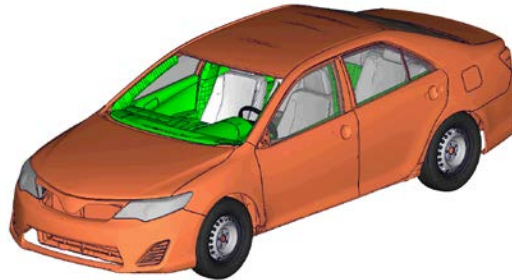


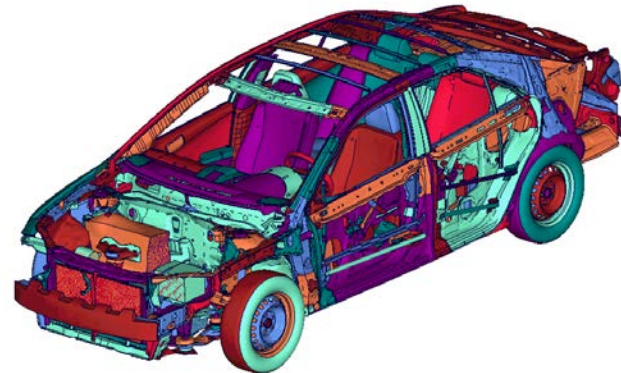
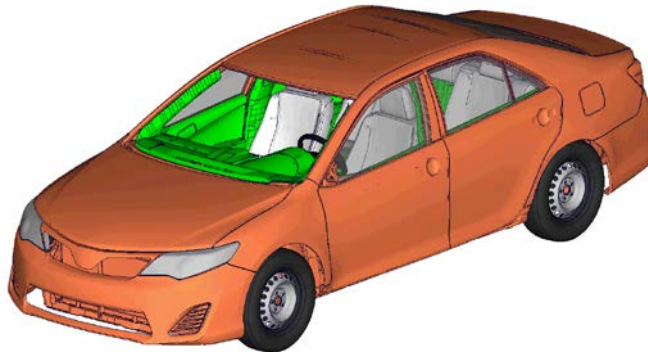
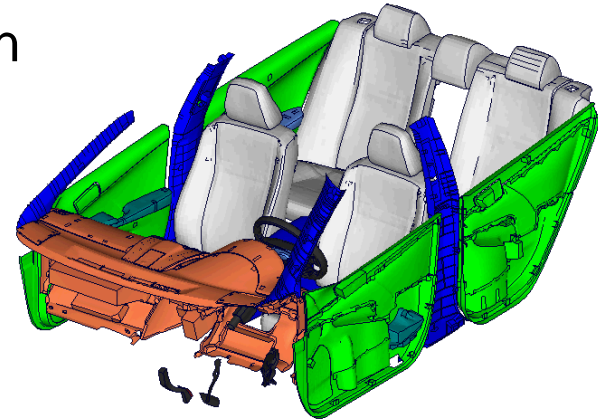
# 2012 Toyota Camry Detailed Model V5

doi:10.13021/G8TS3



# FE-Model Summary

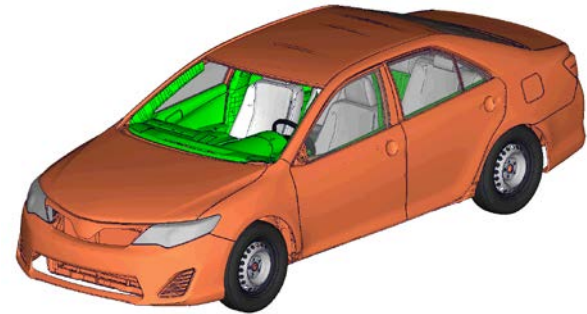
- Vehicle Structure, Interior, and Suspension
- Model size:
  - ~ 2.25 million elements
  - ~ 1000 Parts
- Average element size: 6-8 mm
- Time step: 0.7 microseconds



# Physical Vehicle and FE-Model



VIN 4T1BF1FK2CU079329



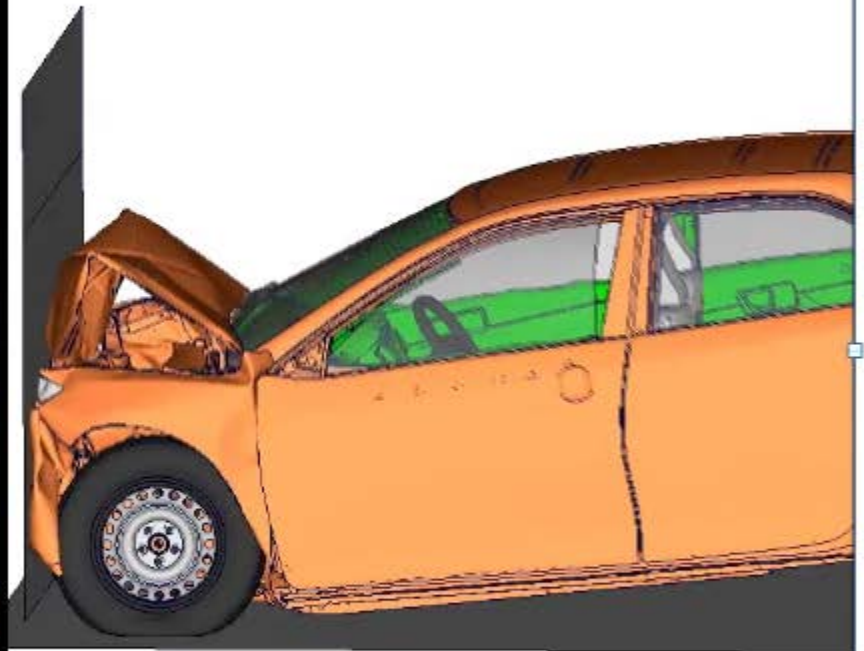
Detailed Finite Element Model

# Mass, Inertias, CG Location

- Mass difference is less than 1%
- Inertia differences is less than 3%
- Vehicle CG difference is less than 3%

	Physical vehicle	FE model	Difference
Mass [kg]	1452	1462	0.7 %
Pitch inertia [kg*m <sup>2</sup> ]	2519	2524	0,2 %
Yaw inertia [kg*m <sup>2</sup> ]	2796	2807	0.4 %
Roll inertia [kg*m <sup>2</sup> ]	560	572	2.1 %
Vehicle CG x [mm]	1063	1086	2.2 %
Vehicle CG y [mm]	-9	-1	n/a
Vehicle CG z [mm]	561	560	0.2 %

# Frontal 56 km/h NCAP - $t=100\text{ms}$

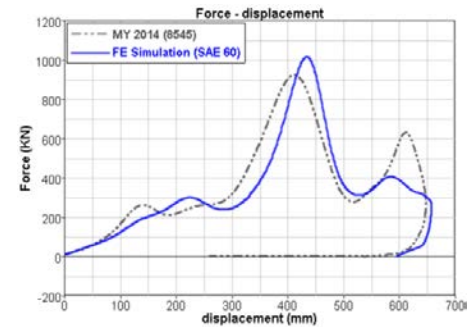


Z  
Y  
CAMRY BIW - State 11 at time 0.100000

# Frontal 56 km/h NCAP - Results

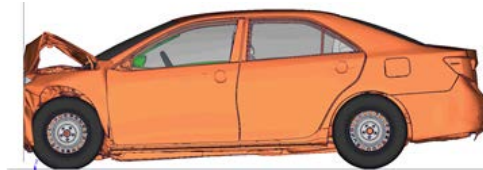
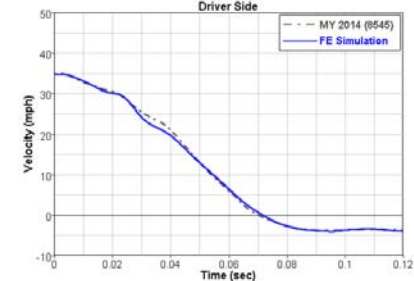
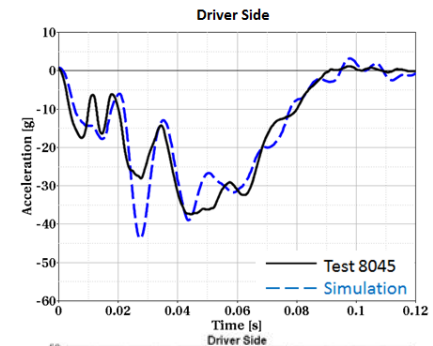
## Barrier Force vs Displacement

- Vehicle Displacement within 1%
- Maximum barrier force within 10%
- CORA Rating: 0.88



## Vehicle Pulse

- CORA (Acceleration): 0.84
- CORA (Velocity): 0.98





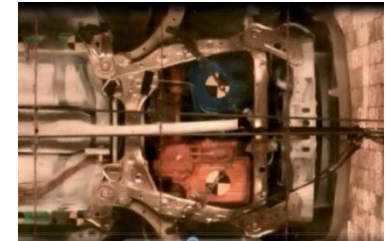
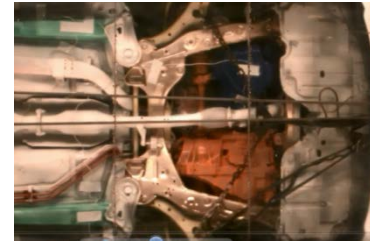
# Frontal 40 km/h NCAP - t=100ms



# Frontal 40 km/h NCAP - Results

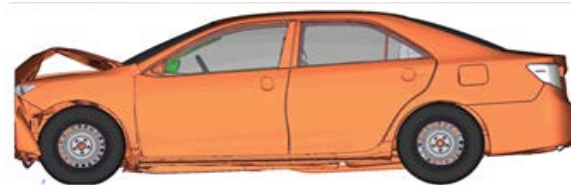
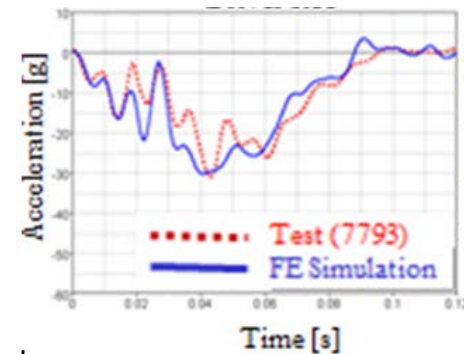
## Limitation

- Test: Hybrid Synergy Drive®
- Simulation: Conventional Engine



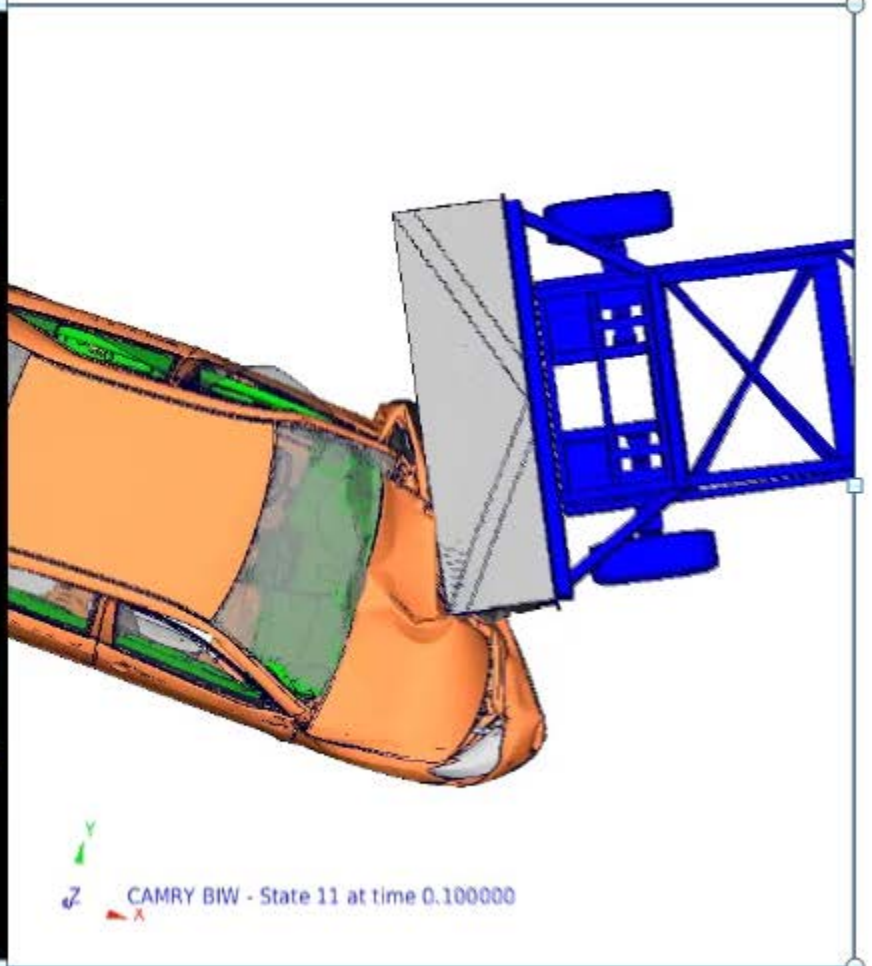
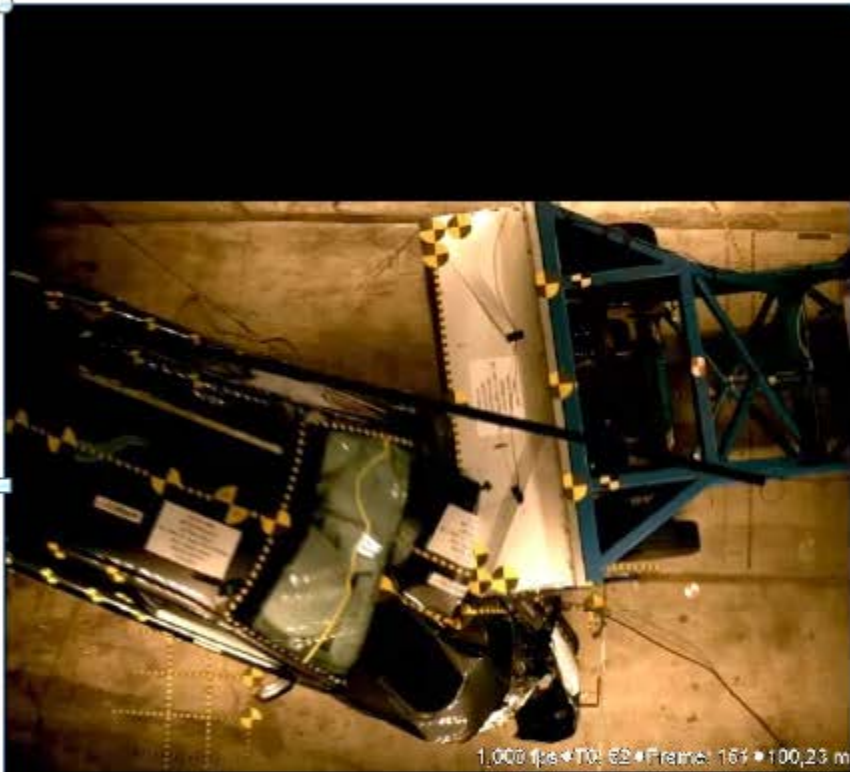
## Vehicle Pulse

- Acceleration Peak within 3%
- CORA (Acceleration): 0.81





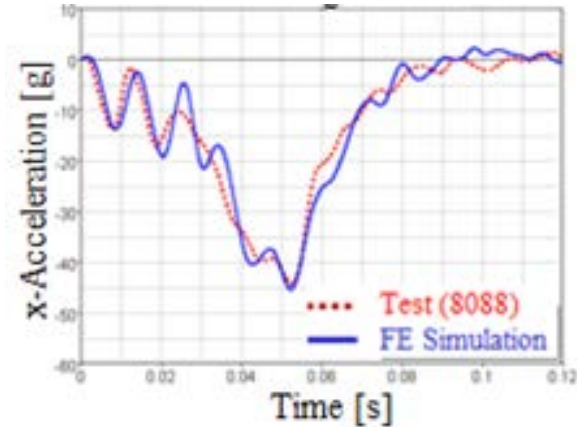
# Frontal Left Oblique 90 km/h - t=100ms



# Frontal Left Oblique 90 km/h - Results

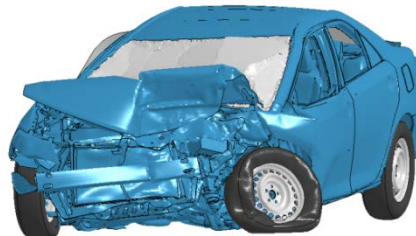
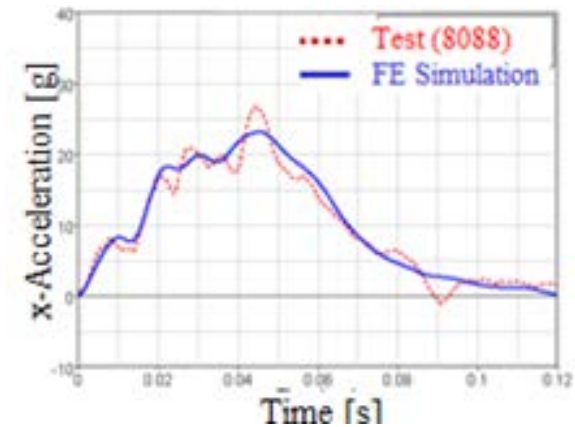
## Vehicle Kinematics & Pulse

- Kinematics well captured
- Peak well captured
- CORA-Rating: 0.93

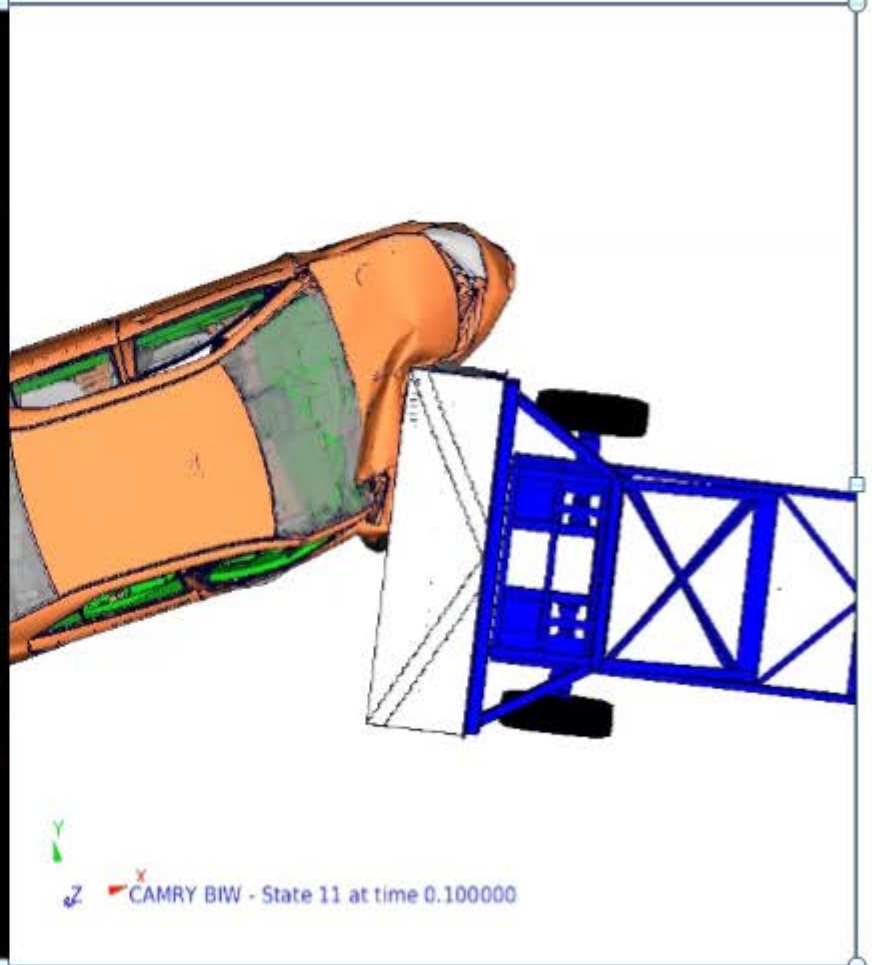


## Barrier Pulse

- Good Correlation
- CORA-Rating: 0.95



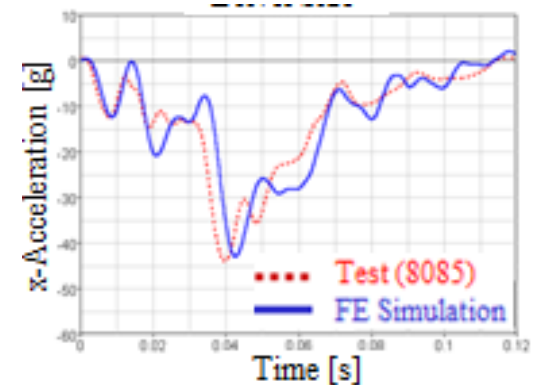
# Frontal Right Oblique 90 km/h - t=100ms



# Frontal Right Oblique 90 km/h - Results

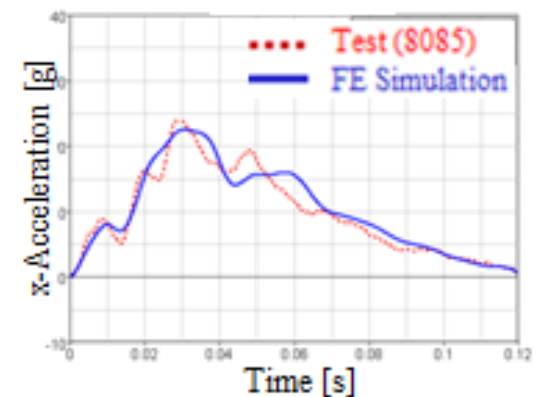
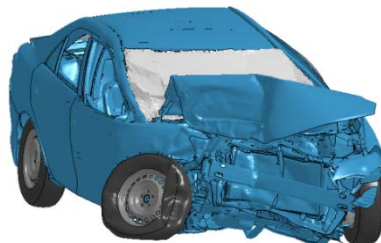
## Vehicle Kinematics & Pulse

- Wheel kinematics influence pulse
- Peak maximum value well captured
- CORA-Rating: 0.80



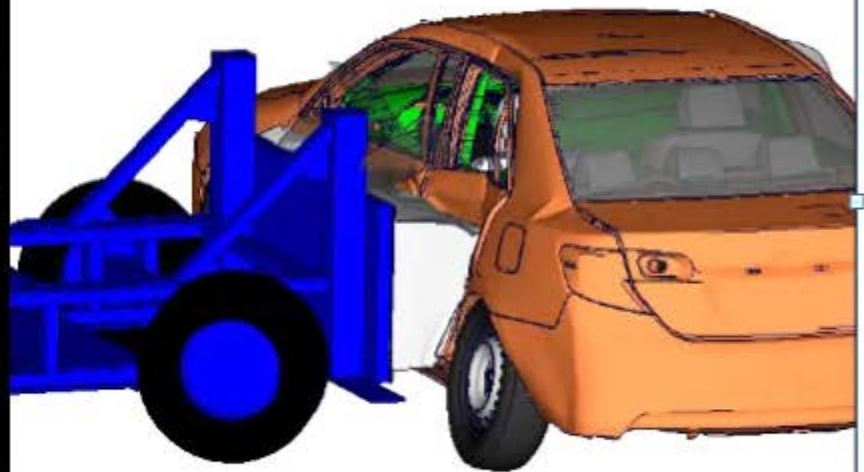
## Barrier Pulse

- CORA-Rating: 0.90





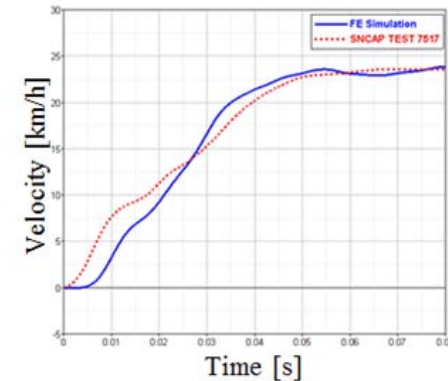
# Side NCAP Barrier 62 km/h $t=100\text{ms}$



# Side NCAP Barrier 62 km/h - Results

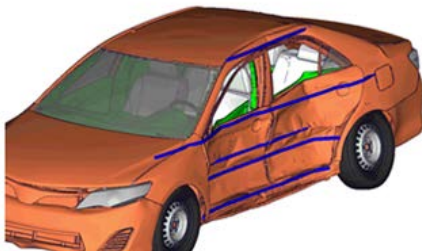
## Vehicle Kinematics and Pulse

- Similar overall vehicle kinematics
- Vehicle accelerates to 23km/h
- CORA-Rating: 0.92



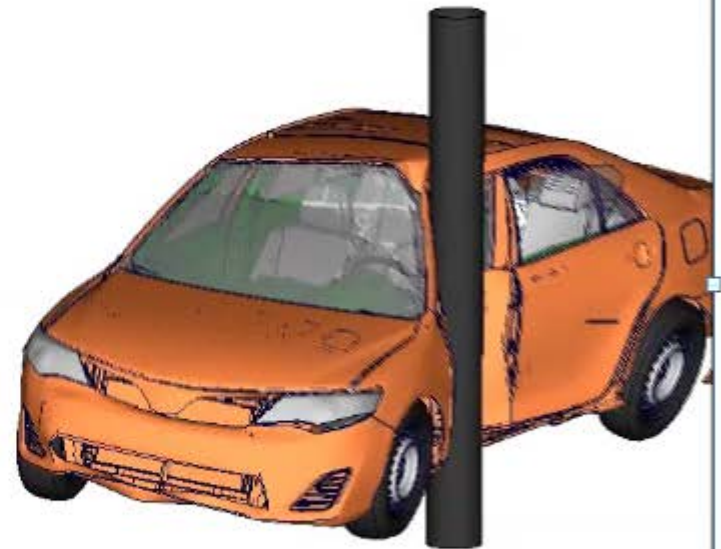
## Vehicle Damage Comparison

- Post crash intrusion measurements at 5 different heights (sill top, occupant hip point, mid door, window sill, and window top) compare well in test and simulation





# Side NCAP Pole 32 km/h t=100ms

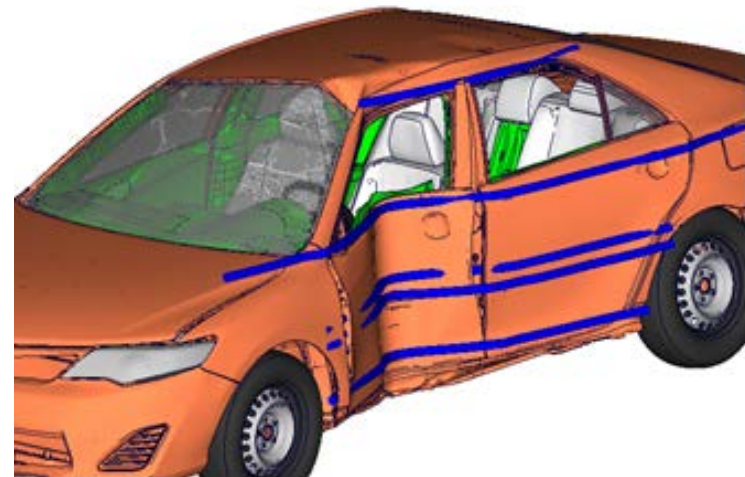


$Z$   
 $X_t$  CAMRY BIW - State 11 at time 0.100000

# Side NCAP Pole 32 km/h - Results

## Vehicle Damage Comparison

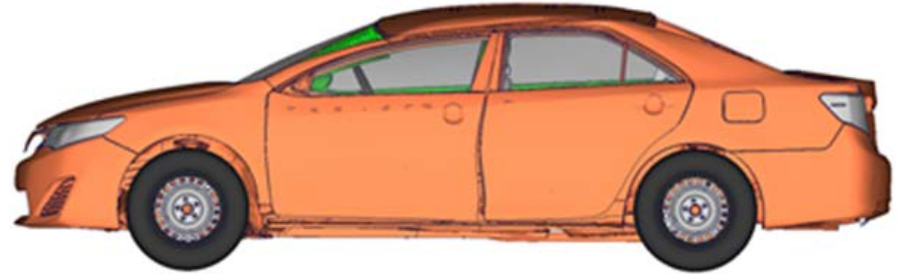
- Post crash intrusion measurements at 5 different heights (sill top, occupant hip point, mid door, window sill, and window top) compare well in test and simulation



# Roof Crush Resistance - Results

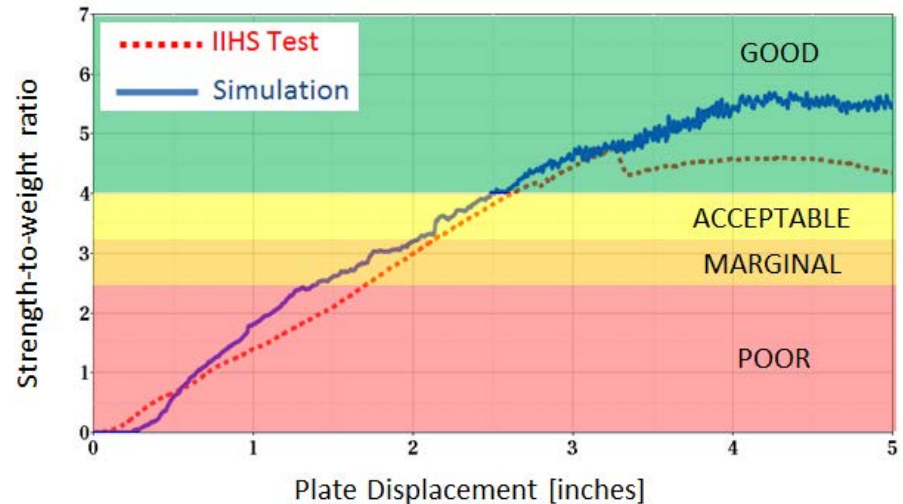
## Test

- Quasi-static
- Front windshield failure occurs after 3.2 inches
- IIHS rating: GOOD



## Simulation

- Dynamic
- Material strain rate effects affect S-to-W ratio
- IIHS rating: GOOD



# Summary

## **FE Model Development & Availability**

- A detailed Finite Element Model of a 2012 Toyota Camry has been developed using a reverse engineering process
- Model has been validated using test data from available full scale crash tests including frontal, side, and roof crush configurations
- Toyota Camry is the latest in a fleet of FE full vehicle models, developed and publicly available through the Center for Collision Safety and Analysis

## **Acknowledgment**

- The effort was sponsored by the Federal Highway Administration (FHWA)