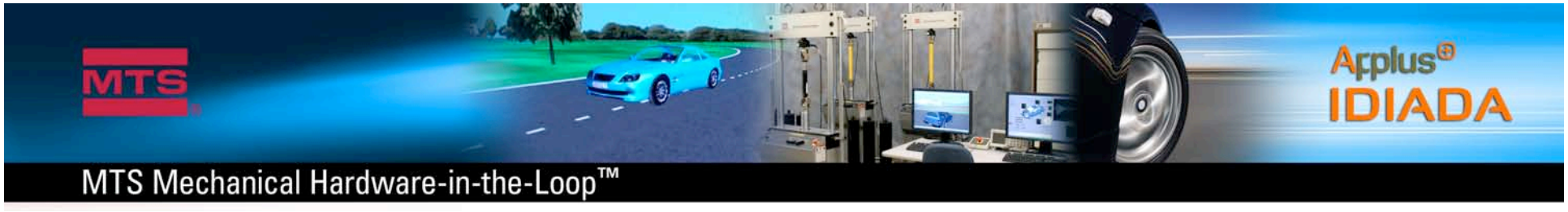
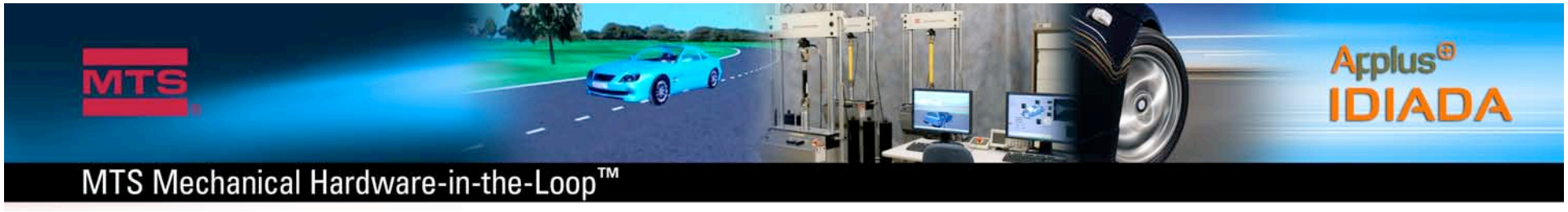


MTS Mechanical Hardware-in-the-Loop™
IDIADA Program

Jonathan Webb
Applus+ IDIADA

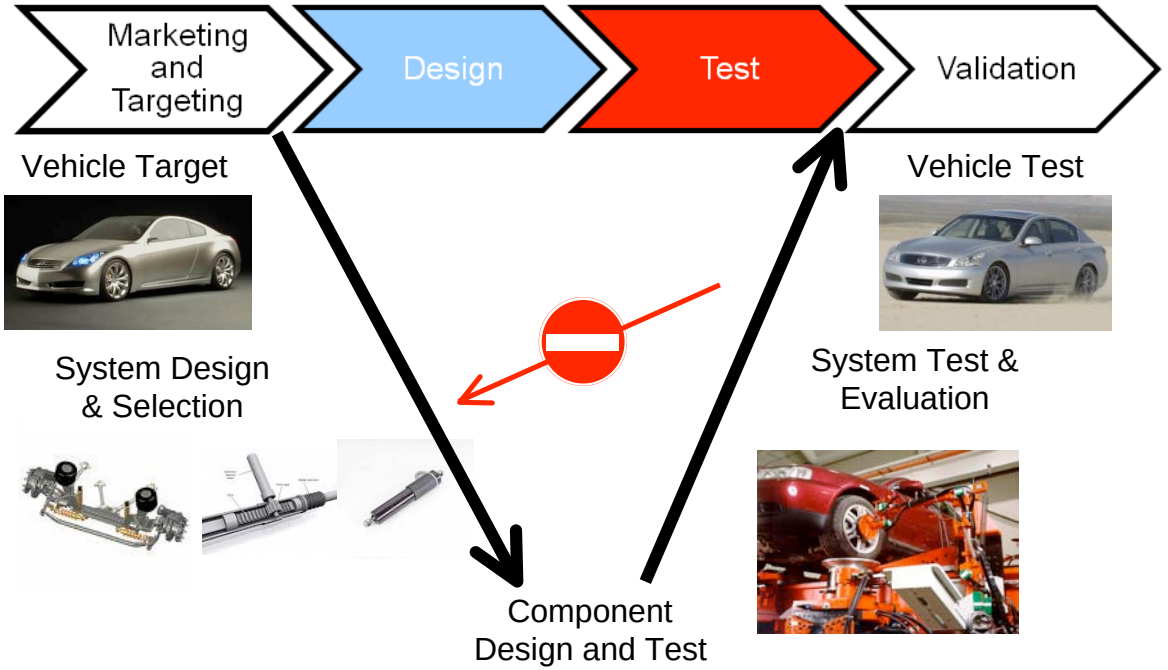
Thomas Stachel
MTS Systems

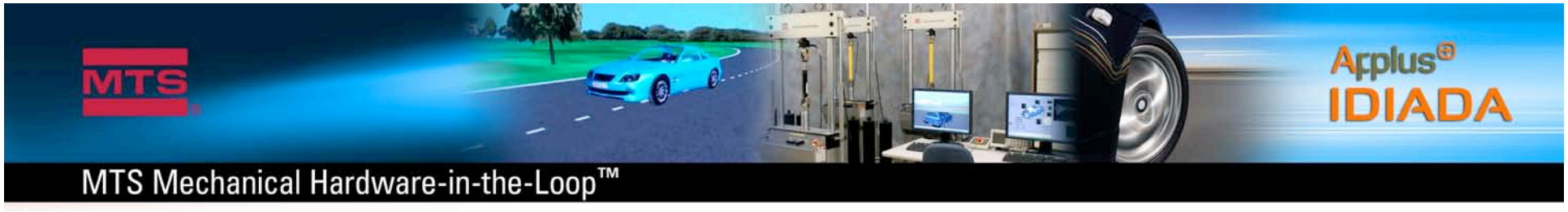


Industry Driven Challenge

"Increased model variants, resource limitations, cost constraints and time to market goals require accelerated vehicle dynamics development tools and methods."

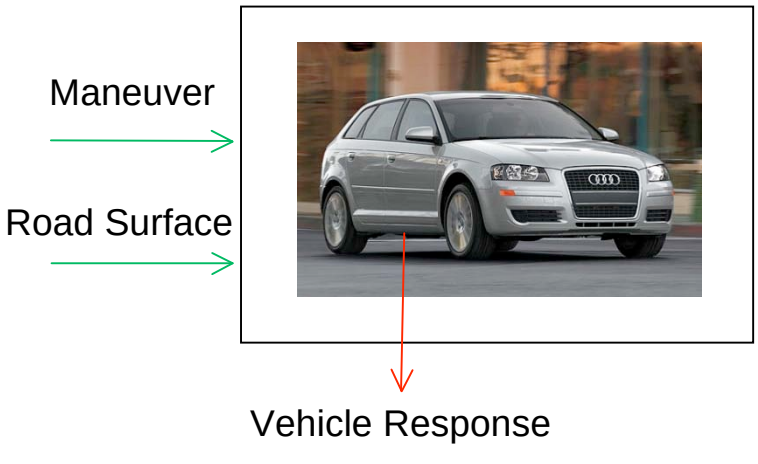
- Adapt to current development programs and processes
- Early vehicle level evaluation & analysis
- Effective system design & efficient system test
  - Extend simulation
  - Enhanced validation
  - Reduced iterations
  - Optimize prototypes



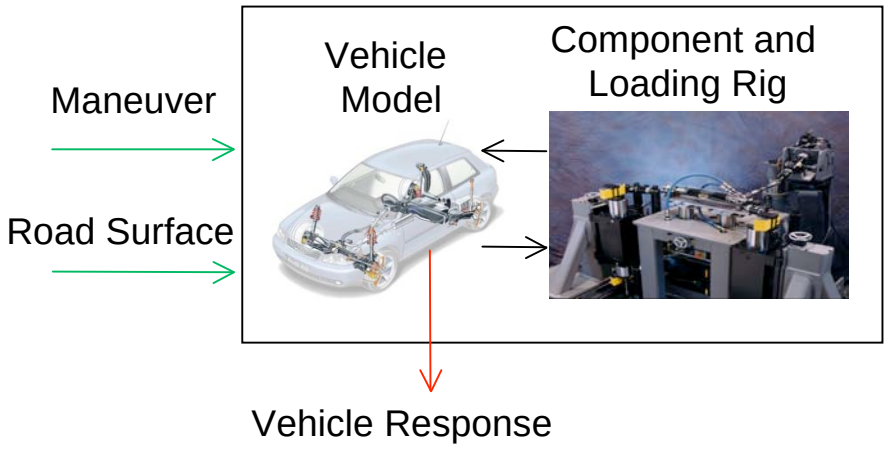


MTS Response - Mechanical Hardware in the Loop (mHIL)

Real Vehicle System



mHIL™ System



Make vehicle-level analysis more timely, repeatable, methodical, and faster.

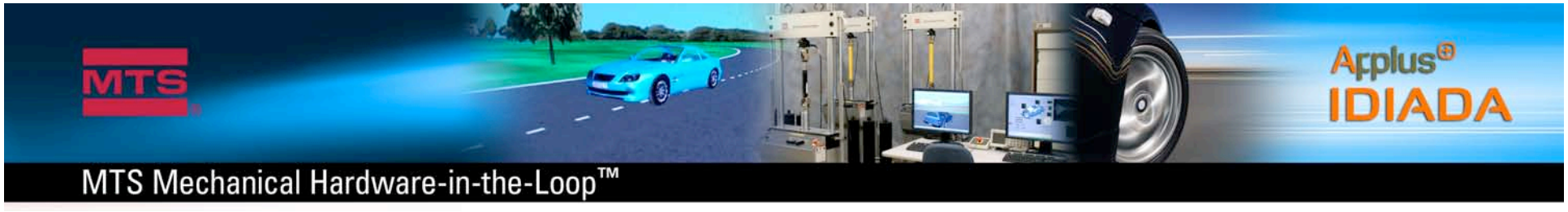
mHIL Application – Four Corner Damper System

Application Interest :

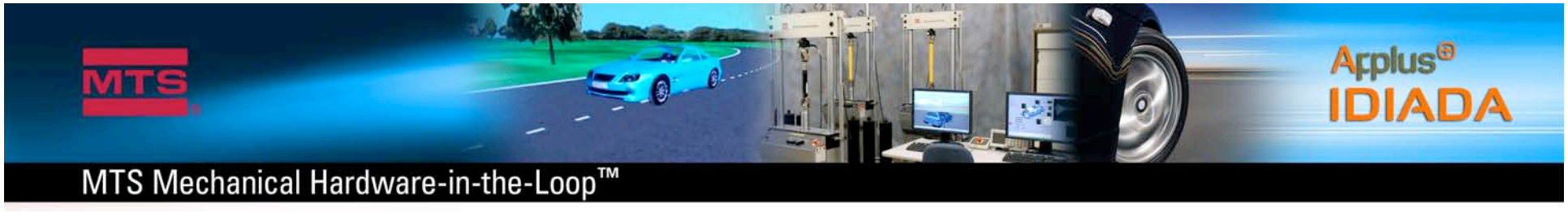
- Vehicle level handling & primary ride evaluation
- Active and passive damper development & characterization
- Environmental characterization
- Algorithm development

System Description:

- 4 optimized damper load fames
- Moment input fixture for struts
- dSPACE ASM adapted real-time vehicle simulation
- Stable and responsive closed loop control



MTS Mechanical Hardware-in-the-Loop
Applus+ IDIADA Programme



Hypothesis

In an objective based metric system, mHIL can be used to effectively advance the state of chassis development.

Plan

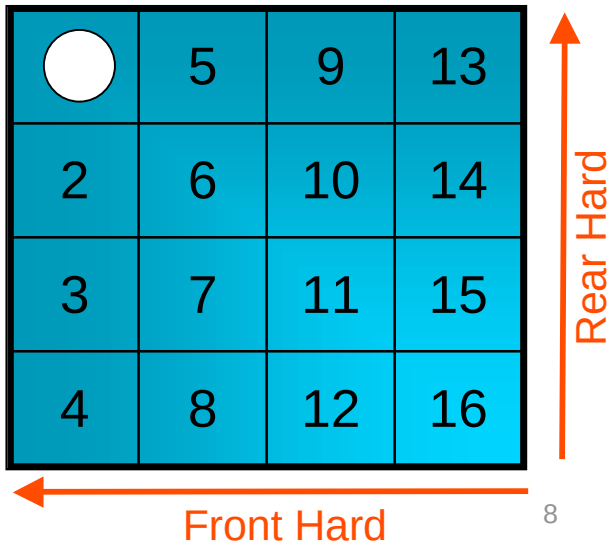
- Leverage ongoing metric development efforts
- Execute pseudo damper evaluation programme
- Evaluate sensitivity of simulation with and without mHIL
- Application of mHIL in a “metric” based programme

Initial Preparation

- IDIADA developing Metrics as a means to guide chassis development
  - Based on objective test data parameters
  - Related to driver's subjective feedback
  - Define clear targets to achieve during development
- Decision taken to investigate if damper selection could be addressed through metric derivation
  - Target vehicle selected, adjustable dampers fitted
  - Simultaneous subjective and objective test program
- Assess following damper development areas:
  - Handling **- Linear**
  - Ride **- Primary**
  - Steering **- Future**

mHIL Project Execution

- Real-time model
  - Laboratory and Track measurements
  - Real-time model build
  - Off-line correlation
- Preparation of maneuvers and signals for analyzing Ride and Handling performance
  - Step steer
  - Frequency Response
  - 4-poster
- Run simulations with adjusted damper forces to ascertain sensitivity of pure simulation environment



mHIL Project Execution

- Run mHIL system using adjustable dampers

Step Steer Maneuver

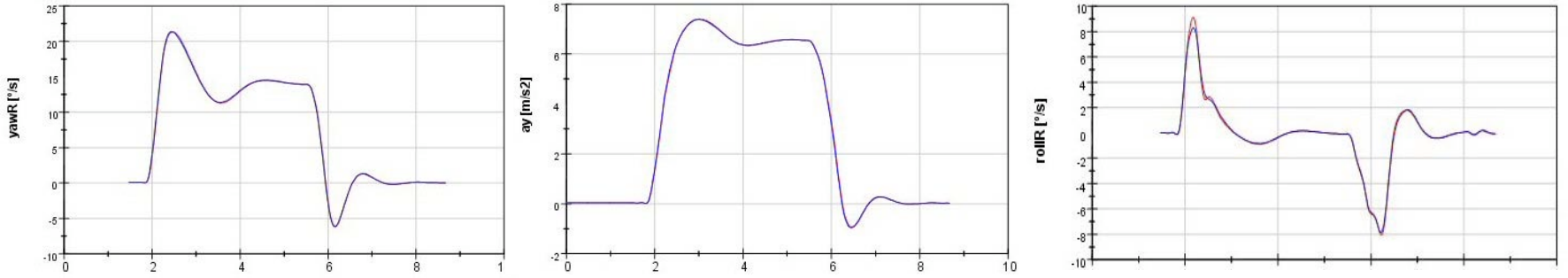
Project results - Sensitivity of simulation vs mHIL

0.4g Step steer test

Comparison vs soft and hard damper setting

Simulation

Firm Damper Setting _____ Soft Damper Setting _____



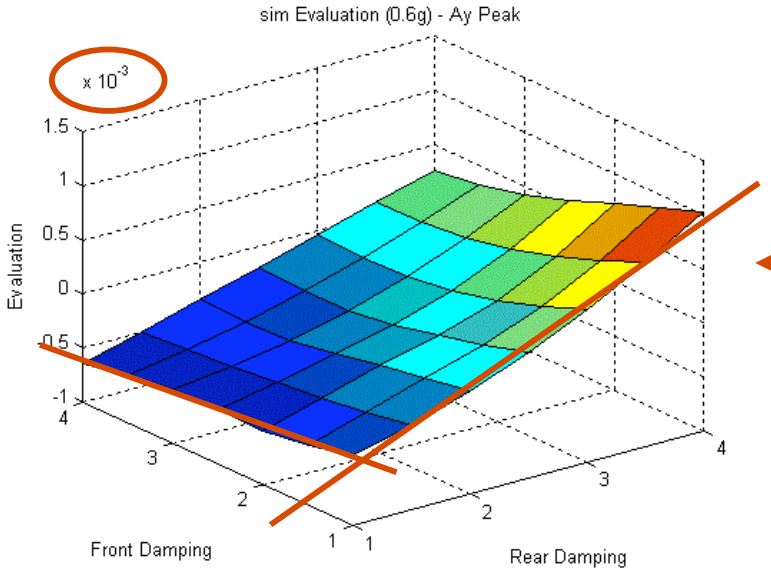
mHIL

Firm Damper Setting _____ Soft Damper Setting _____

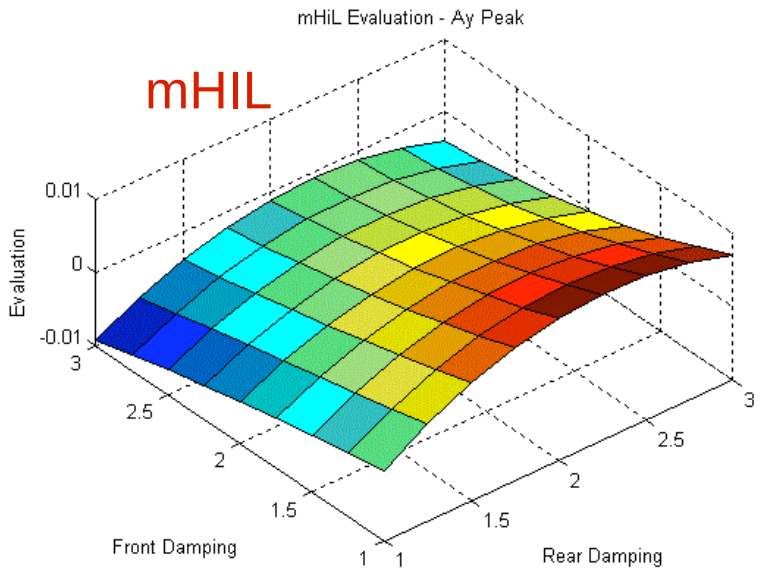
Yaw Rate | Lateral Acceleration | Roll Rate

Project results

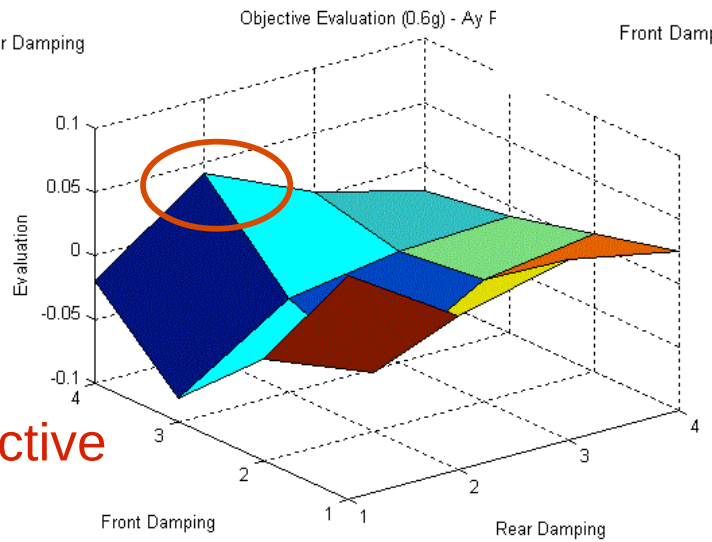
• Sensitivity of simulation vs mHIL vs objective



Simulation



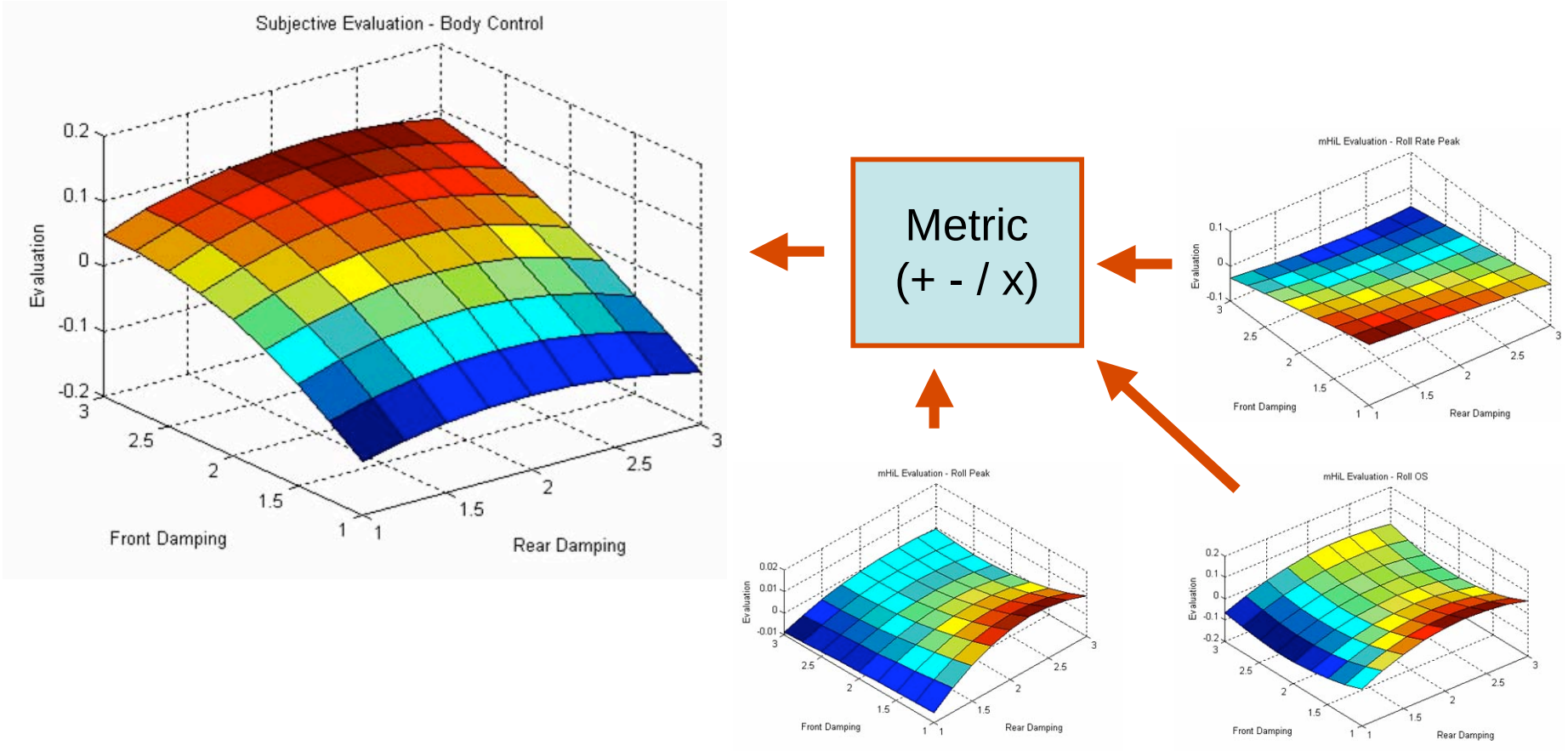
mHIL



Objective

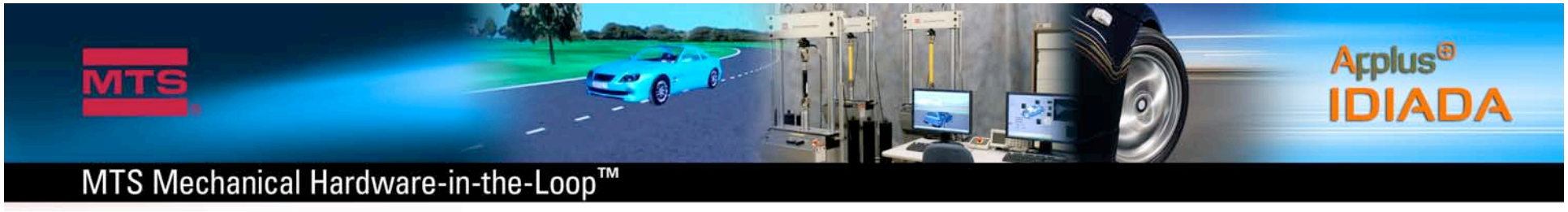
Peak Lateral Acceleration

Project results: Application of higher resolution mHIL data in a “metric” based programme



Conclusion

- mHIL is a beneficial tool in advancing chassis development
  - Supports damper development
  - Productive time saving environment
  - Allows evaluation of an optimal solution
- More thorough than pure simulation
  - More realistic
  - More sensitive
  - Extends simulation design effectiveness
- Contains “Hidden” advantages
  - Visualization of performance at component level
  - Data available for Rig and Simulation results



Thank you for your interest

If you have more questions or would like to discuss further please visit Applus+ Idiada and MTS at Booth 10000