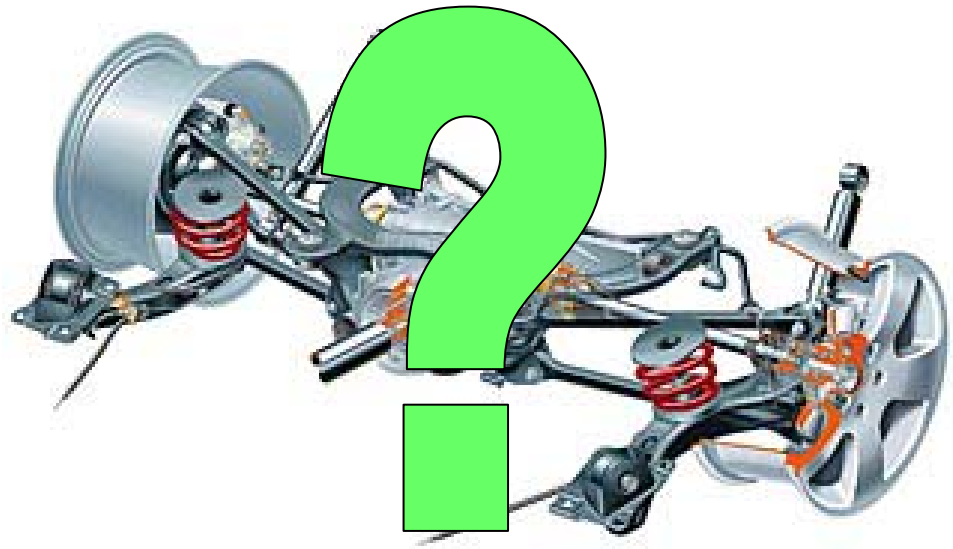
The Goals:

- Determine ball joint loads experienced during service life.
- Translate those loads into an easily-reproducible laboratory test.

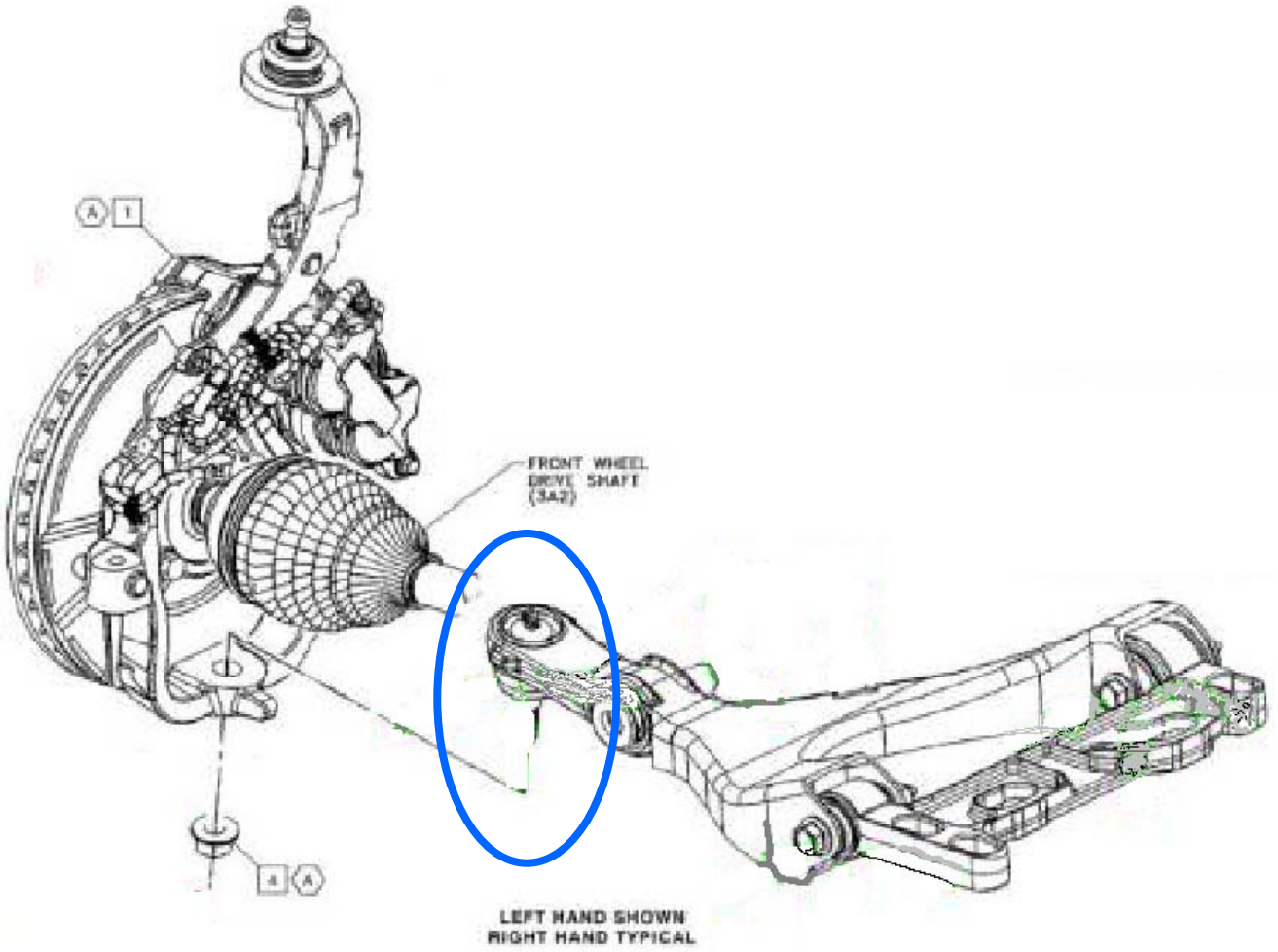
J193 Loading and Cycle Life Criteria

Comments on Loading/Cycle Life from J193

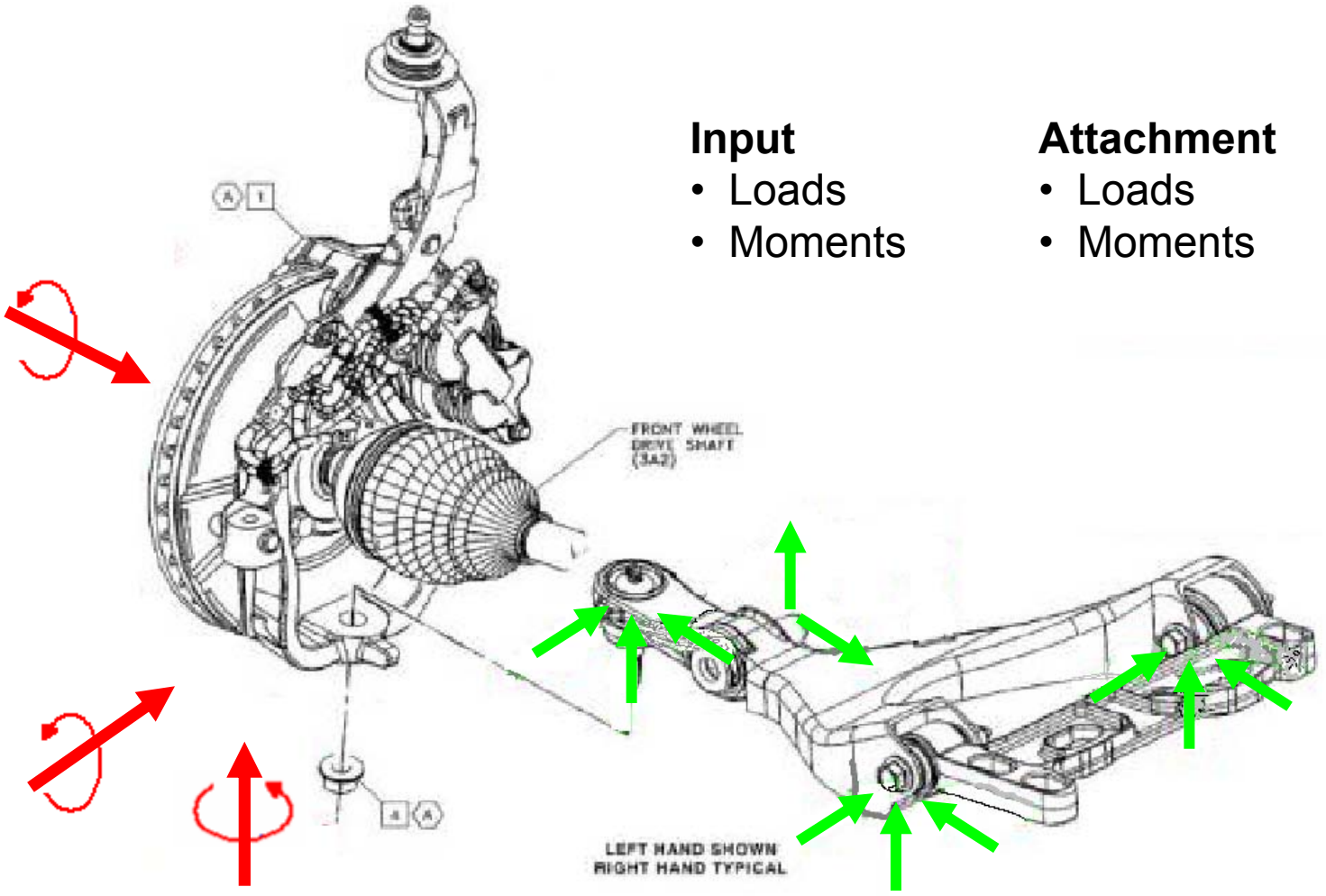
- "The loading use in the test procedures should be as representative as possible in magnitude and direction with loads encountered in the design application."
- "Using a vehicle . . . a program loading procedure can be utilized to obtain a more realistic loading assessment."



Focus: Front Lower Control Arm



What is the Loading Environment?

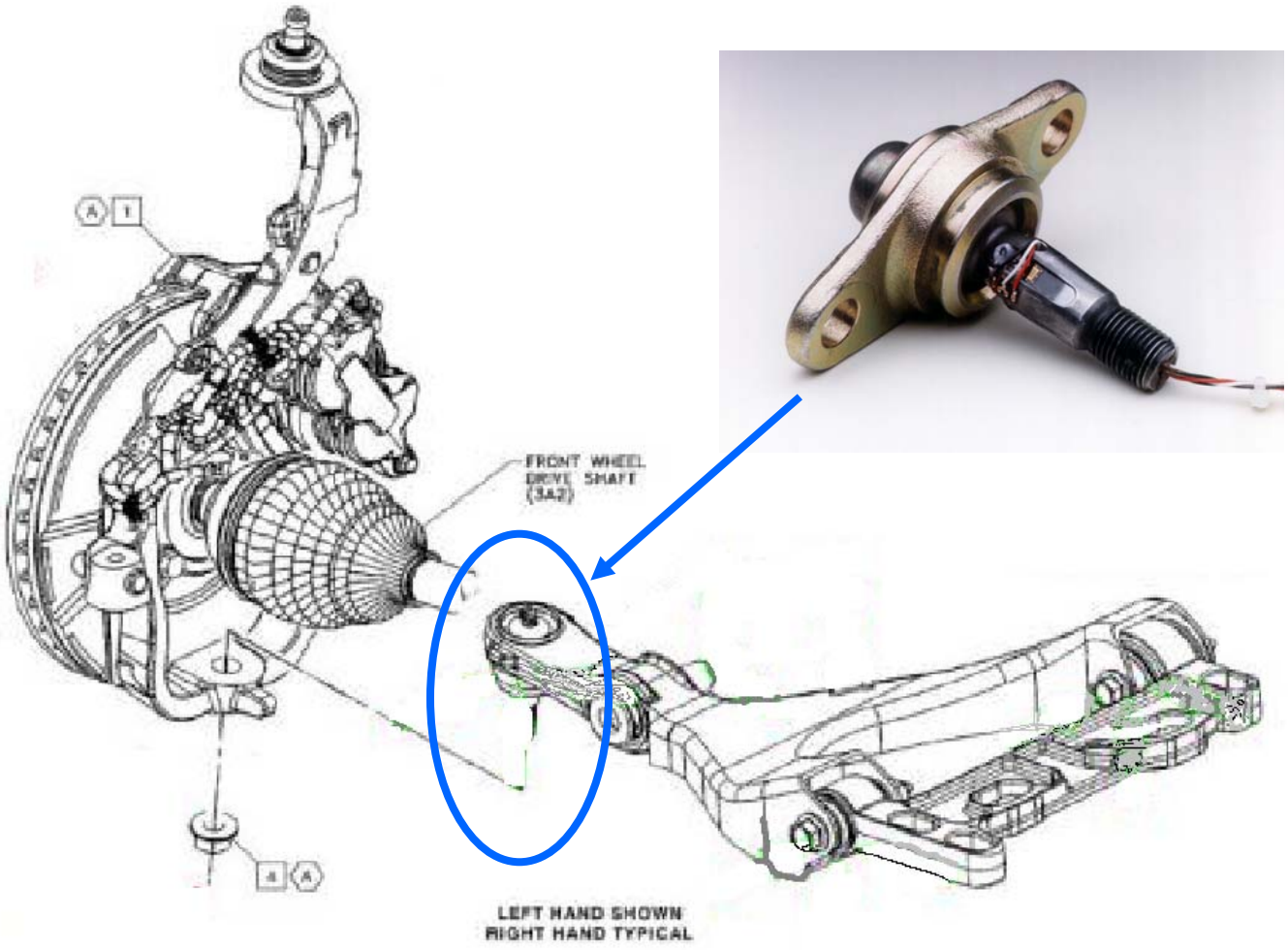


Input
- Loads
- Moments

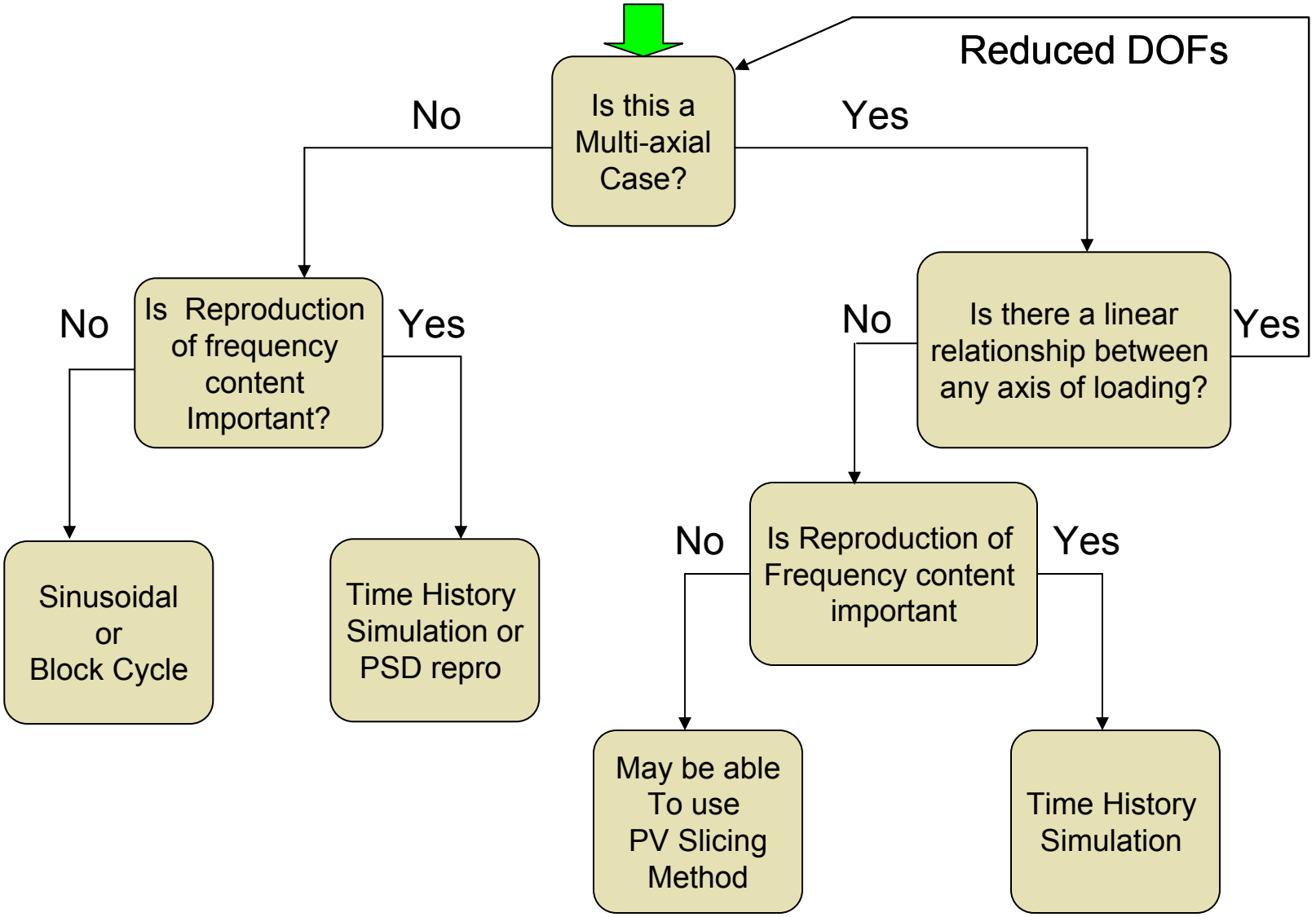
Attachment
- Loads
- Moments

What is the Loading Environment?

Strain Gauged Ball Joint

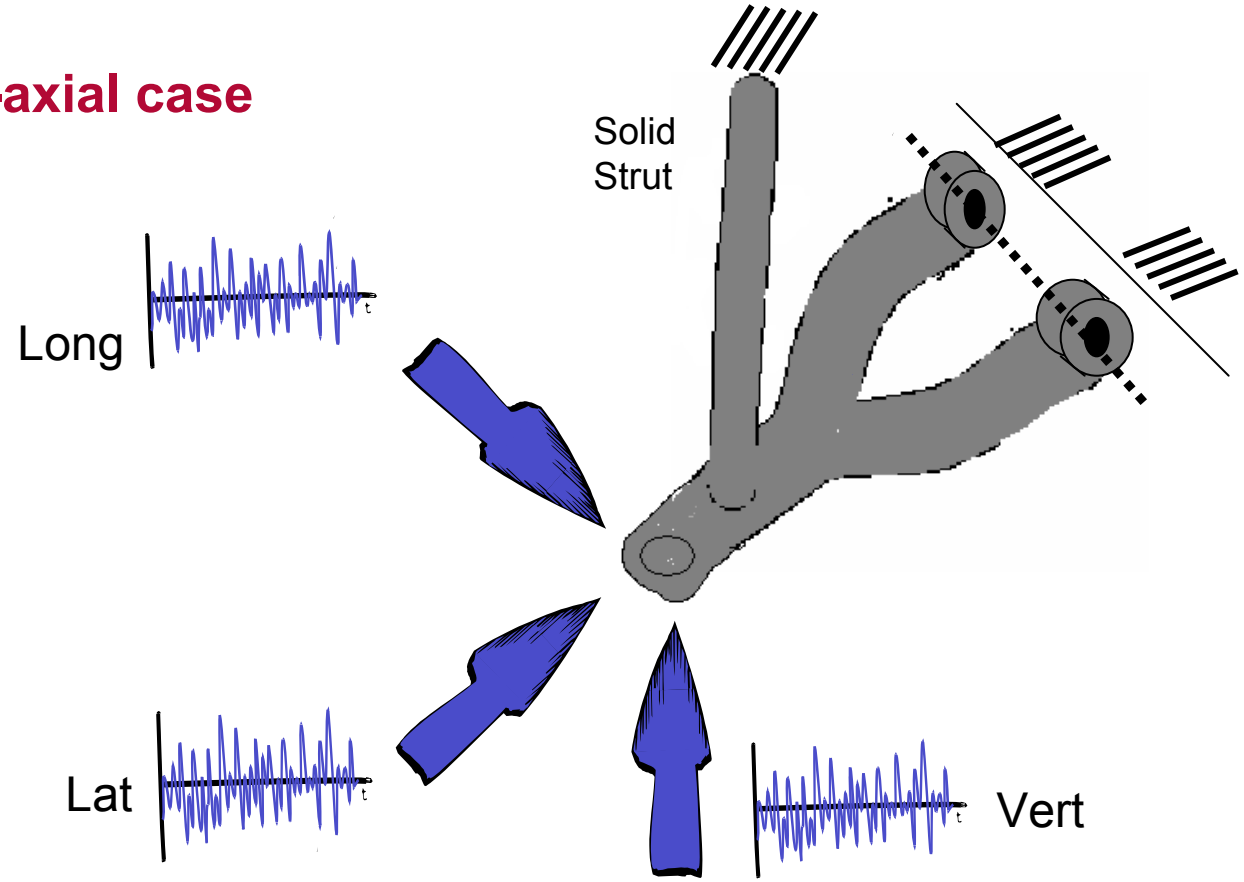


Test Planning – Peak Valley Slicing



Peak Valley Slice Technique

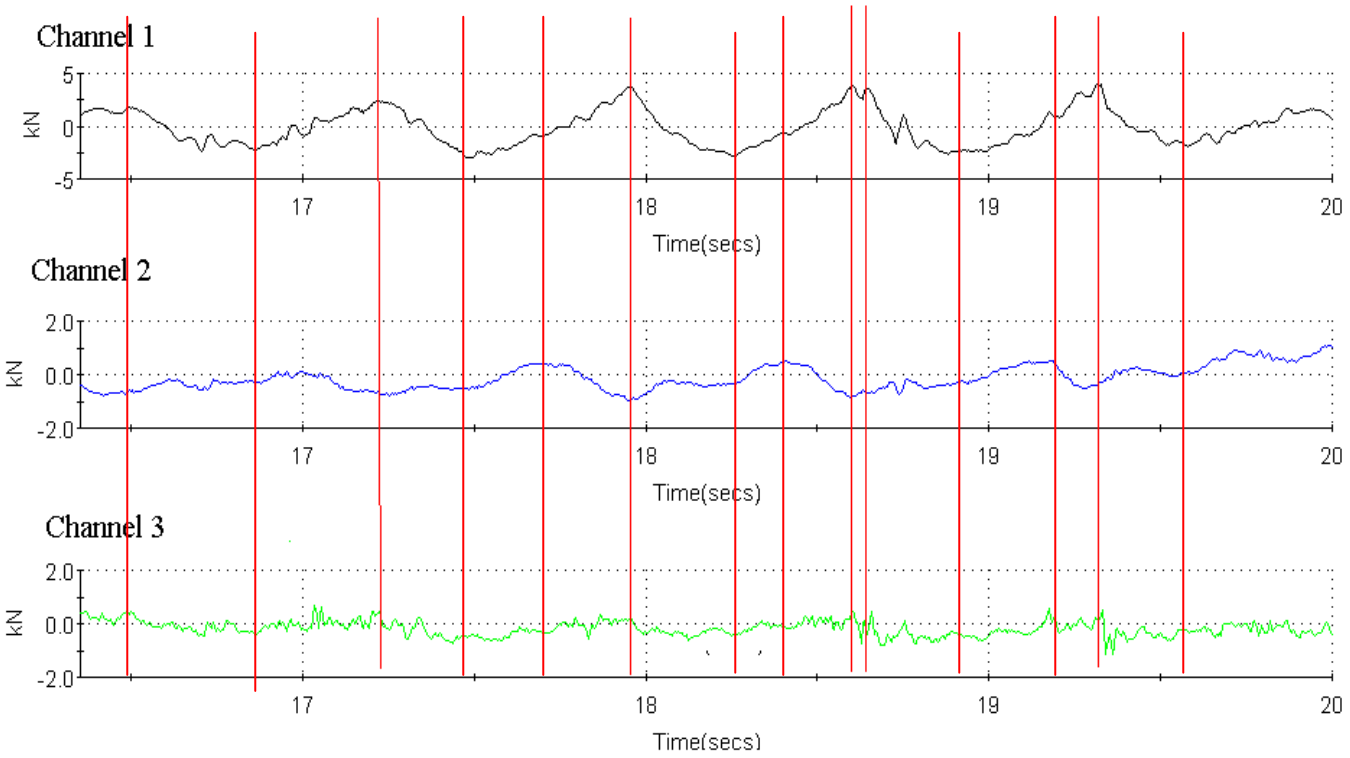
Multi-axial case



Phasing between Vertical, Lateral & Long Inputs is critical; frequency reproduction is not important

Peak Valley Test Methodology

Peak Valley Slice Test Method



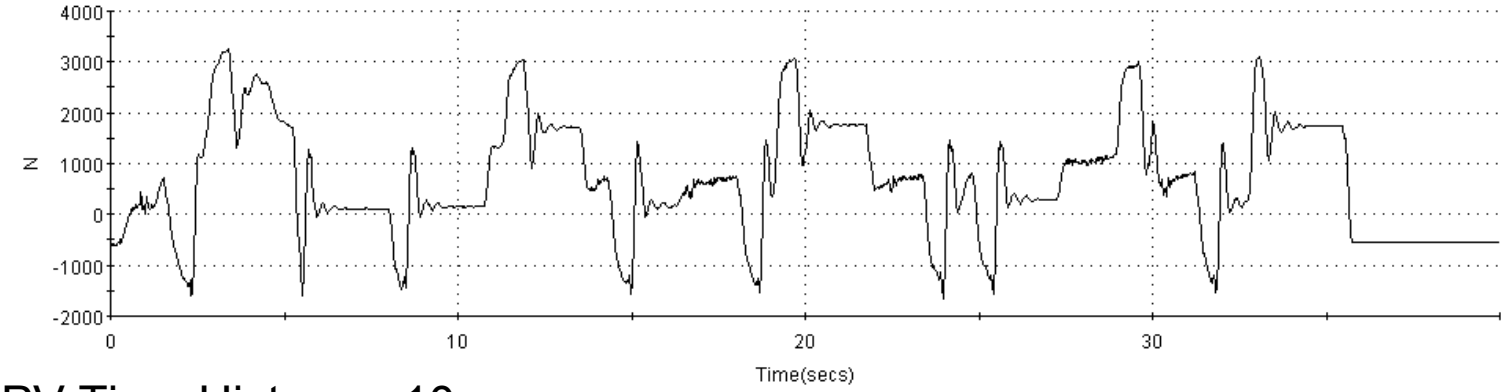
Identify Peak/Valley pairs in multi-channel data.

Peak Valley Slice Test Method

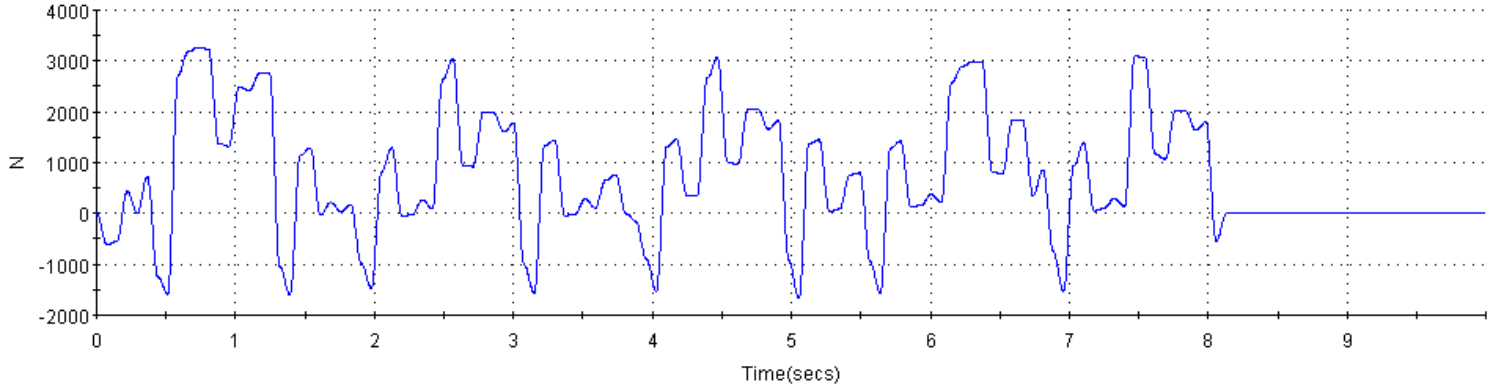
5 kph Braking events

Longitudinal Force

Raw Time History = 40 sec



PV Time History = 10 sec



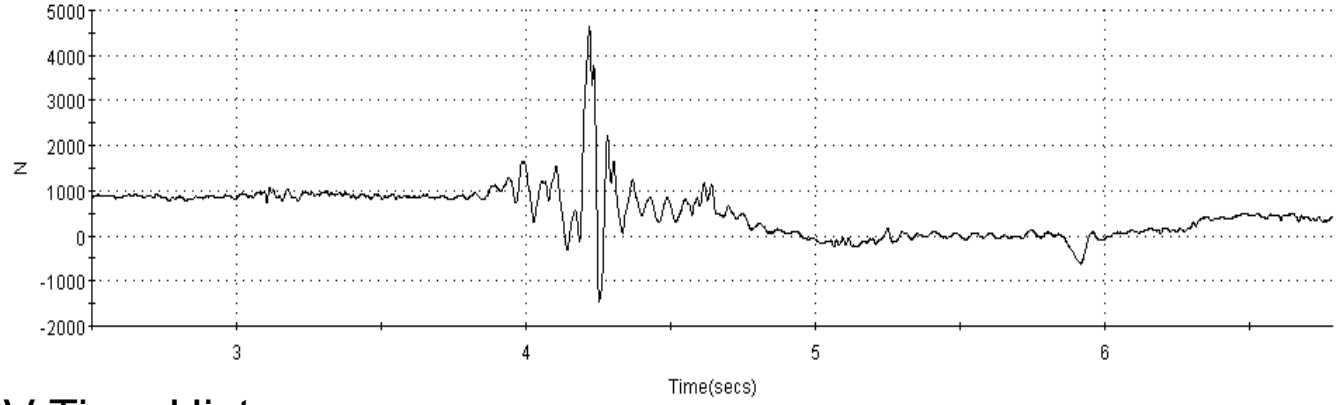
Benefit: Speed up "slow" events

Peak Valley Slice Test Method

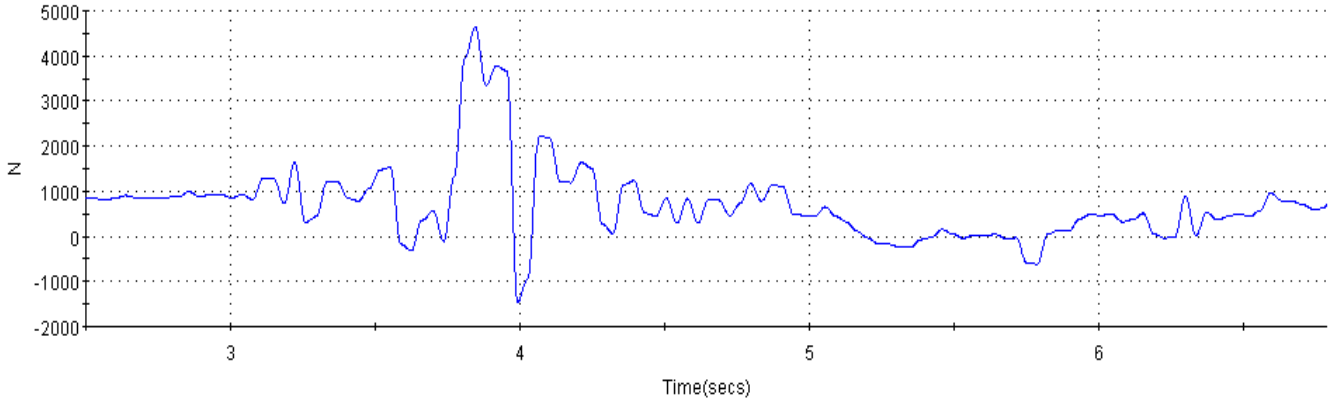
Pothole Strike Reproduction

Longitudinal Force

Raw Time History



PV Time History



Benefit: Slow down "fast" events

Peak Valley Slicing

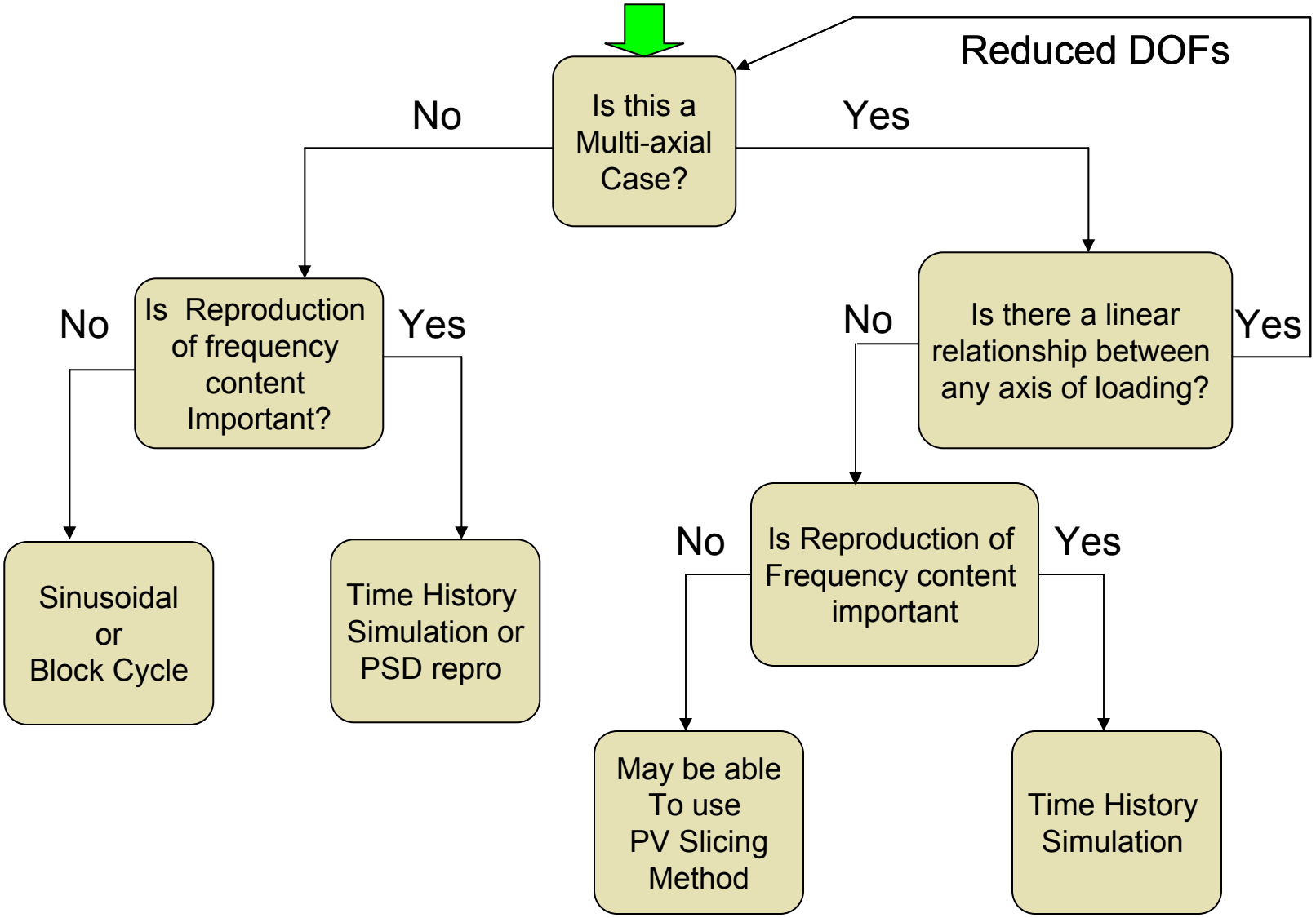
Benefits of PV Slicing

- Applies accurate max/min displacements to specimens.
- Ensures phase relationships between peak loads are maintained.
- Can reduce test time.
- More representative damage accumulation than block cycle testing.

When PV Slicing is not applicable

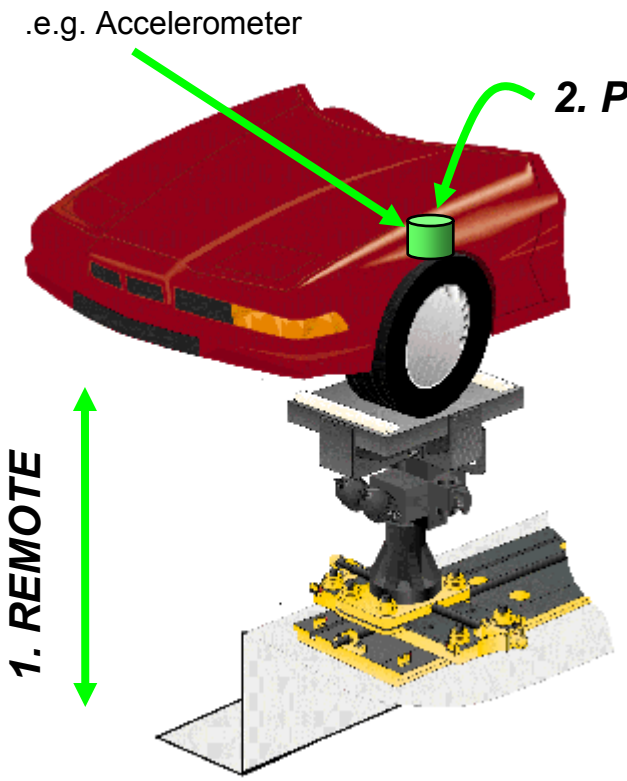
- Elastomeric or components with frequency-dependent characteristics.

Test Planning – Time History



What is Remote Parameter Control?

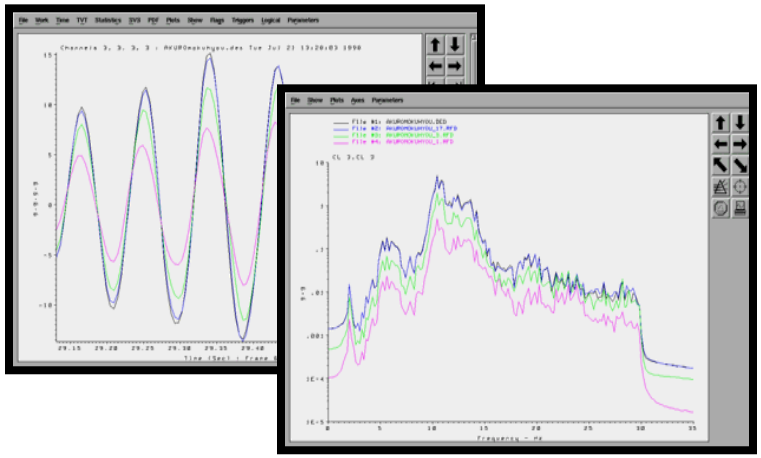
Remote Parameter Control (RPC) is an advanced simulation technique used to repeatedly replicate and analyze “in service” vibrations and motions of a specimen using a dynamic mechanical system in a controlled laboratory environment.



3. CONTROL

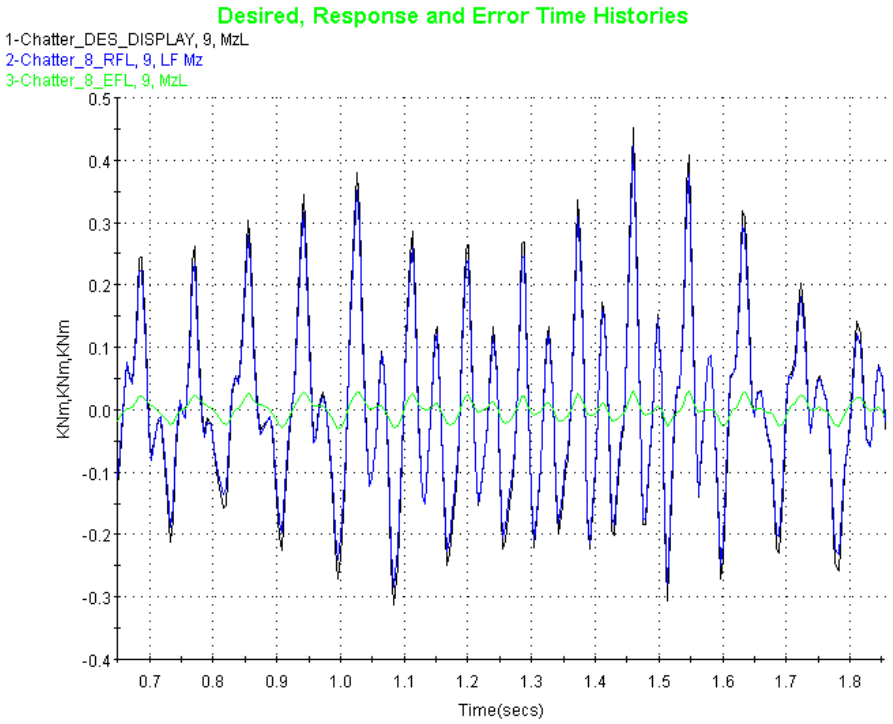
Control of

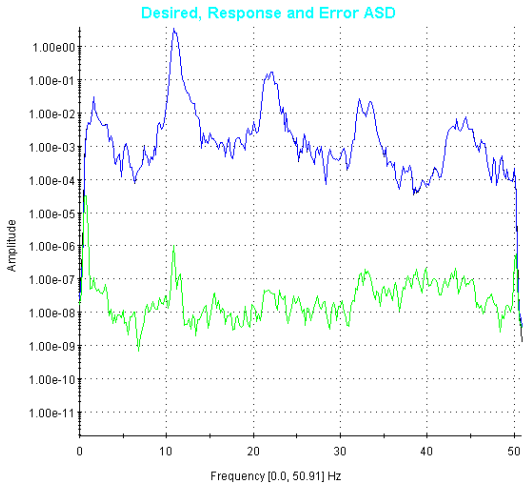
- Amplitude Distributions
- Spectral Densities
- Multi-axial Phase Relationship

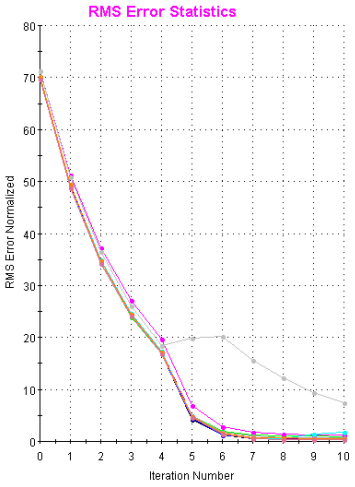


The RPC Process – Typical Correlation

Iterations – example response data





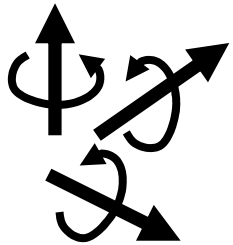


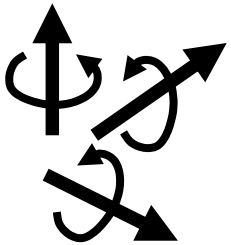
Simulation results are typically evaluated in the time, frequency, and statistics domains; often times fatigue is also used.

MTS Standard Ball Joint Test System Examples

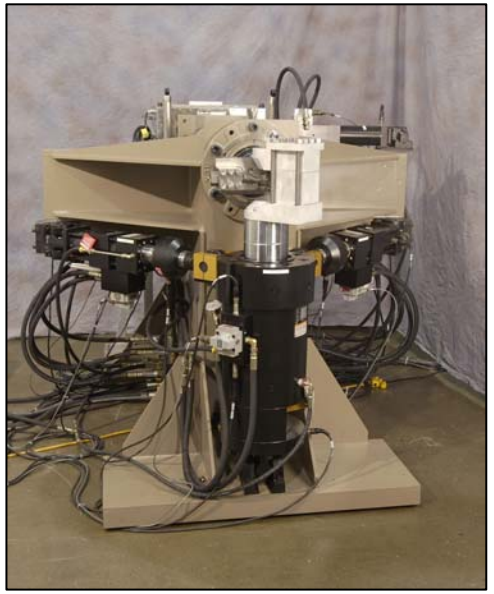
Three Axis Test

(Inner Ball Joints)

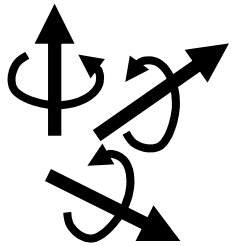




Four Axis Test



Five Axis Test



Thank you for your attention