Evaluation of DyMESH Wheel Impact in a Rollover Collision

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Goal

To evaluate the performance of the wheel impact model within SIMON DyMESH by simulating a rollover crash test involving significant interaction between the wheel of the bullet vehicle and the body of the target vehicle.

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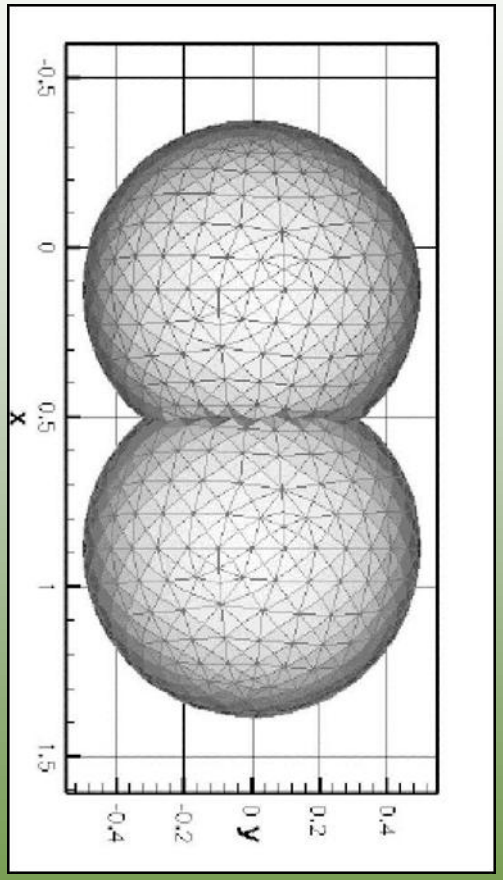
Outline

1. Review of SIMON/DyMESH Wheel Impact Model
2. Full Scale Test Configuration and Simulation Set-Up
3. Simulation Results

1. Review of SIMON/DyMESH Wheel Impact Model

Review of SIMON/DyMESH Wheel Impact Model

- DyMESH: "**Dy**namic **ME**chanical **Sh**ell".
- Wheel impact model introduced in SIMON Version 3 within HVE Version 9, in April 2012
- Allows DyMESH simulations involving impacts between the wheels and sprung masses of other vehicles
- Still considered "beta" software pending further user feedback



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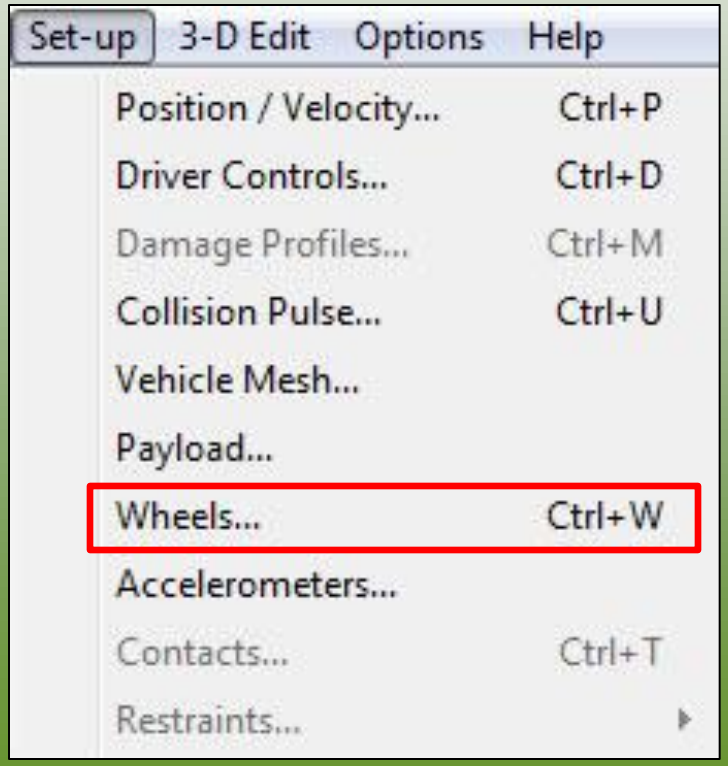
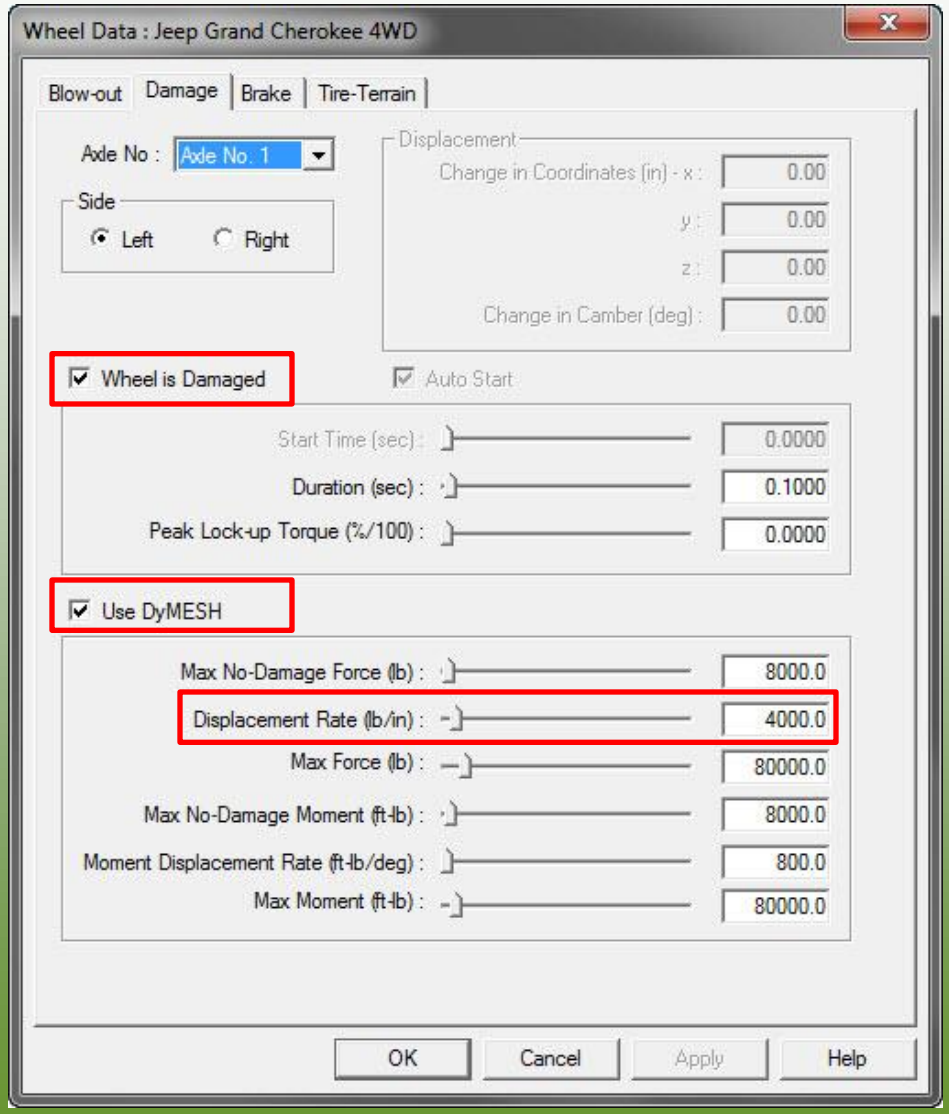
Review of SIMON/DyMESH Wheel Impact Model

- Each wheel assembly is a DyMESH object with mass and a mesh
- Properties of the wheel assembly are defined by tire dimensions, inertia and radial stiffness
- Tire kinematics are included: spinning wheels create moments and forces from tangential friction
- The resulting forces and moments are incorporated into the equations of motion
- Forces and moments on wheels can cause displacement, based on suspension stiffness properties

Review of SIMON/DyMESH Wheel Impact Model

Enabling DyMESH modeling of wheel impact:





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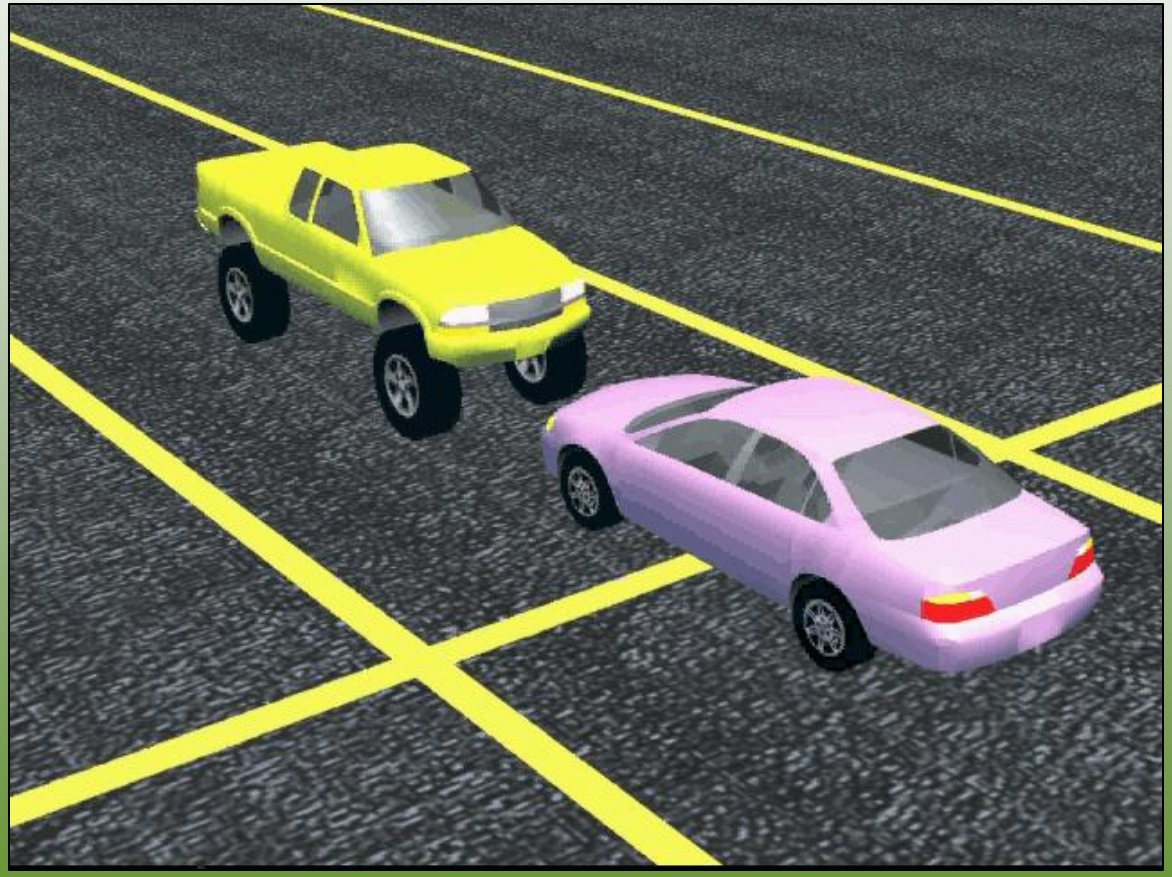
Review of SIMON/DyMESH Wheel Impact Model

- EDC DyMESH wheel impact model demonstration:



2. Full Scale Test Configuration and Simulation Set-Up

Full-Scale Test Configuration

- Test conducted by W.R. Haight at 2012 ARC-CSI Crash Conference
- 2011 Jeep Grand Cherokee induced to roll over by driving up and over 1987 Bertone (“Fiat”) X1/9 sports car

Full-Scale Test Configuration

- 2011 Jeep Grand Cherokee
- 5,080 lb test weight
- Radio-controlled
- 3-axis accelerometers and rate gyros

Full-Scale Test Configuration

- 1987 Bertone X1/9
- 2,010 lb test weight
- Parked in neutral
- 3-axis accelerometer

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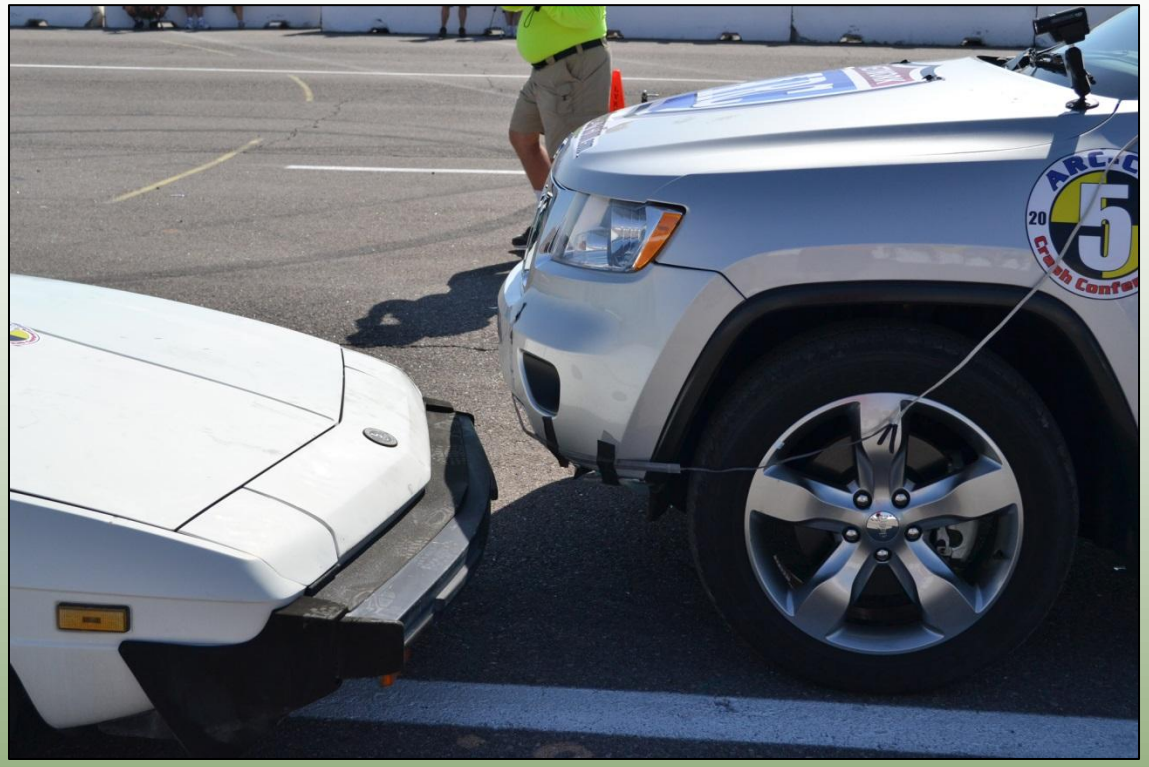
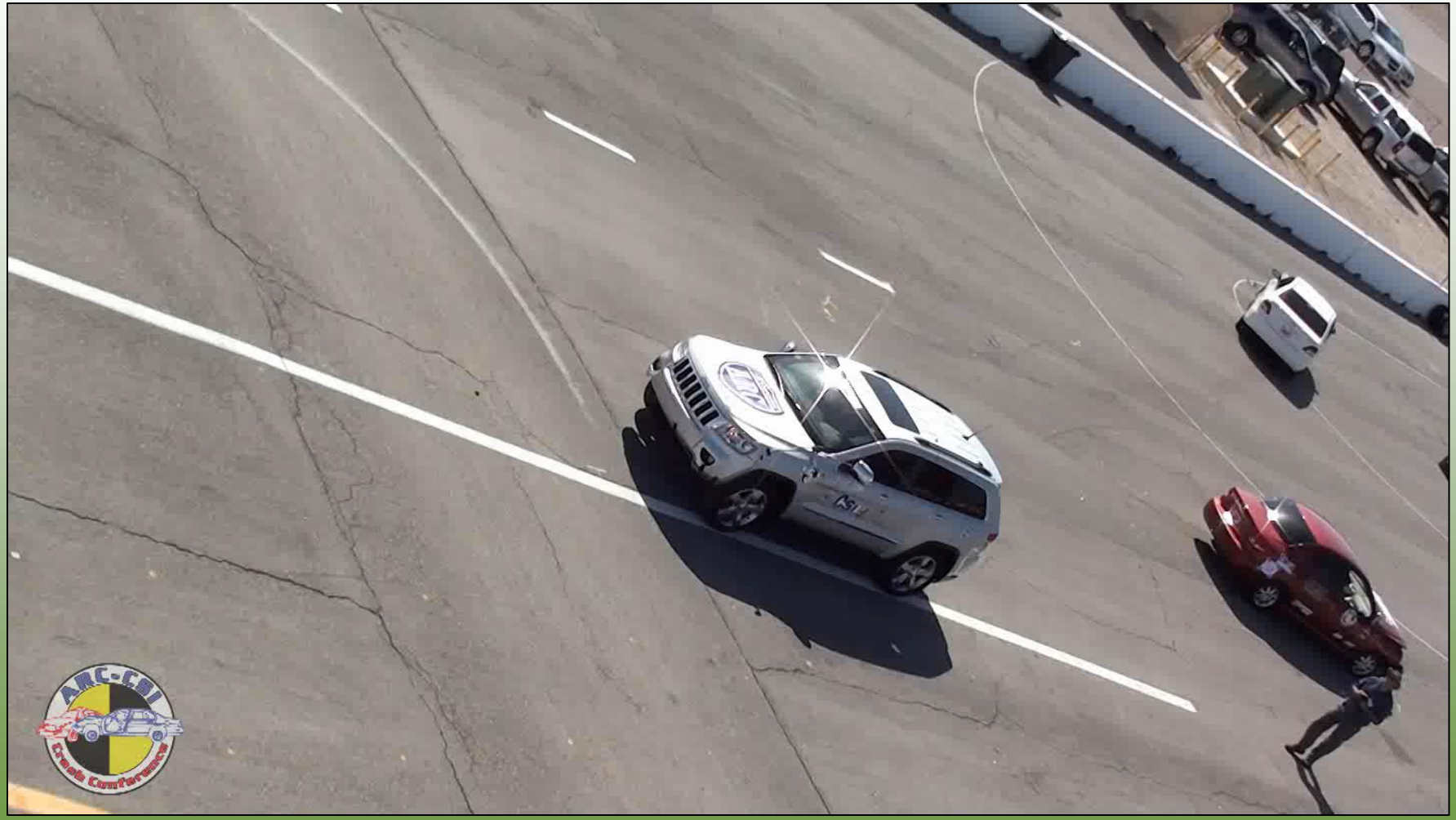
Full-Scale Test Configuration



- Offset frontal impact (half width of Fiat)
- ~41 mph impact speed for Jeep

Full-Scale Test Configuration



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Full-Scale Test Configuration

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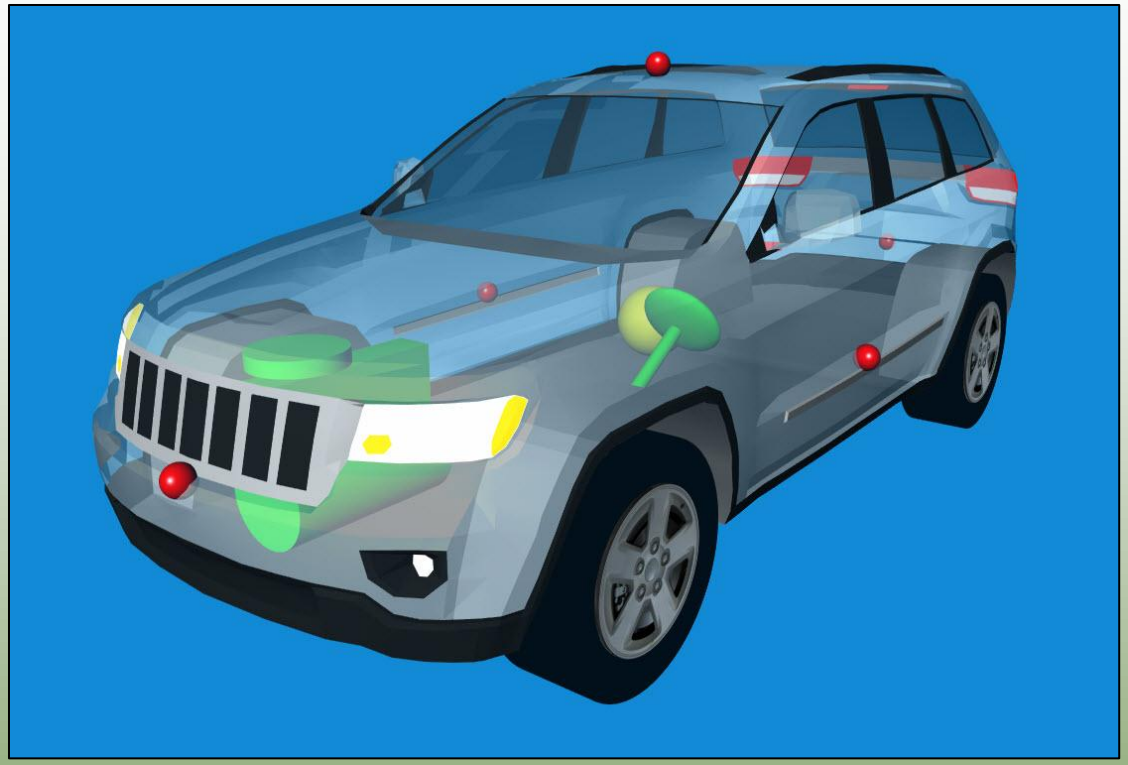
Full-Scale Test Configuration

Simulation Set-Up



- 2011-2012 Jeep Grand Cherokee from Vehiclemetrics database
- DyMESH wheel displacement rate increased from default

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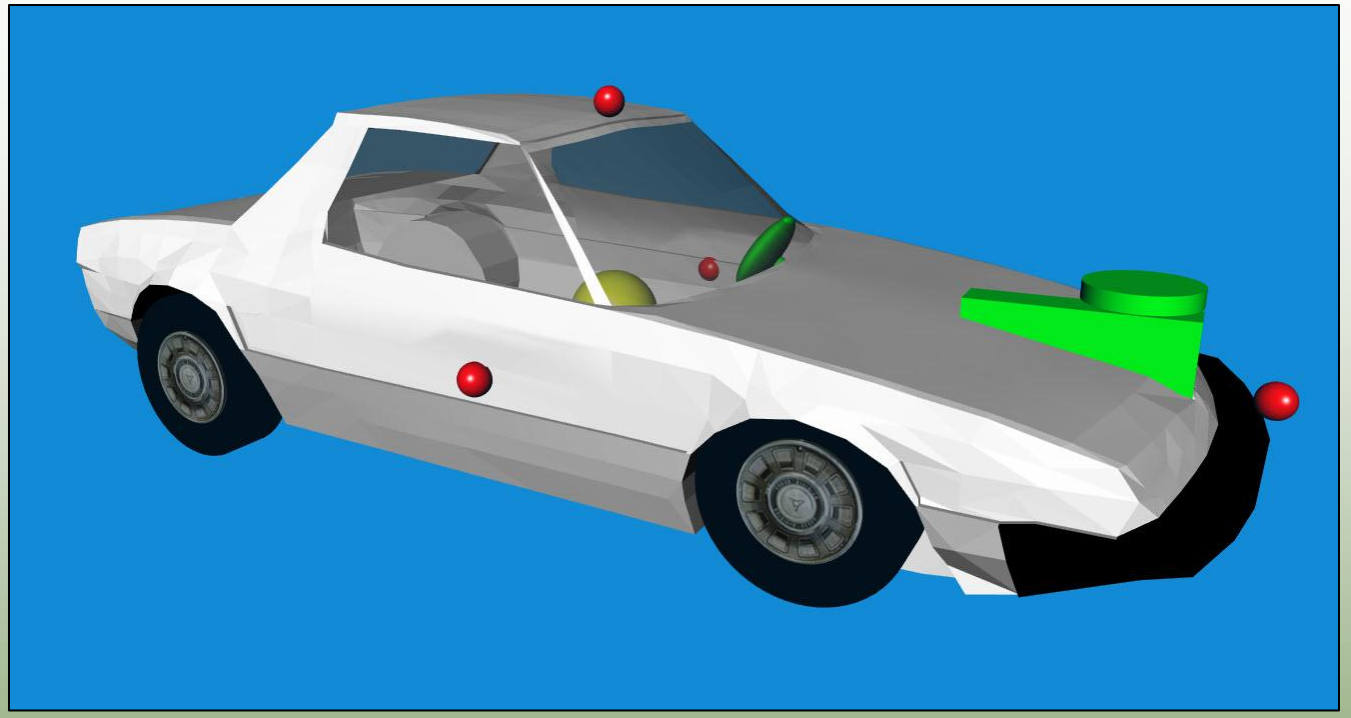
Simulation Set-Up



- Vehicle data based on Class 1 Generic Vehicle
- Body geometry from 3D CAD Browser, matched against surveyed test vehicle
- Front and top body stiffness increased via reduction of conversion height from 30” to 8” (yes, there is a frontal crash test for this vehicle!)

Simulation Set-Up

- Integration timesteps = 0.001 sec
- Point contact tire model active, only
- Results in 1 ¼-minute run time for 2 ½-sec simulation on 3.40 GHz PC with 12 GB RAM running Windows 7 64-bit + Nvidia GeForce GT420 video accelerator (2 GB RAM)

3. Simulation Results

Simulation Results

Simulation Results

t = 0.01 sec

Simulation Results

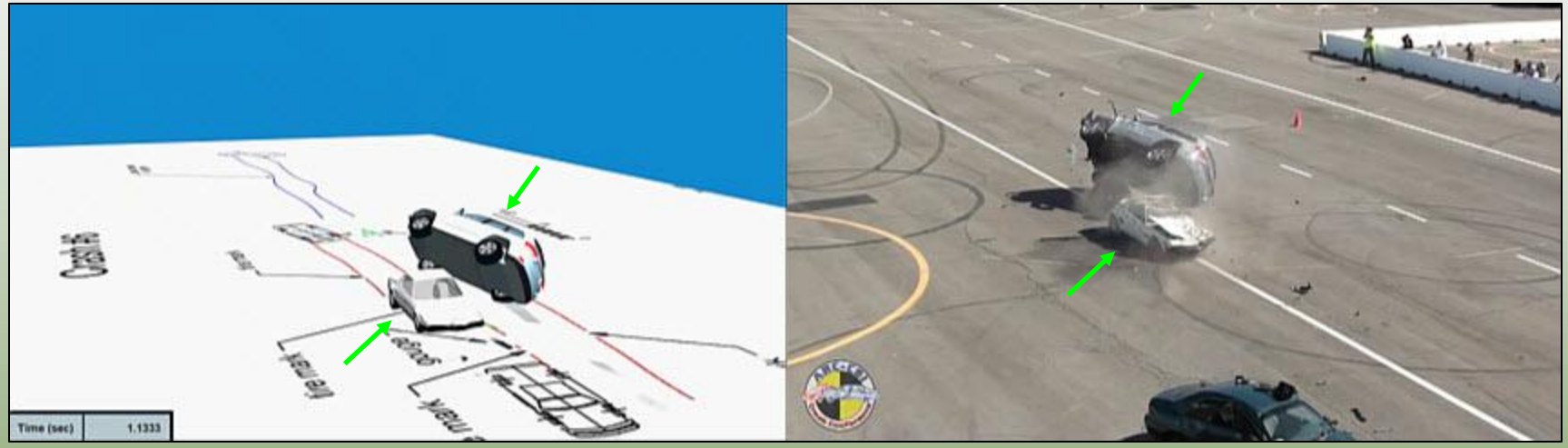
t = 0.11 sec

Simulation Results

t = 0.51 sec

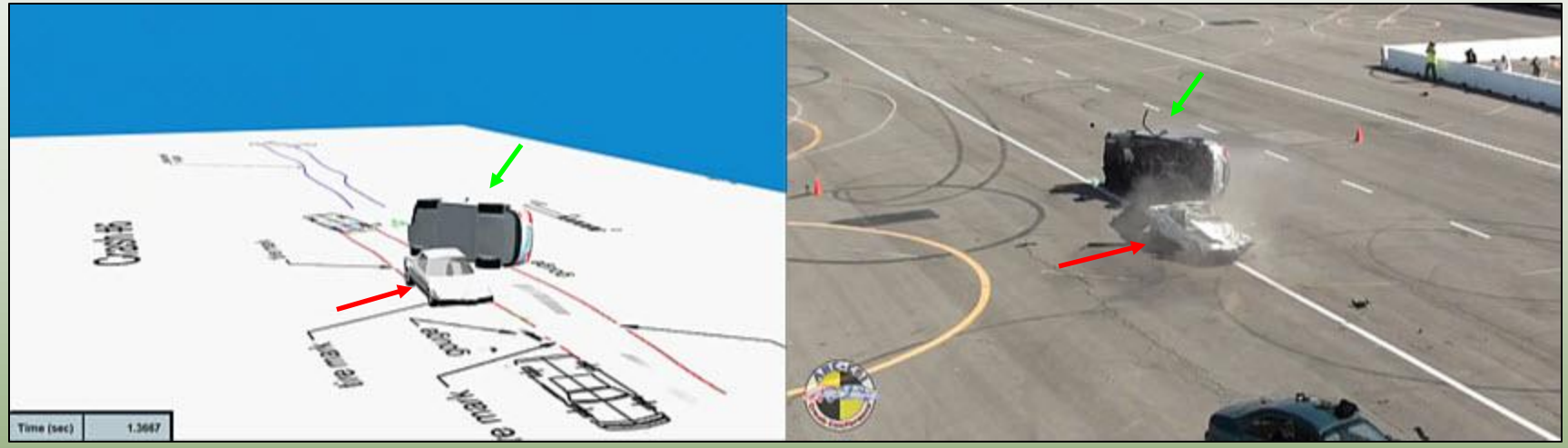
Simulation Results

t = 0.88 sec

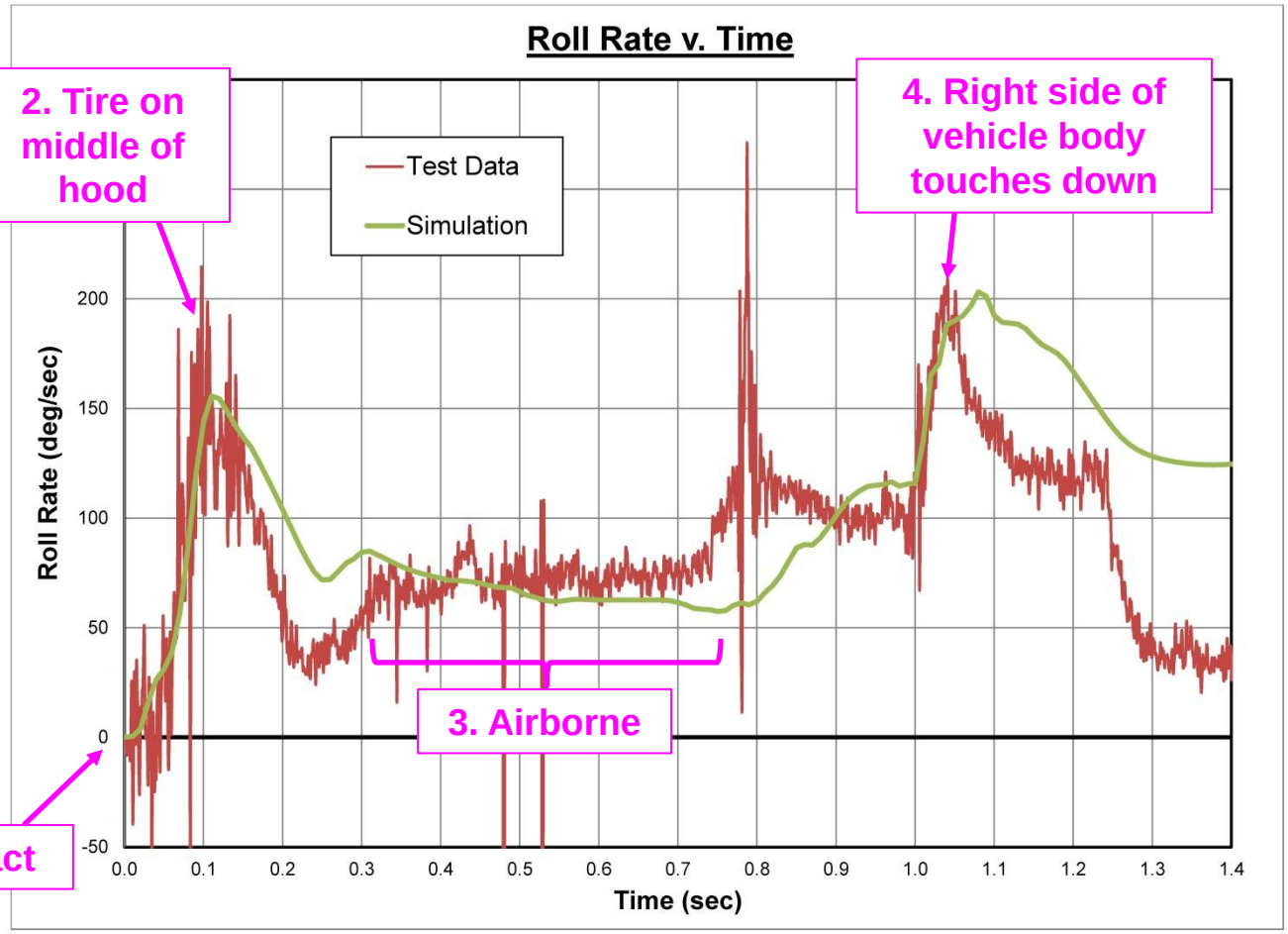


Simulation Results

t = 1.10 sec



Simulation Results



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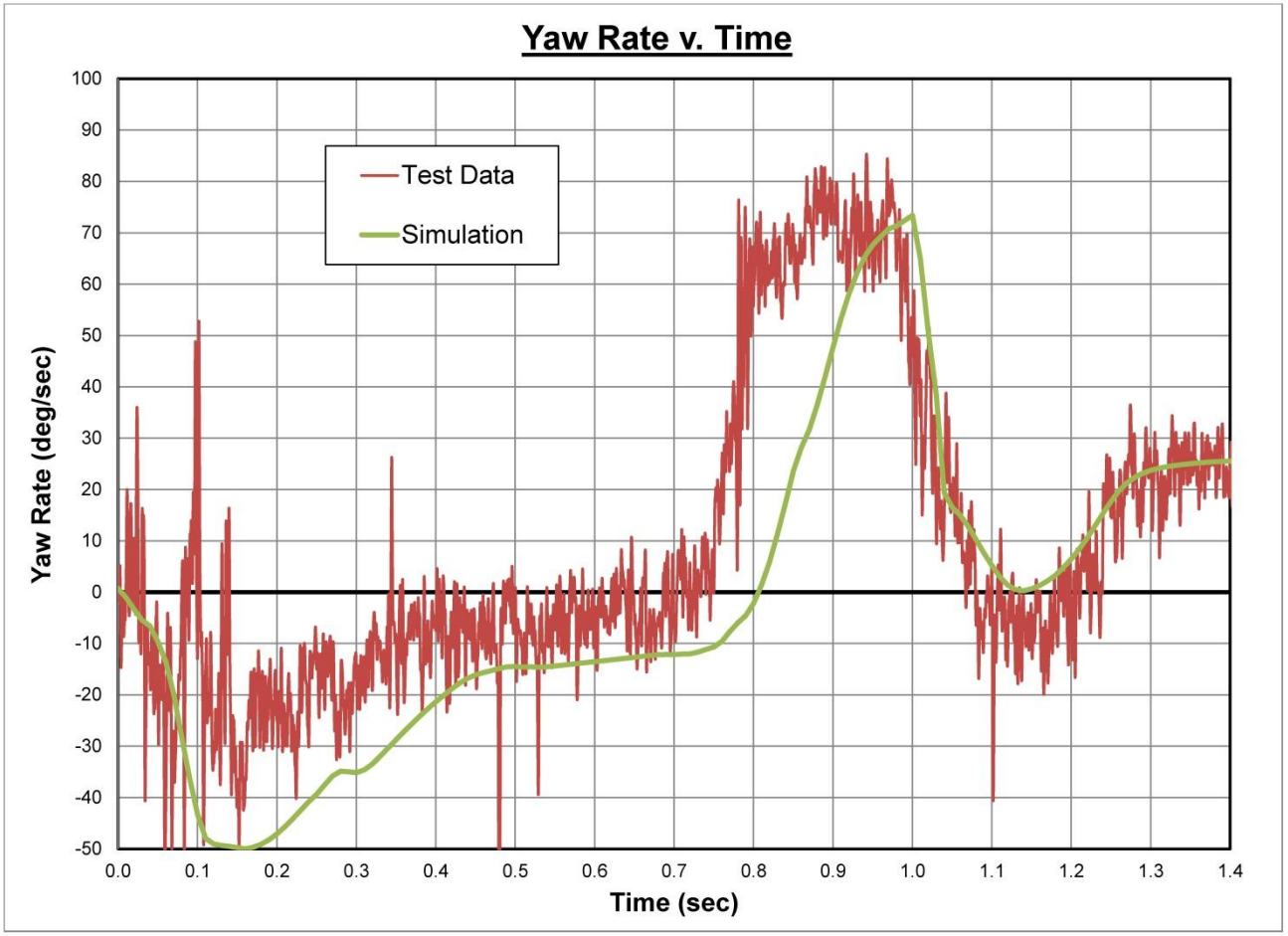
Simulation Results



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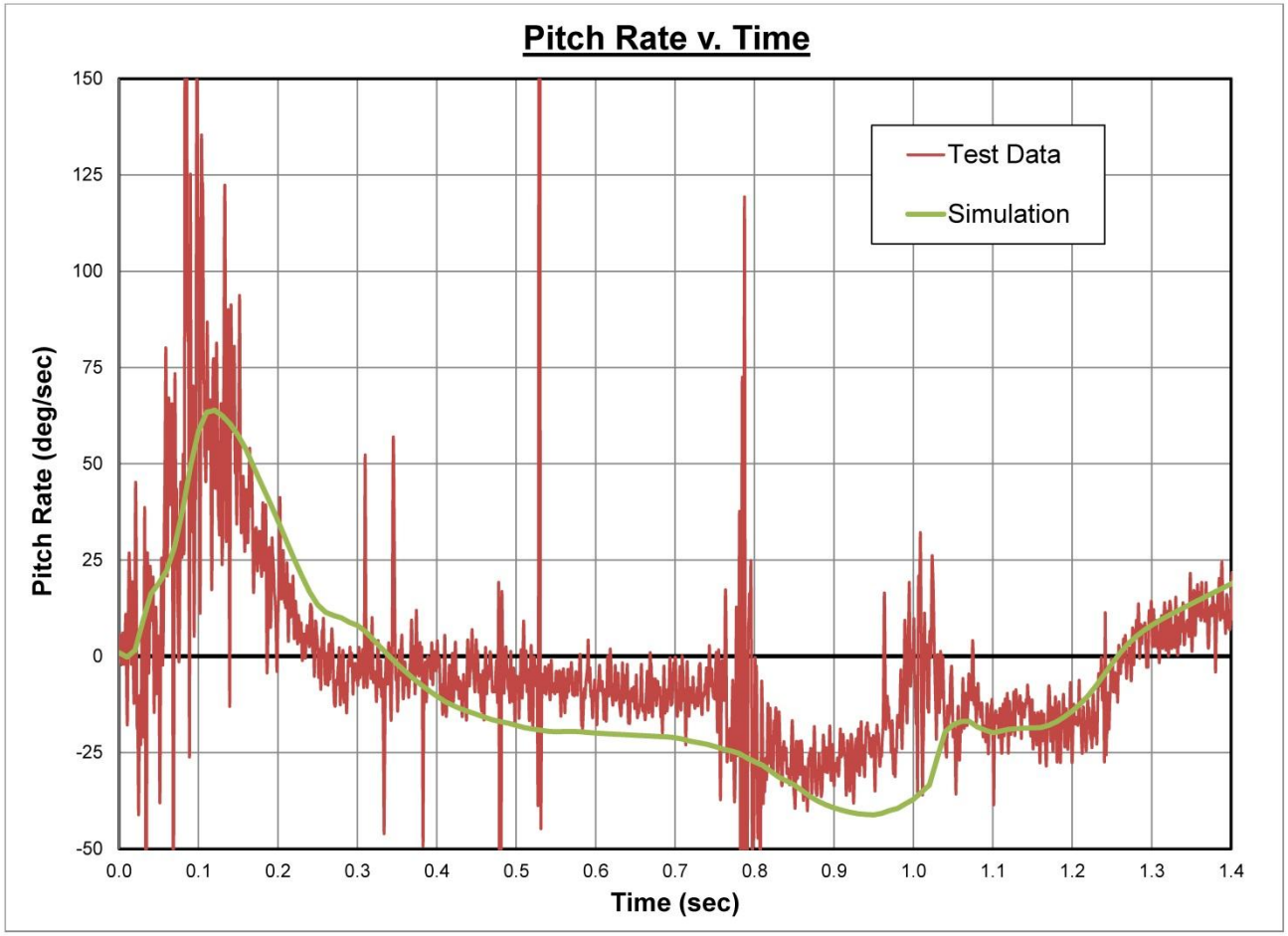
Simulation Results



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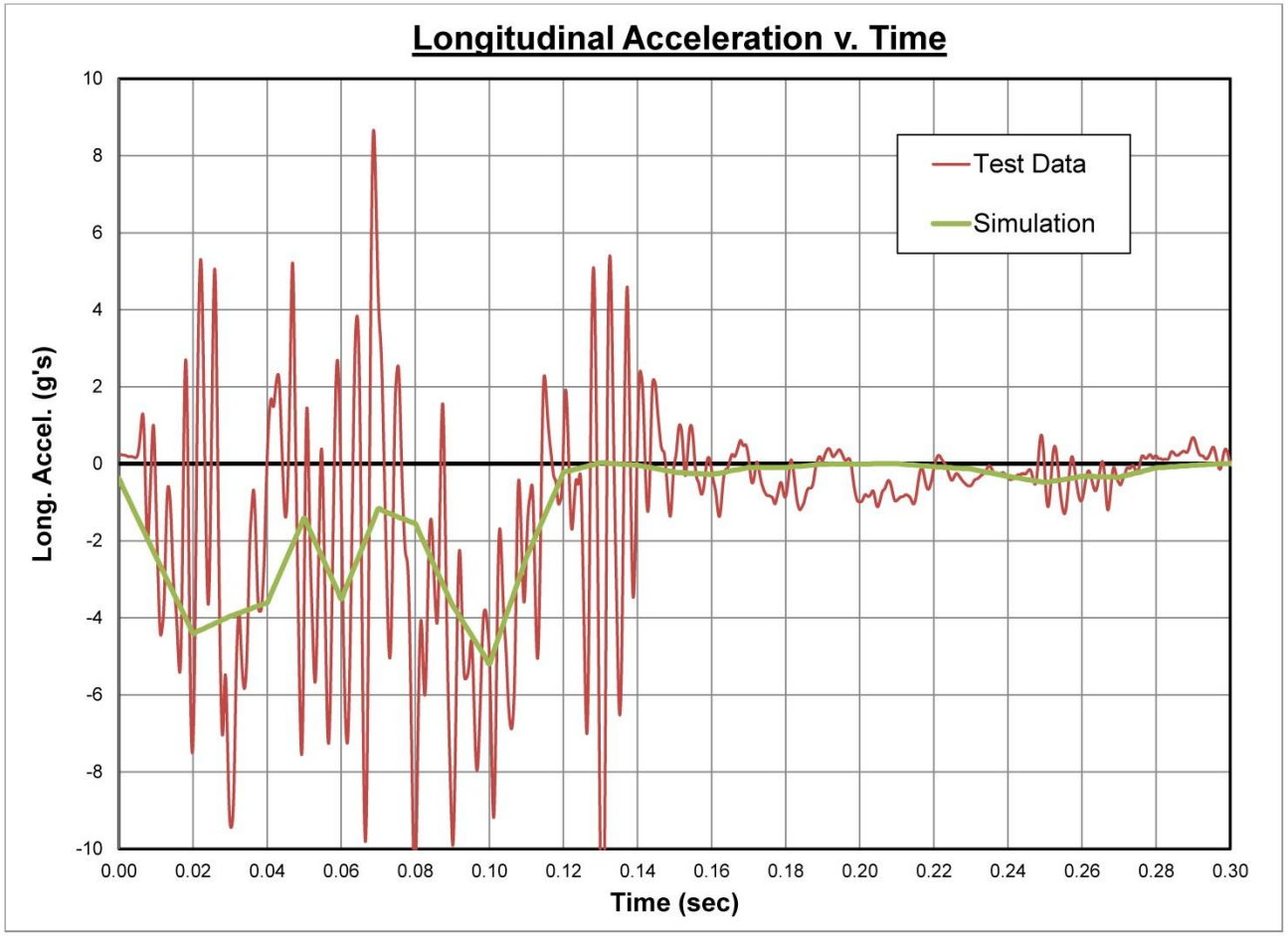
Simulation Results



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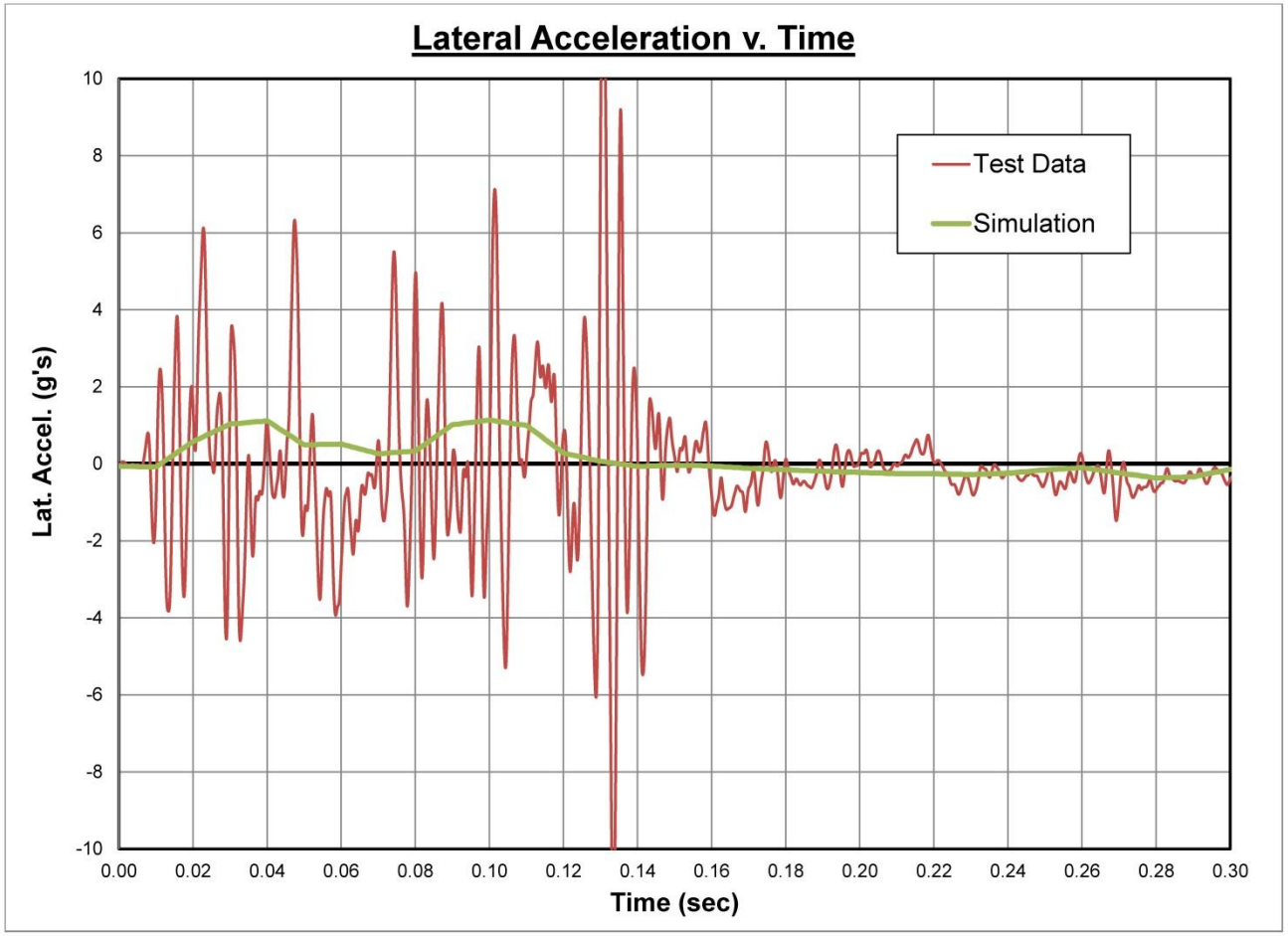
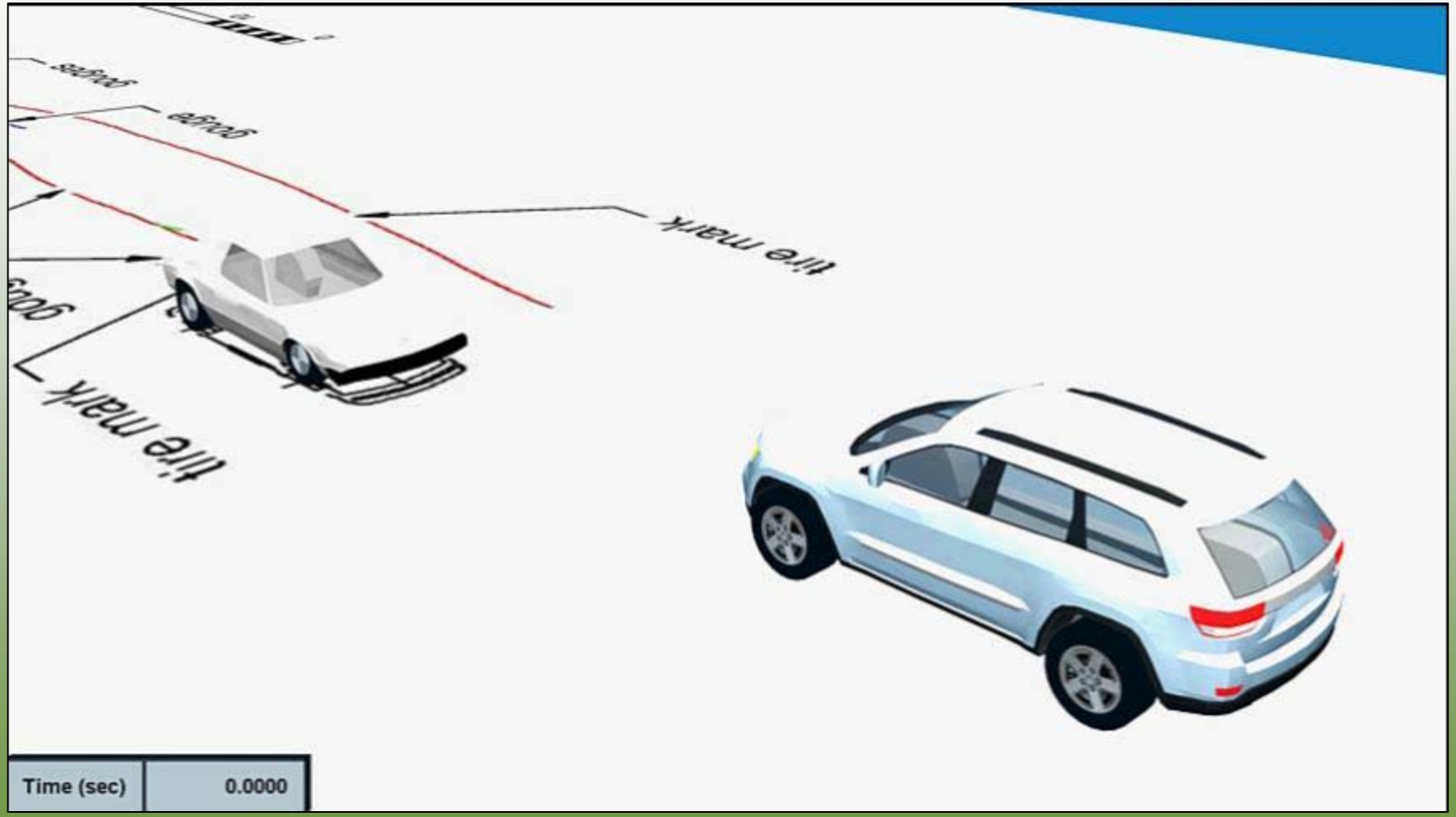
Simulation Results



Simulation Results



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Summary

- In an initial comparison study, the DyMESH wheel impact model functioned to properly alter the path of the bullet vehicle as it overran the body of the target vehicle
- The primary parameters examined in this study were the stiffness of the body of the target vehicle and the force-deflection relationship of the wheel assembly of the bullet vehicle
- The proper simulation of the entirety of the rollover event was not a focus of this study, however, the bullet vehicle's behavior was adequately modeled from impact through separation from the target vehicle
- Modeling detail for the interaction between a wheel and the body of its own vehicle may affect the trajectory of an overrunning bullet vehicle.
- It is expected that further refinement of this initial study would improve the model correlation (e.g. linear accelerations and angular rates.)

Acknowledgement

- The authors greatly acknowledge W.R. “Rusty” Haight of Collision Safety Institute for undertaking the subject rollover test and for providing the authors with the high-quality documentation and test data upon which this simulation study was based

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Questions?