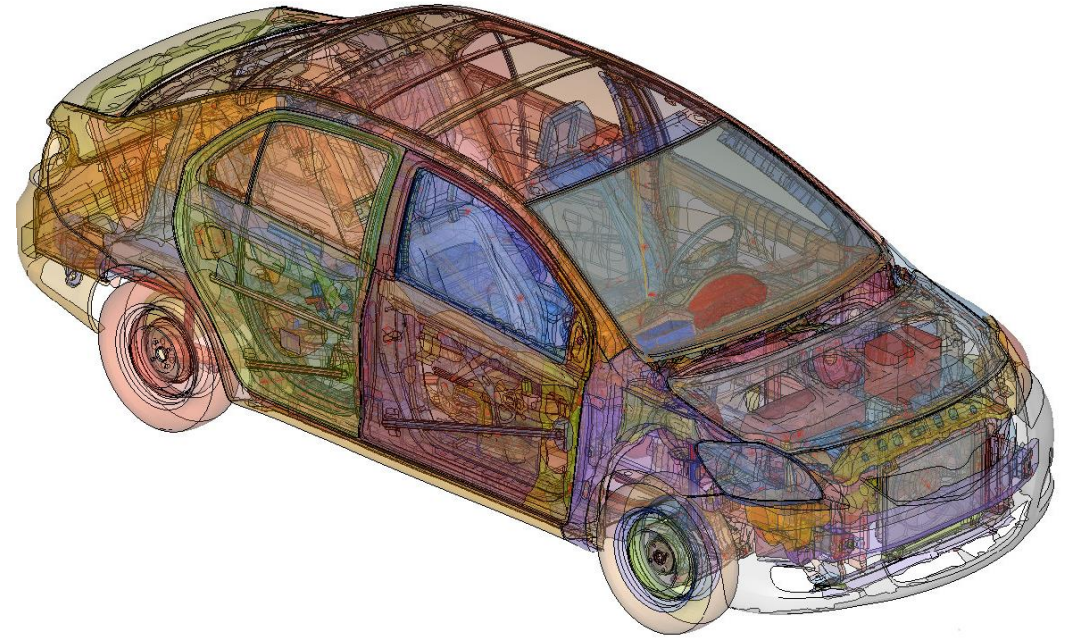
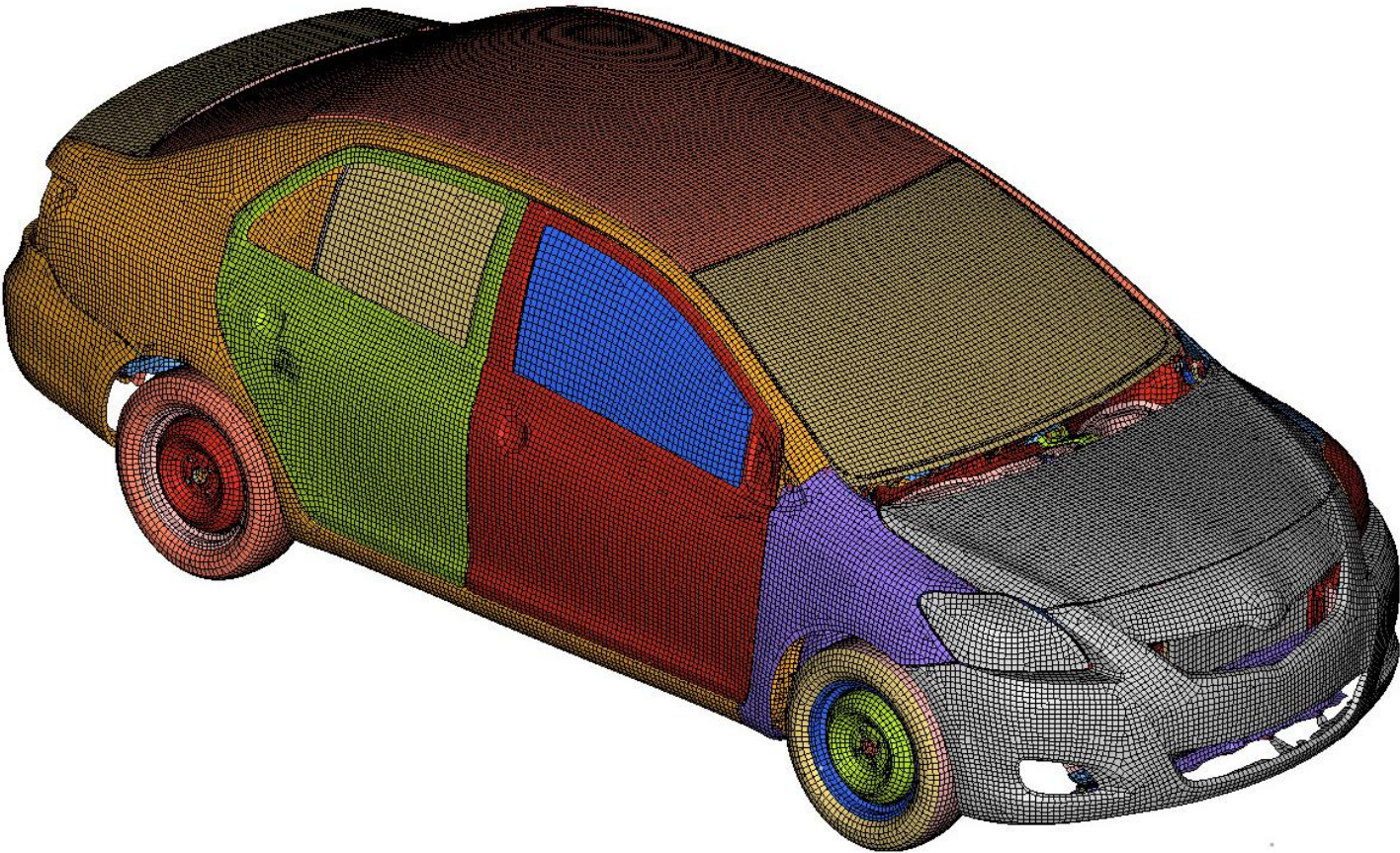


# 2010 Toyota Yaris Finite Element Model Validation Coarse Mesh



doi: 10.13021/G8JS5D

# Model Information

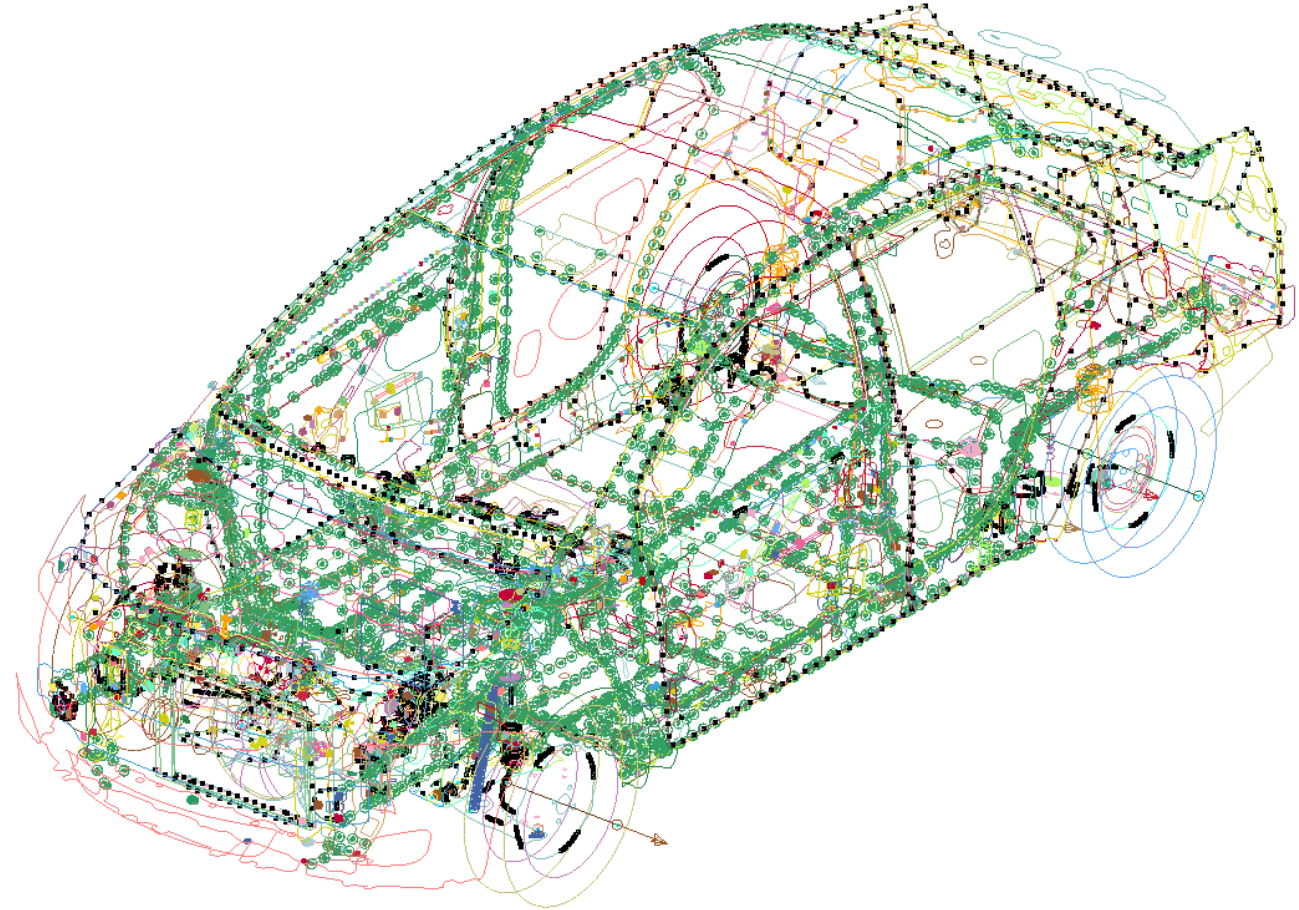


<b>Number of parts</b>	<b>919</b>
<b>Number of nodes</b>	<b>393165</b>
<b>Number of solid elements</b>	<b>15234</b>
<b>Number of shell elements</b>	<b>358457</b>
<b>Number of beam elements</b>	<b>4685</b>
<b>Number of constrained joints</b>	<b>19</b>



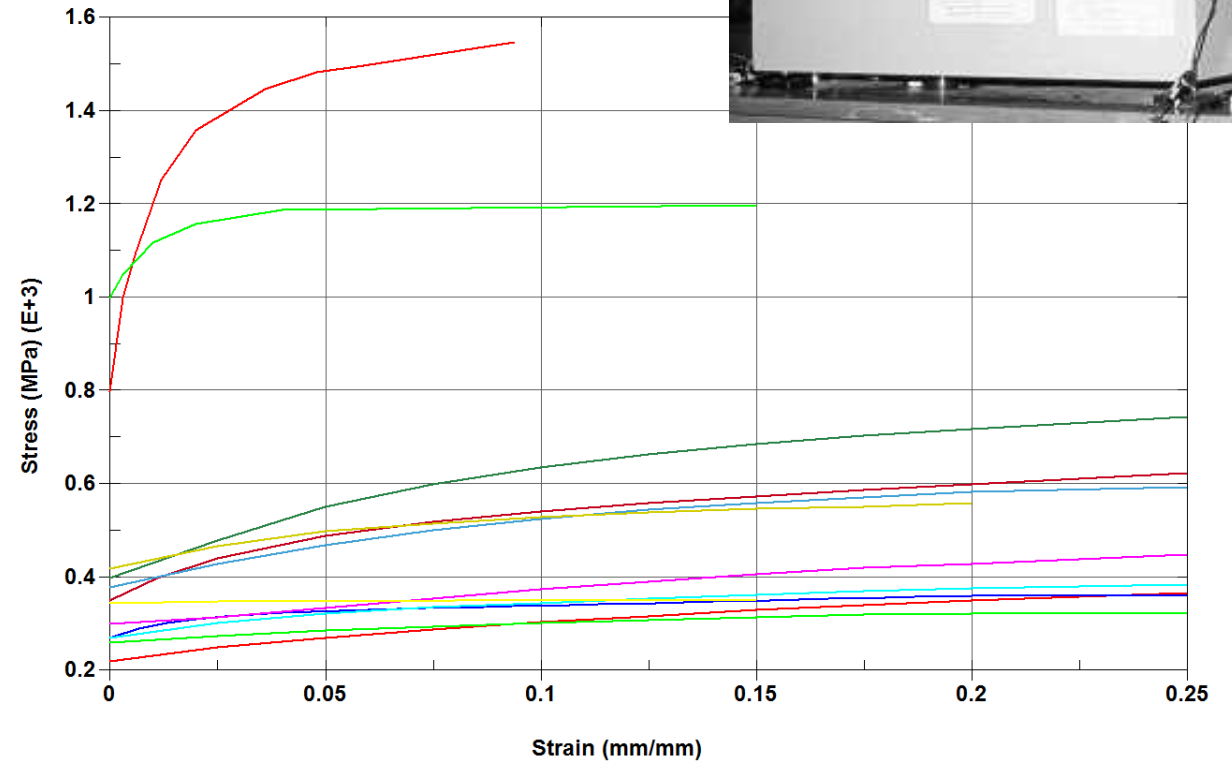
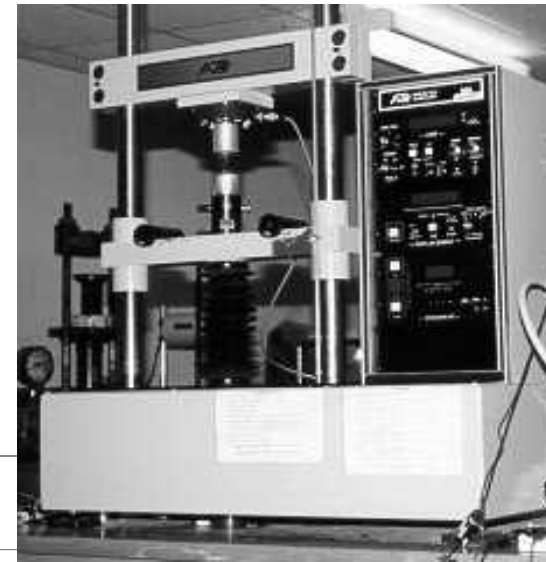
# Connections

● BEAM CONNECTIONS	4685
● NODAL_RIGID_BODY	759
● EXTRA_NODES_SET	20
● JOINTS	44
● RIGID_BODIES	2
● SPOTWELD	2828



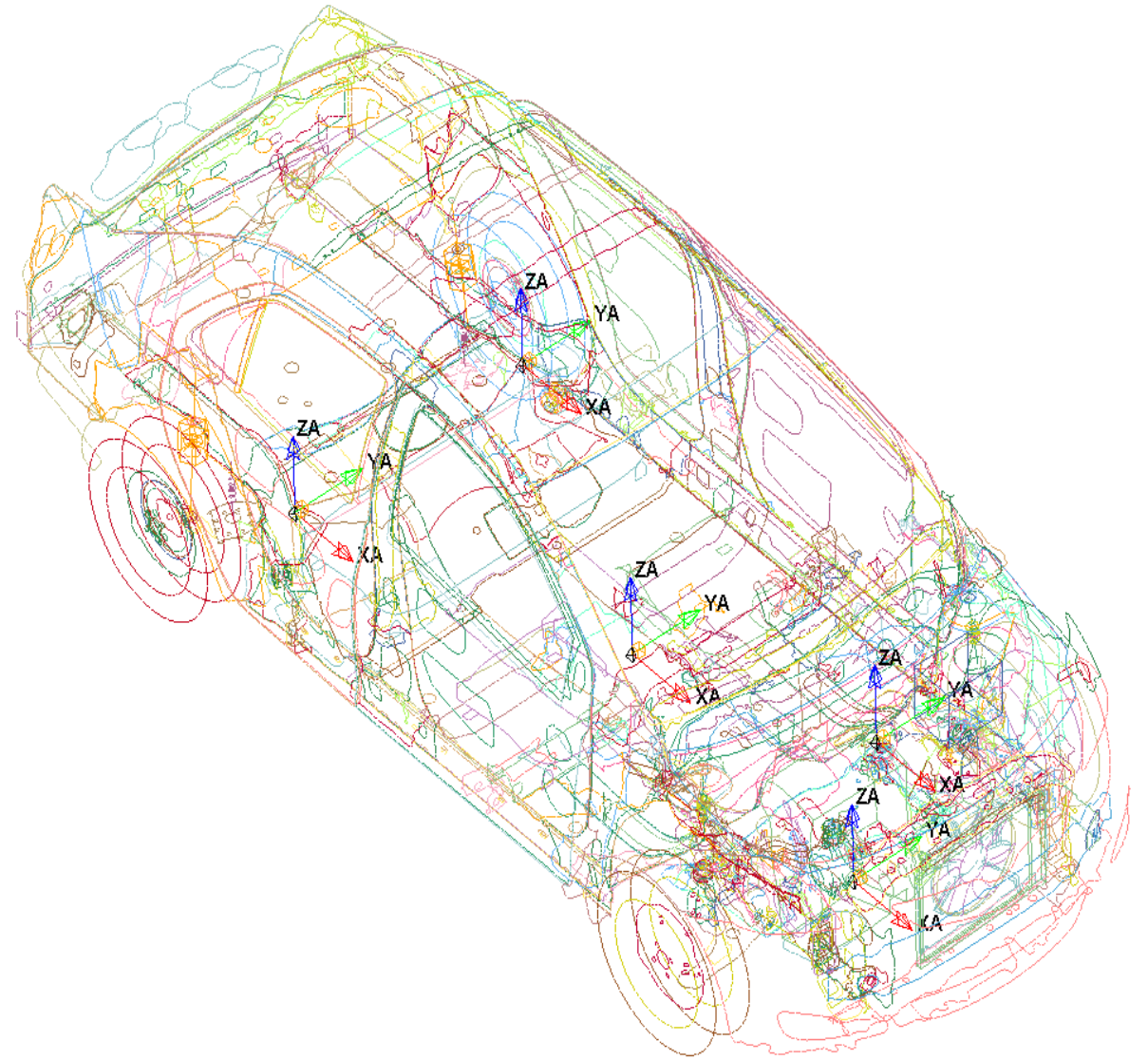
# Material Testing

- Specimens were cut from actual components
- 160 tensile tests
- Data converted
- 12 different materials generated based on test data
- Parts grouped into

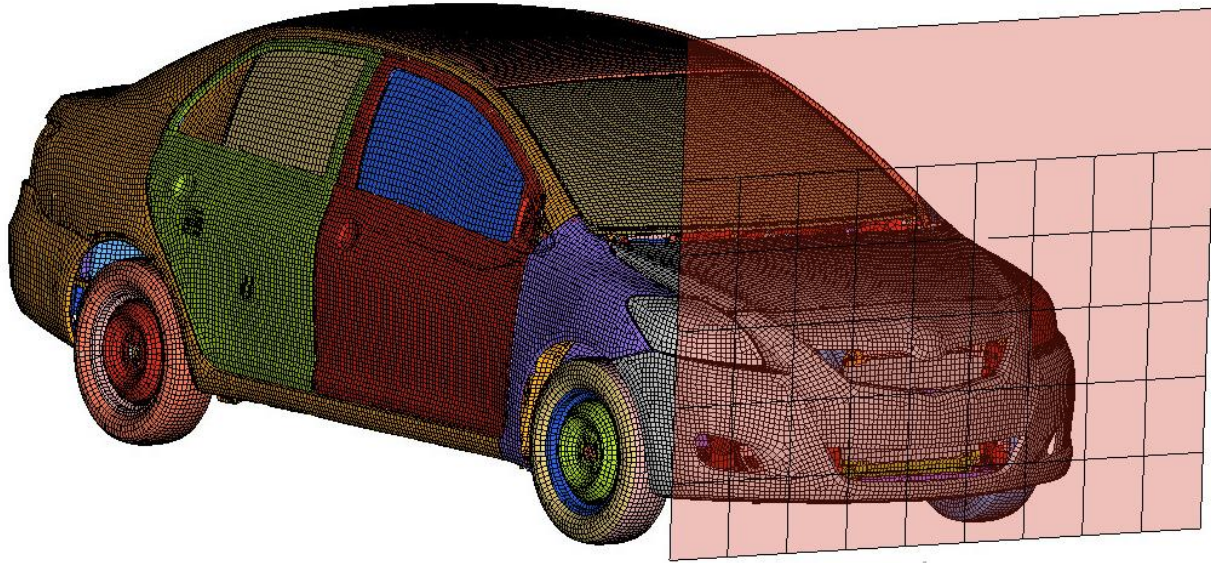


# Accelerometers

- Left Rear Seat (Node 4000390)
- Right Rear Seat (Node 4000398)
- Engine Top (Node 4000414)
- Engine Bottom (Node 4000422)
- Vehicle C.G. (Node 4000406)



# Simulation Benchmark

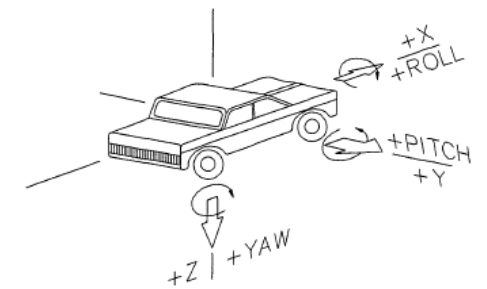


LS-DYNA	
Platform	Linux RHEL 5.4
Version	mpp s R6.1.2
Revision	85139
Precision	Single precision (I4R4)
Time to simulate 200 ms	1 hour 32 min.
Number of processors	16



# Inertia Comparisons

	<i>Actual Vehicle</i>	<i>FE Model</i>
Weight, kg	1078	1101
Pitch inertia, kg-m <sup>2</sup>	1498	1545
Yaw inertia, kg-m <sup>2</sup>	1647	1718
Roll inertia, kg-m <sup>2</sup>	388	396
Vehicle CG X, mm	1022	1025
Vehicle CG Y, mm	-8.3	-3.0
Vehicle CG Z, mm	558	557



# Full-Scale Crash Tests

## ● Toyota Yaris (2006-2010)

Test Type	Test Number
Frontal Full Wall	NHTSA 5677 (56.3 km/hr), 6221 (56.2 km/hr), 6059 (39.8 km/hr), 6060 (39.8 km/hr), 6069 (39.8 km/hr)
Frontal Offset	IIHS CEF0610 (64.7 km/hr)
Side Impact NHTSA	NHTSA 5679 (62.1 km/hr), 6220 (62.3 km/hr), 6558 (61.9 km/h), 6585 (61.8 km/hr)
Side Impact IIHS	IIHS CES50638 (50.2 km/hr), CES0639 (50.0 km/hr)
Rigid Pole Test	NHTSA 7145 (7 deg, 56 km/hr)
Vehicle to Vehicle	NHTSA 7371 (15 deg, 112.7 km/hr, 50 % overlap), 7293 (7 deg, 112.7 km/hr, No frame overlap),
Roof Strength	IIHS SWR0920
Speed Bump	FOIL10002 (8 tests: varied speed bump configurations)
Sloped Terrain	FOIL 10003 (6 tests: 6H:1V slopes, 25 deg - 8, 16, and 24 km/hr)

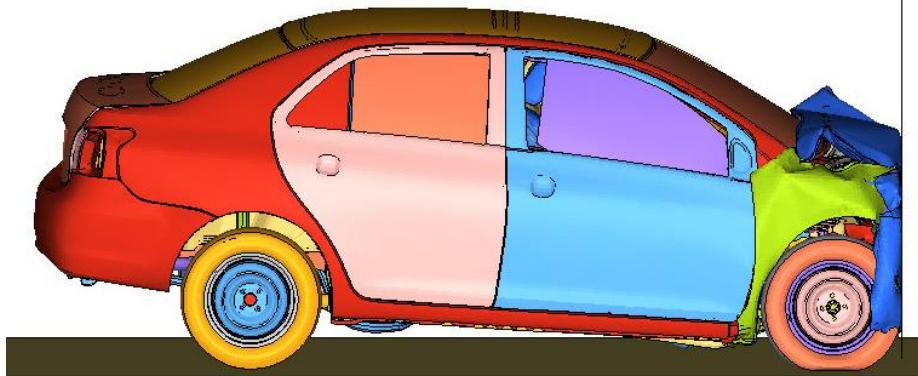


# Yaris – Frontal Full Wall – 56 km/hr

- Two Full-scale Crash Tests @ 56 km/hr:
  - NHTSA 5677 (56.3 km/hr) – 2007 Sedan
  - NHTSA 6221 (56.2 km/hr) – 2008 Hatch Back



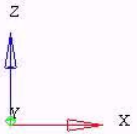
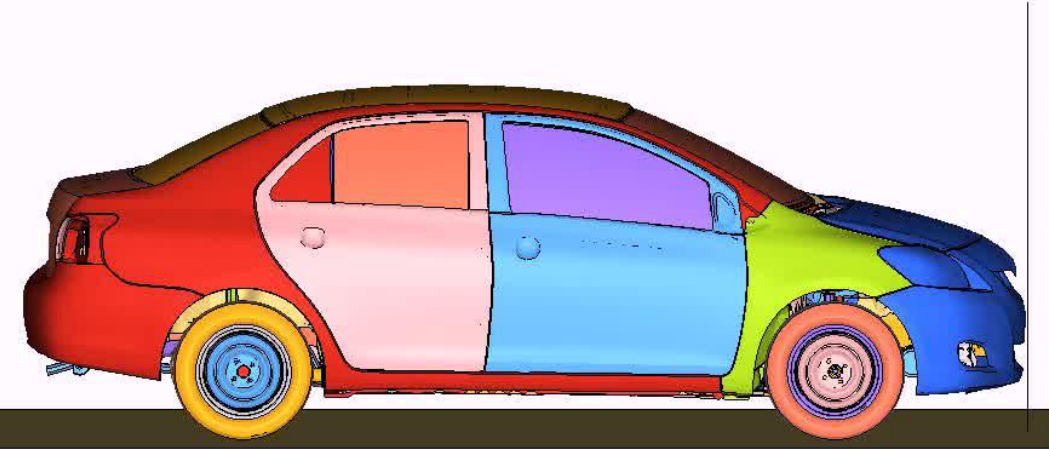
# Yaris – Frontal Full Wall – 56 km/hr



	FE Model	Test 5677	Test 6221
Weight (kg)	1263	1271	1245
Engine Type	1.5L V4	1.5L V4	1.5L V4
Tire size	P185/60R15	P185/60R15	P185/60R15
Attitude (mm) (As delivered)	F – 668	F – 673	F – 675
	R – 673	R – 680	R – 673
Wheelbase (mm)	2538	2551	2463
CG (mm) Rear of front wheel C/L	1035	999	976
Body Style	4 Door Sedan	4 Door Sedan	3 Door Liftback

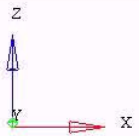
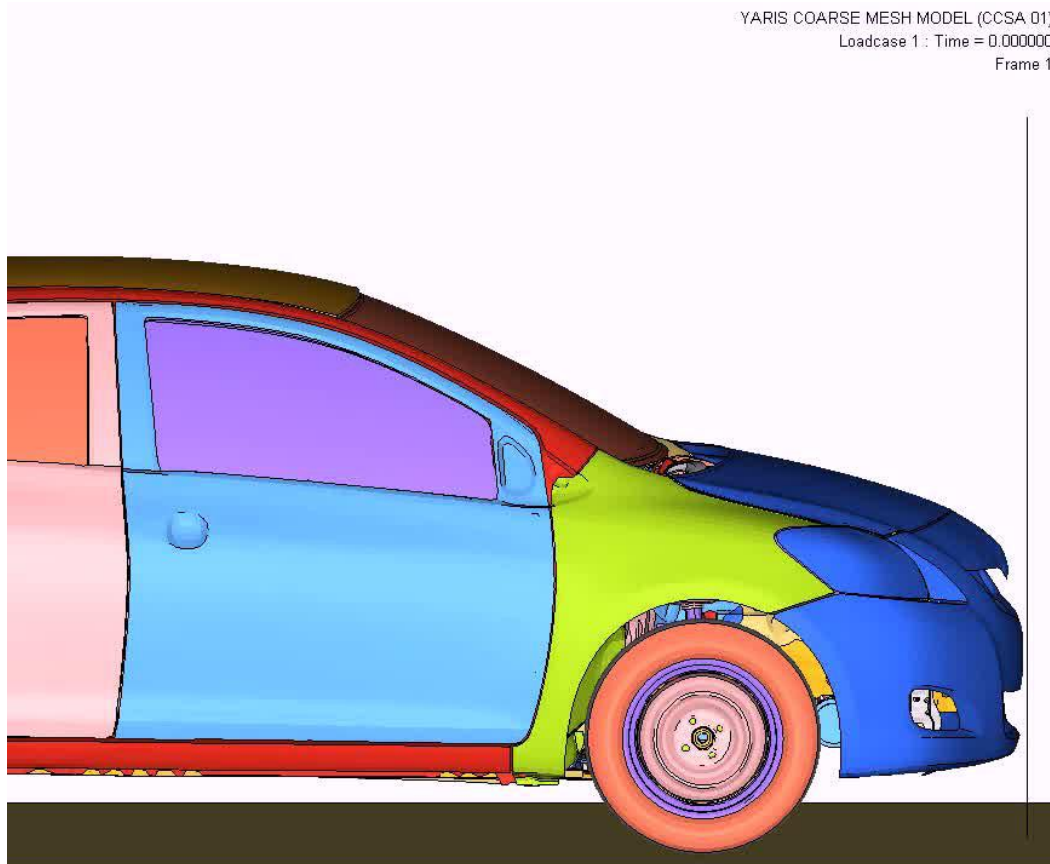
# Yaris – Frontal Full Wall – 56 km/h - Video

YARIS COARSE MESH MODEL (CCSA 01)  
Loadcase 1: Time = 0.000000  
Frame 1



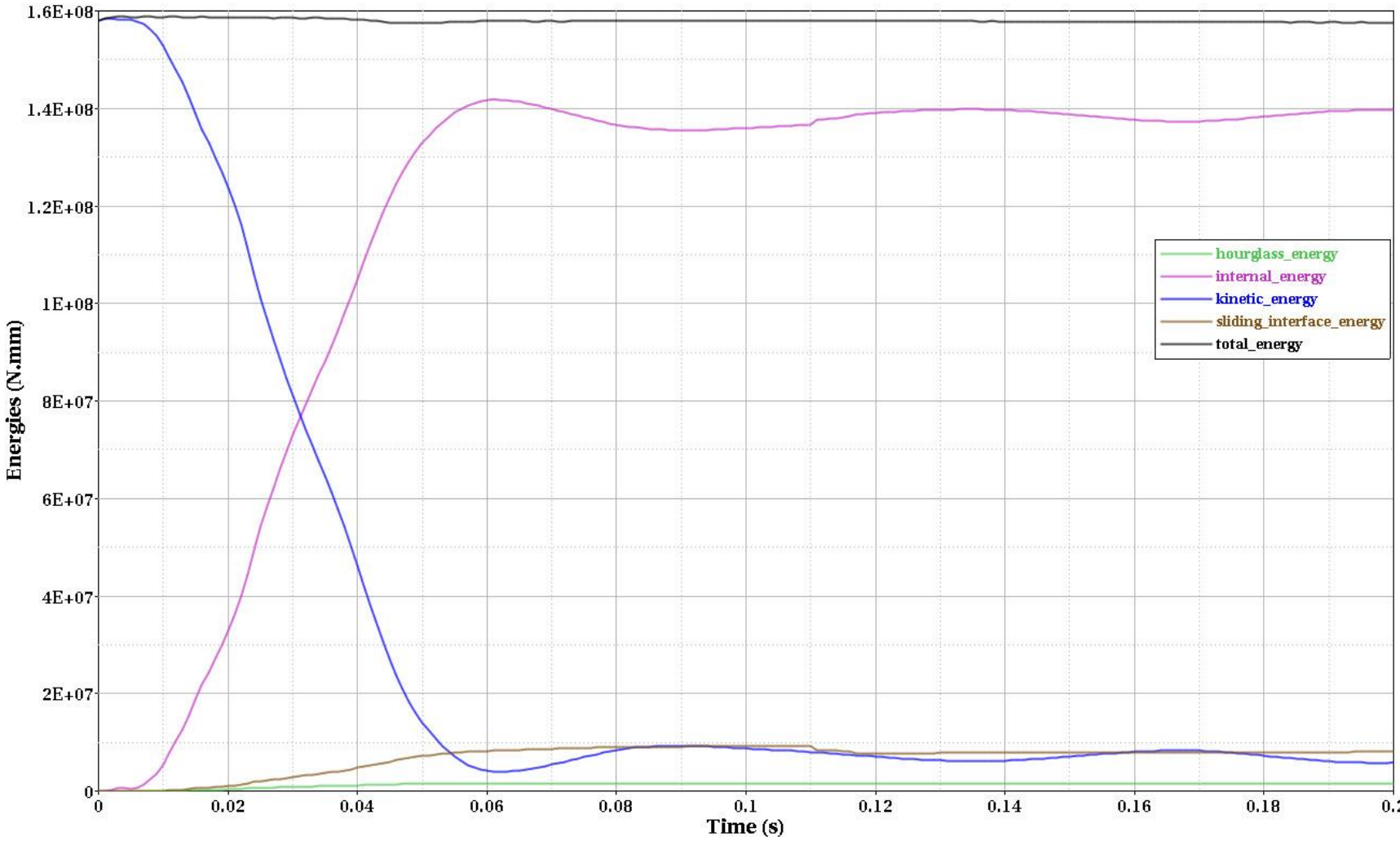


# Yaris – Frontal Full Wall – 56 km/h - Video



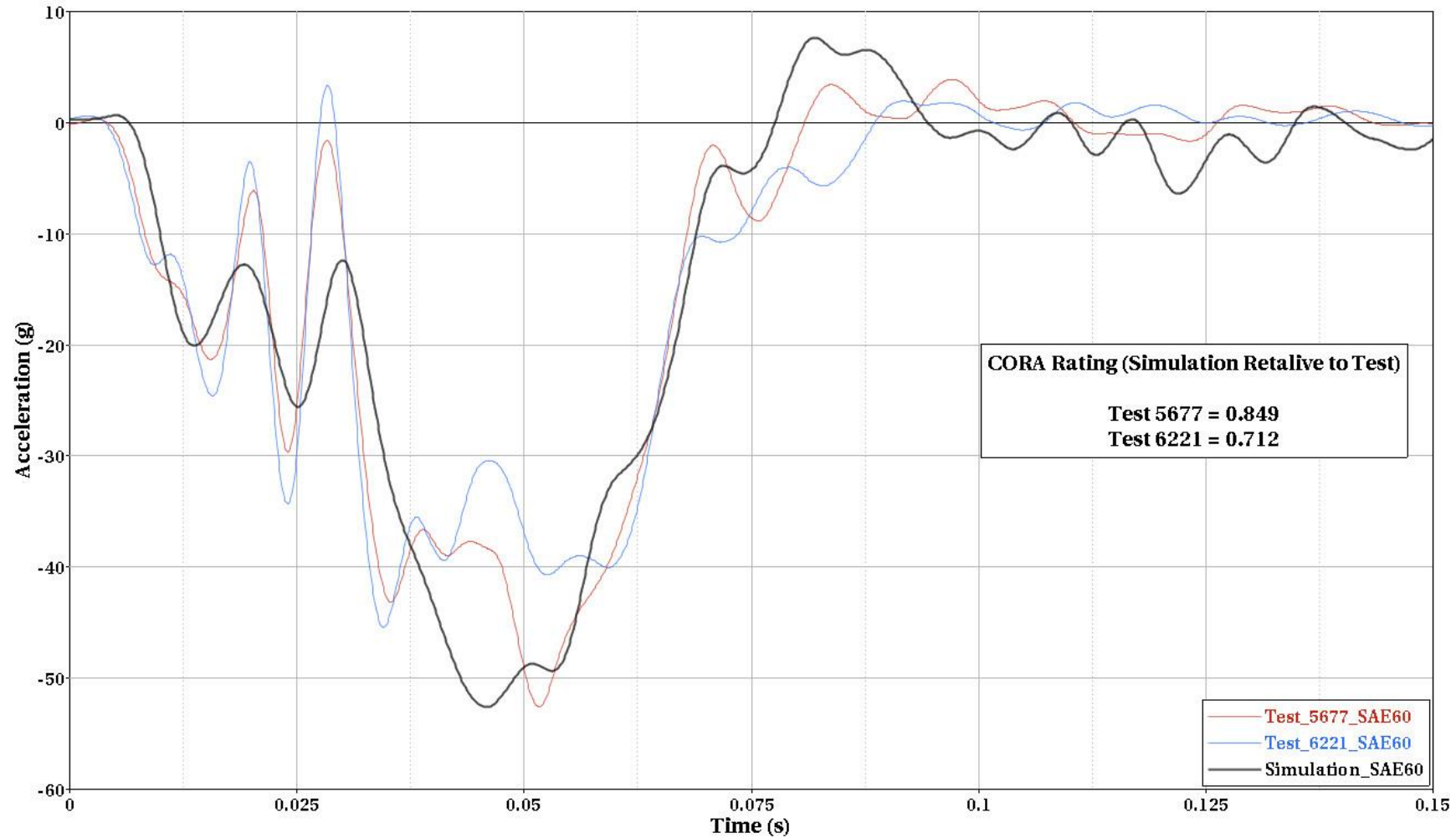


# Yaris – Frontal Full Wall – 56 km/hr - Energy Summary

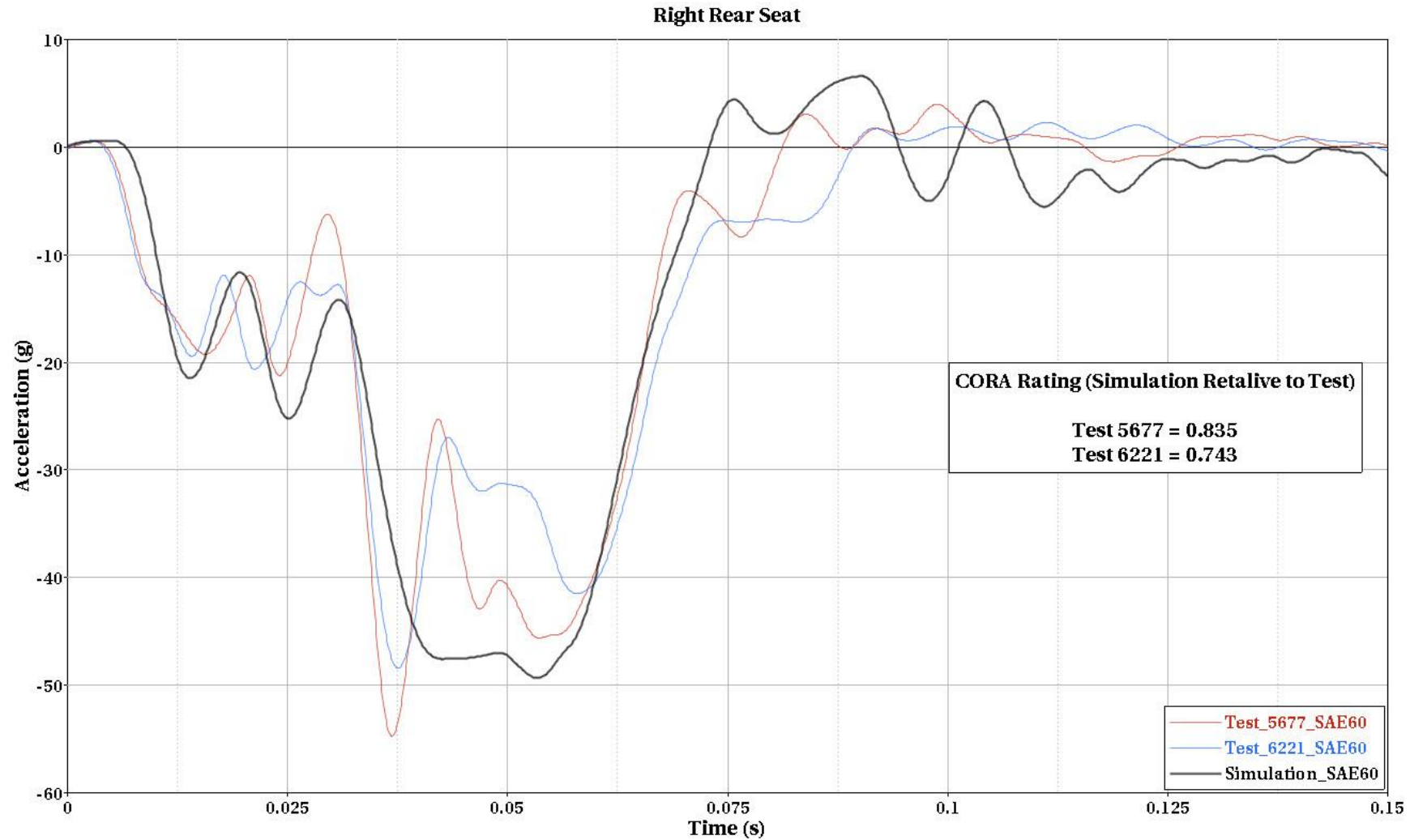


# Yaris – Frontal Full Wall – 56 km/hr - Acceleration

Left Rear Seat

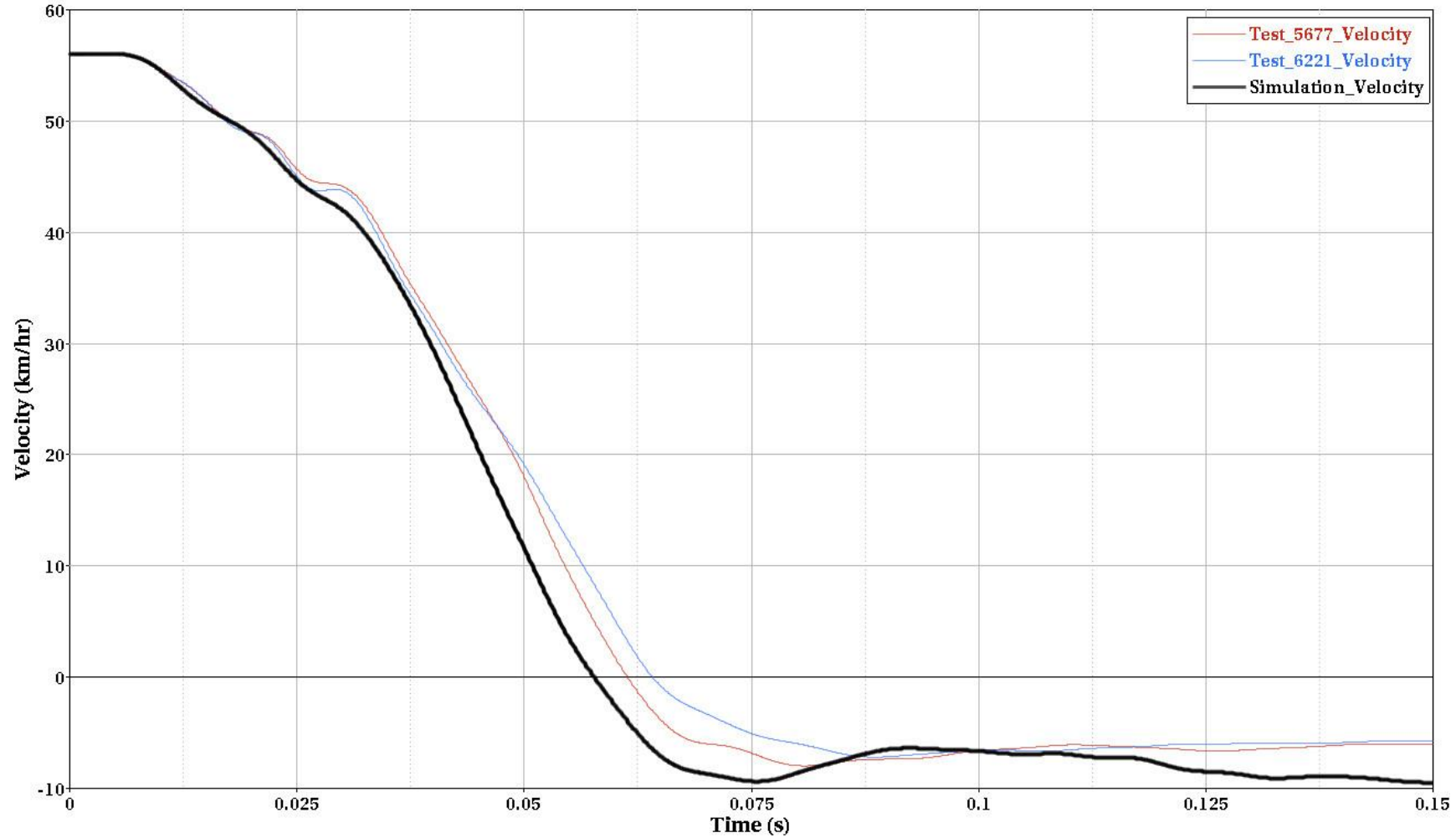


# Yaris – Frontal Full Wall – 56 km/hr - Acceleration



# Yaris – Frontal Full Wall – 56 km/hr - Velocity

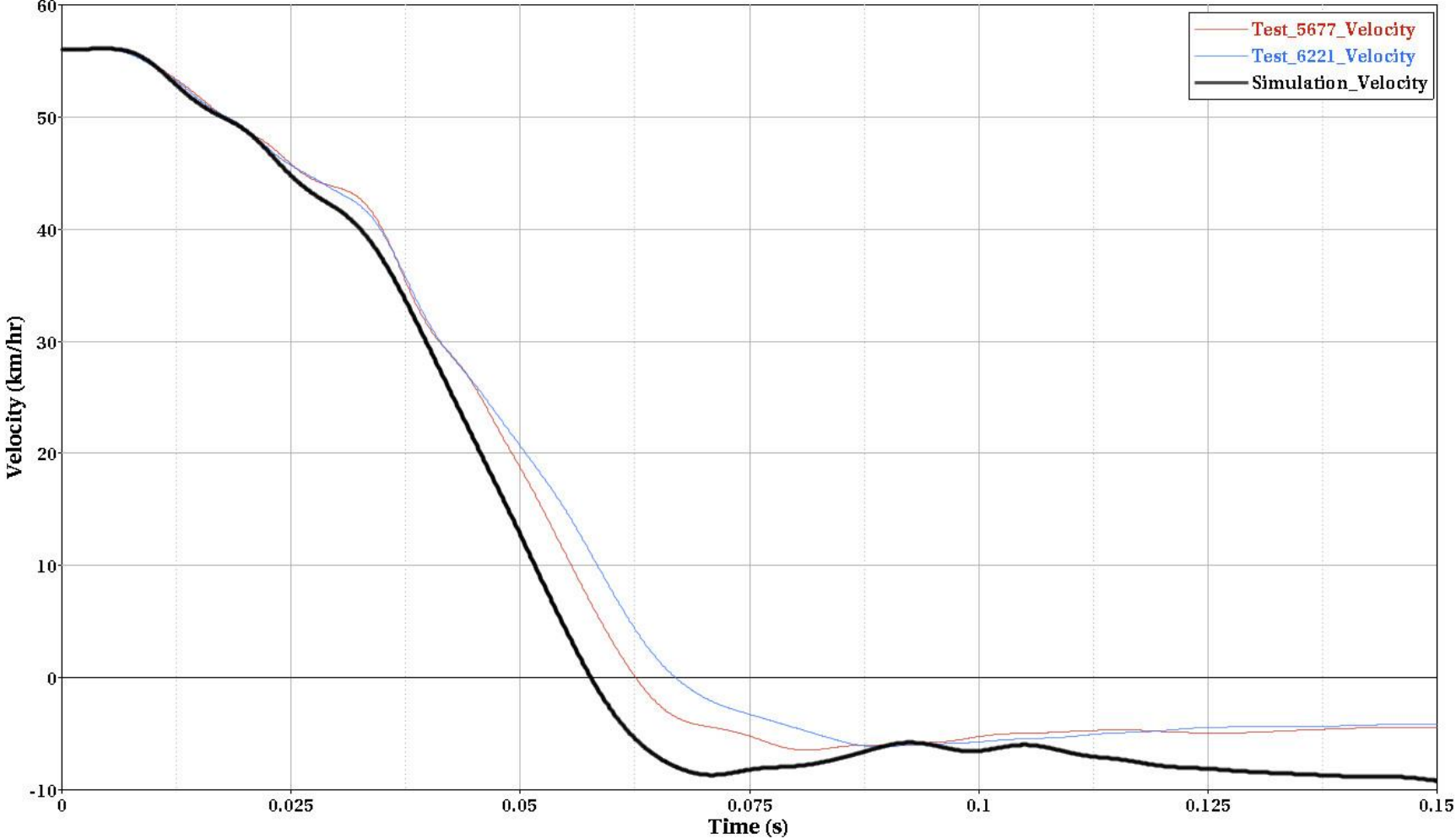
Left Rear Seat



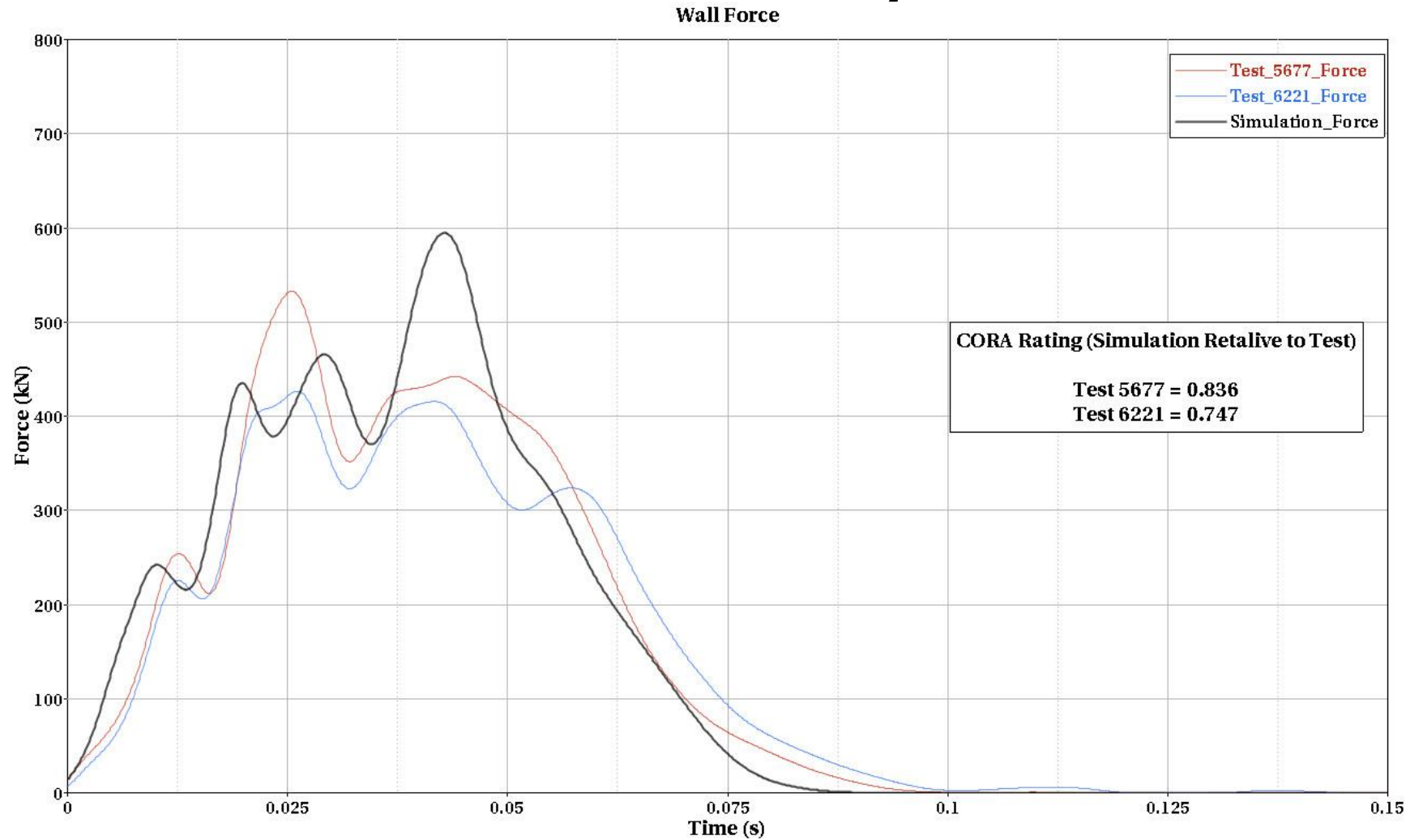


# Yaris – Frontal Full Wall – 56 km/hr - Velocity

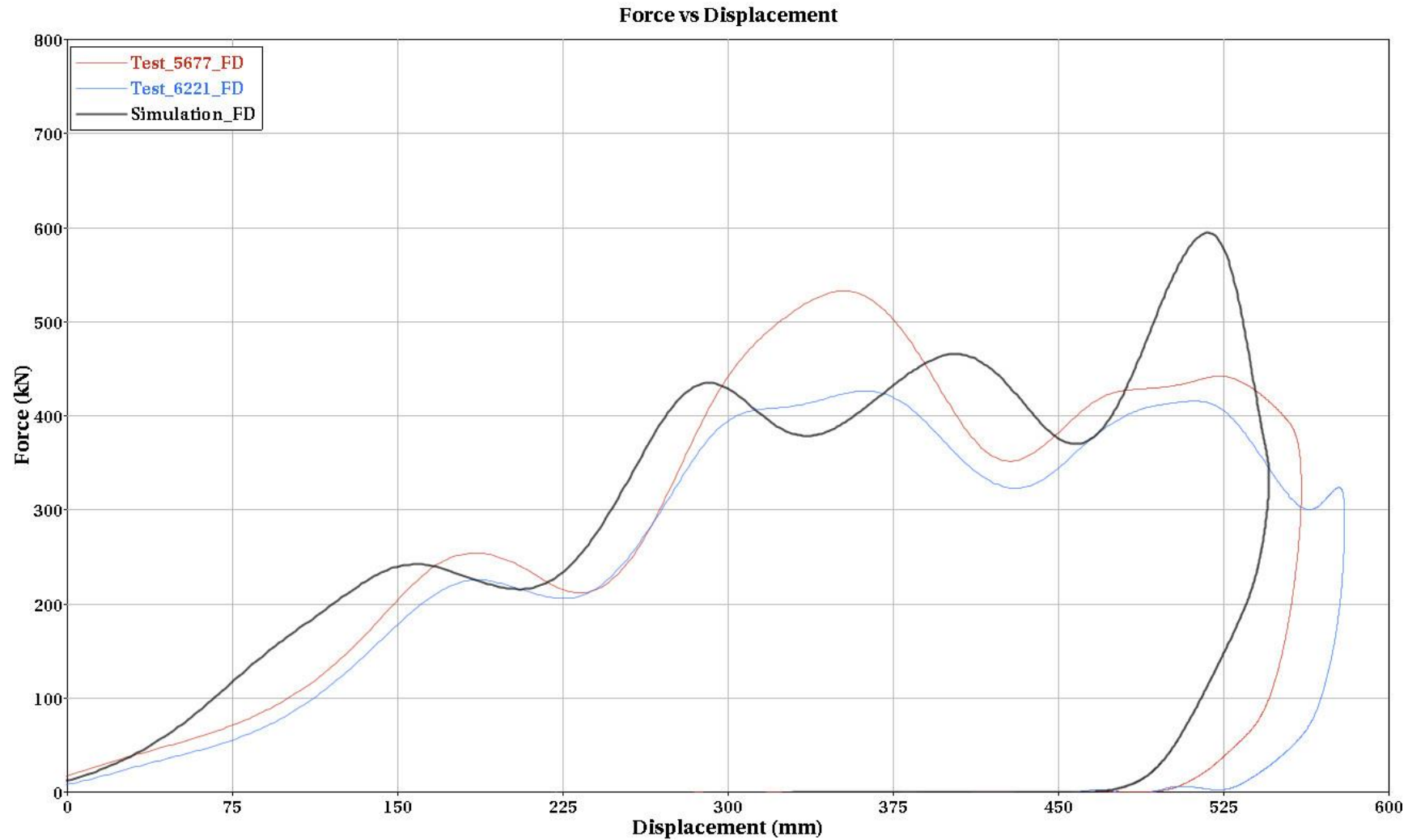
Right Rear Seat



# Yaris – Frontal Full Wall – 56 km/hr – Wall Force



# Yaris – Frontal Full Wall – 56 km/hr – Wall Force



# Yaris / NJ CMB

- MwRSF Test 2214NJ-1

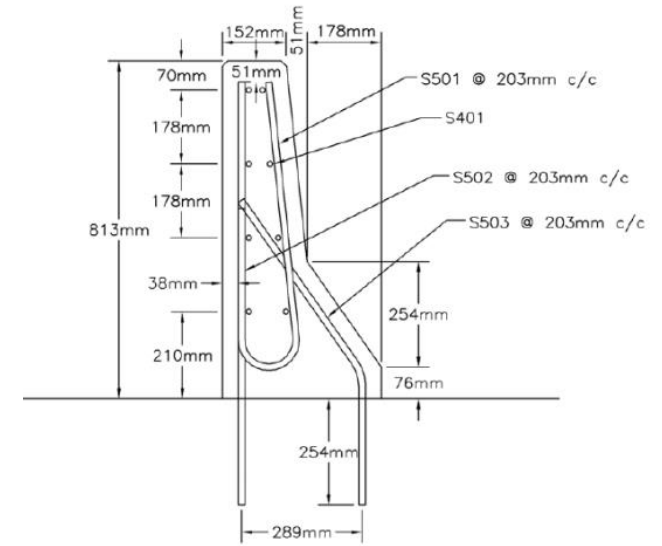
- Impact Condition

  - 62.6 mi/hr

  - 26.1 deg

- Vehicle

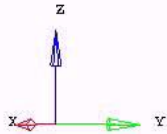
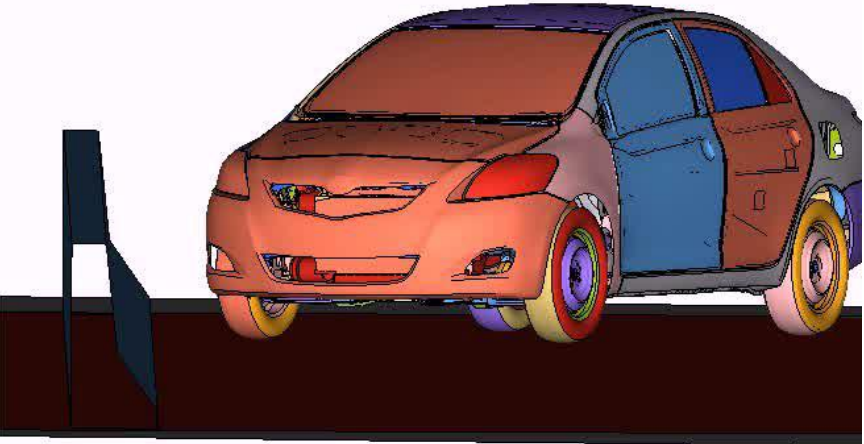
  - 2002 Kia Rio





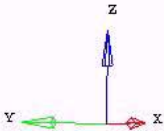
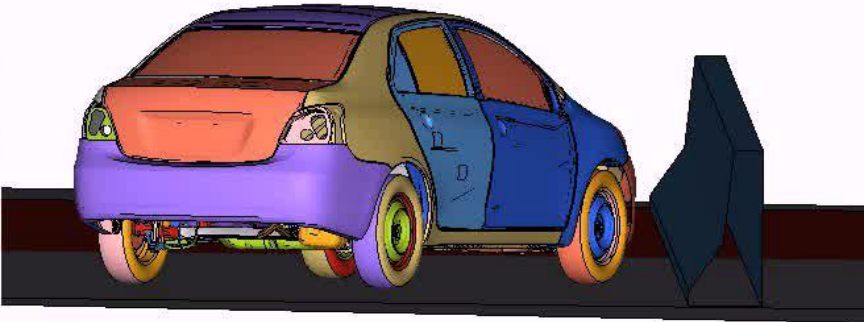
# Yaris / NJ CMB - Video

Model info: YARIS COARSE MESH MODEL (CCSA V01)  
Time = 0.000000  
Frame 1



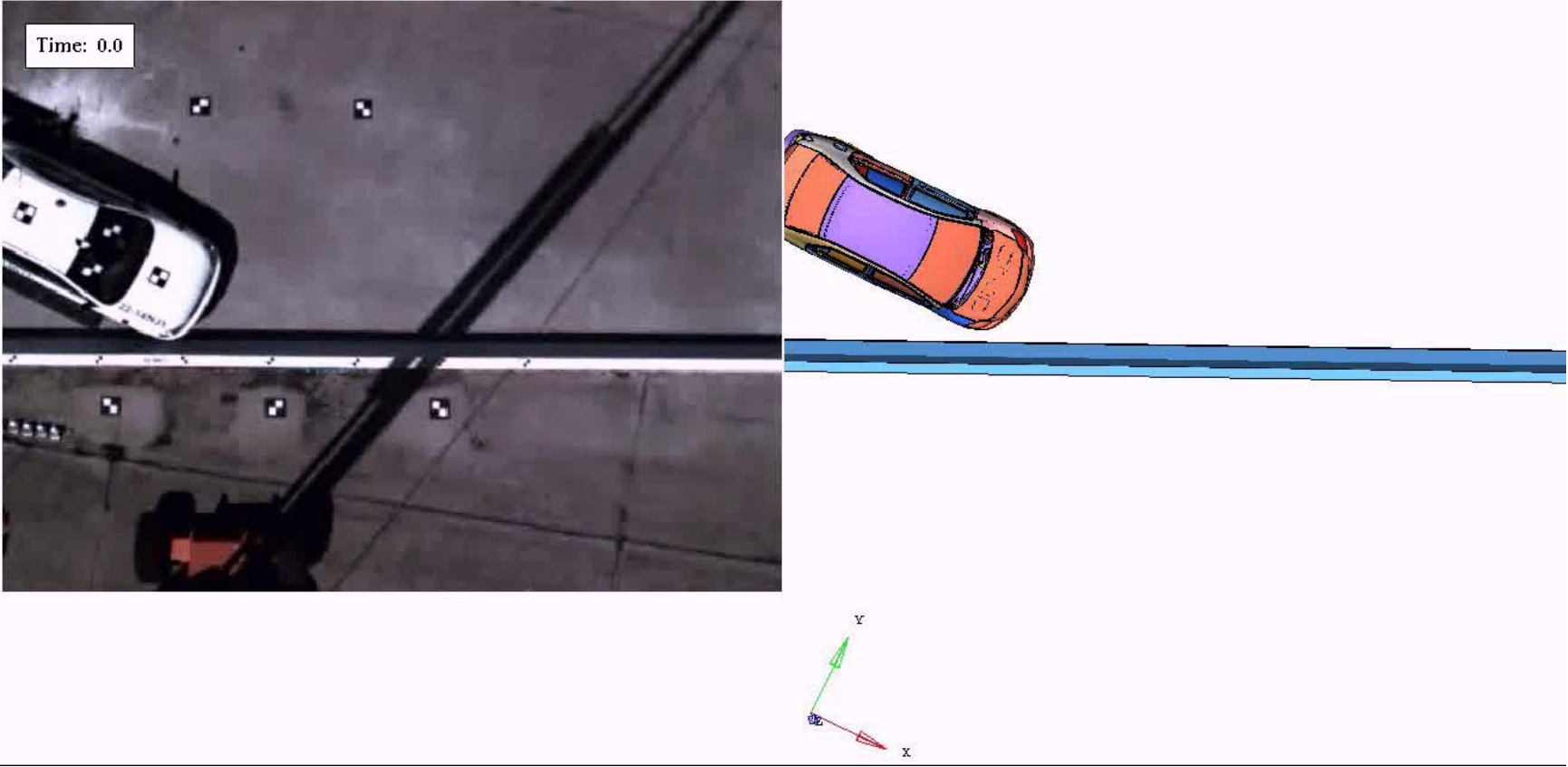
# Yaris / NJ CMB - Video

Model info: YARIS COARSE MESH MODEL (CCSA V01)  
Time = 0.000000  
Frame 1

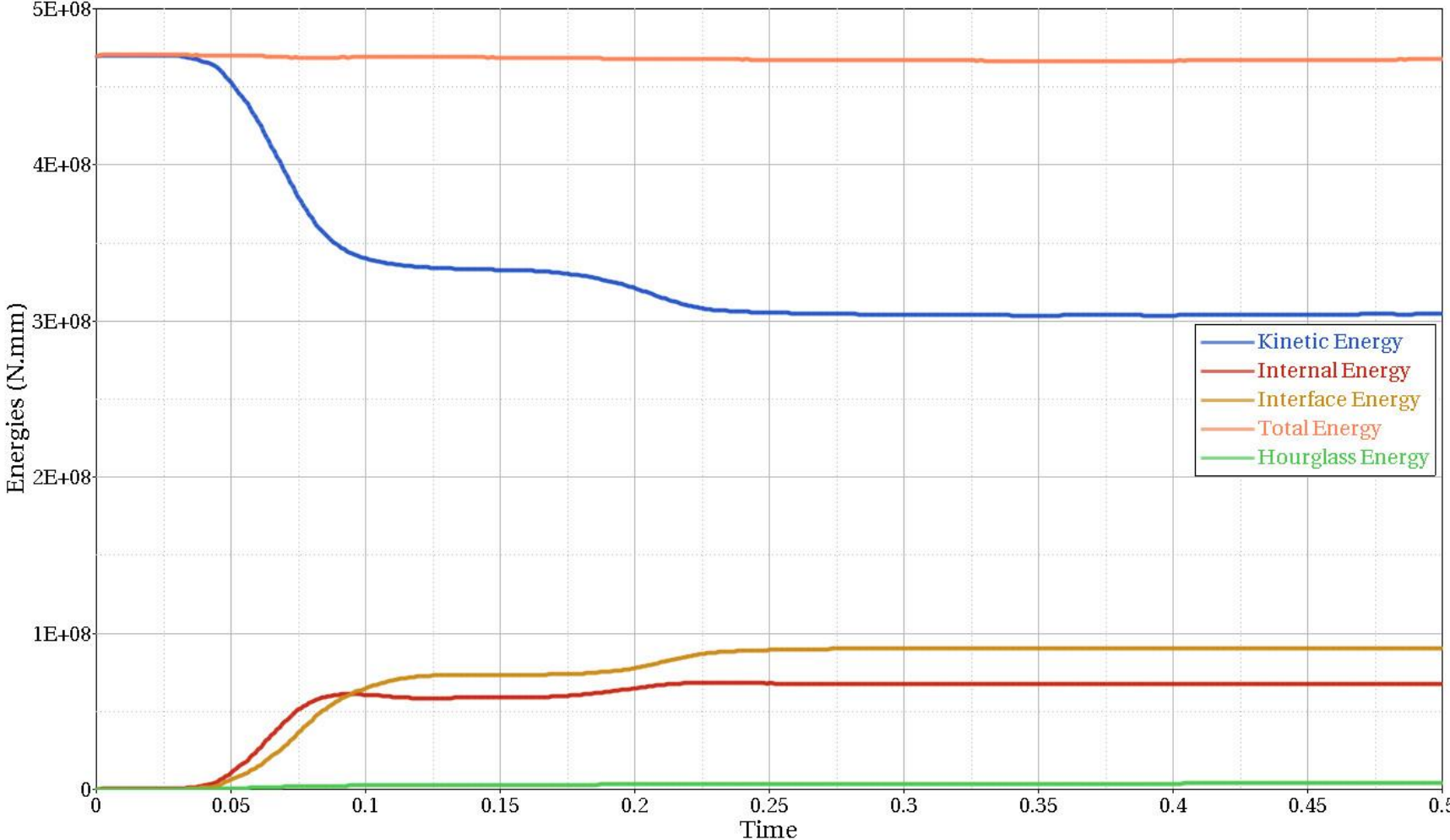


# Yaris / NJ CMB - Video

Model info: YARIS COARSE MESH MODEL (CCSA V01)  
Time = 0.000000  
Frame 1

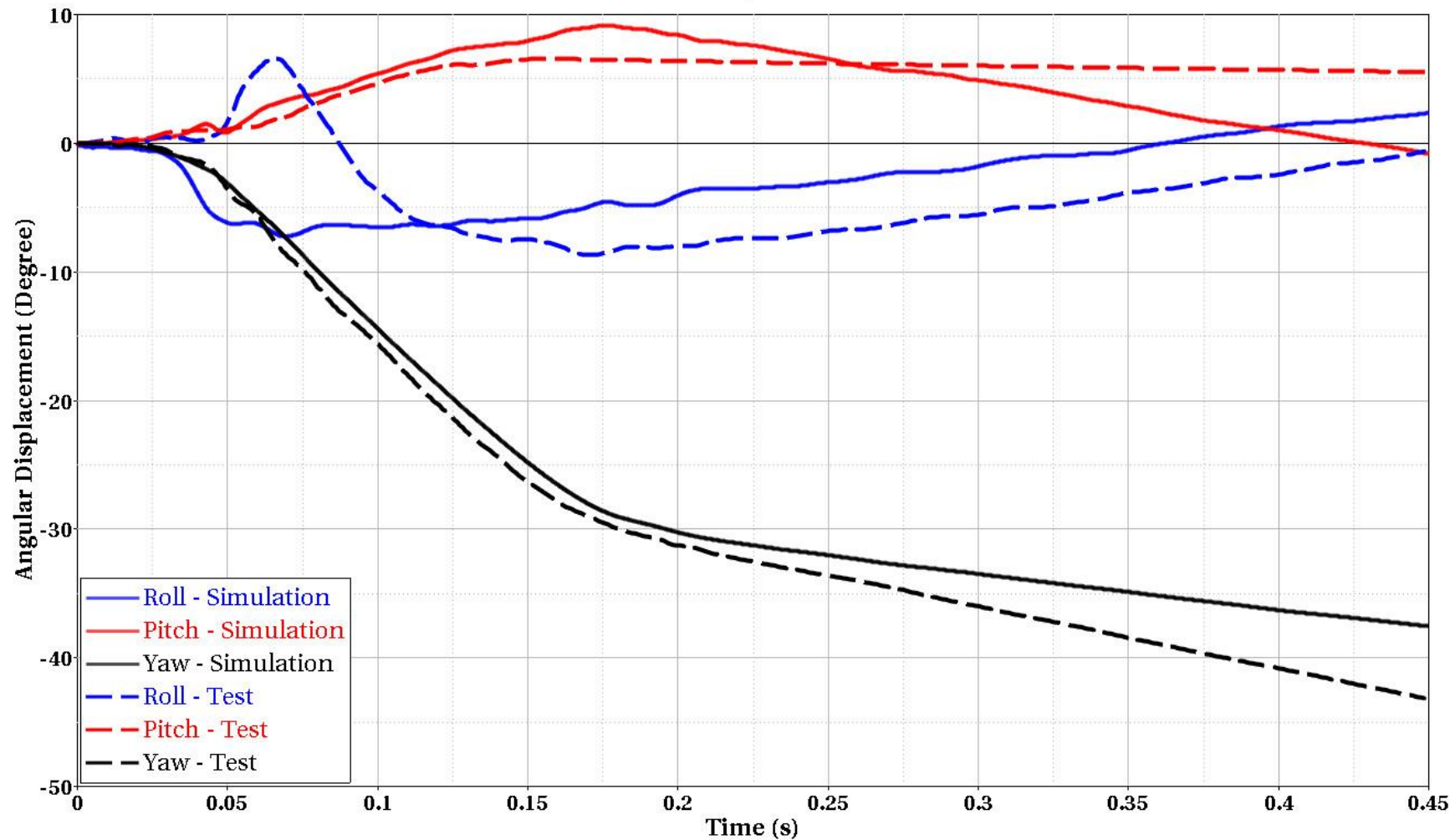


# Yaris / NJ CMB - Energy Summary

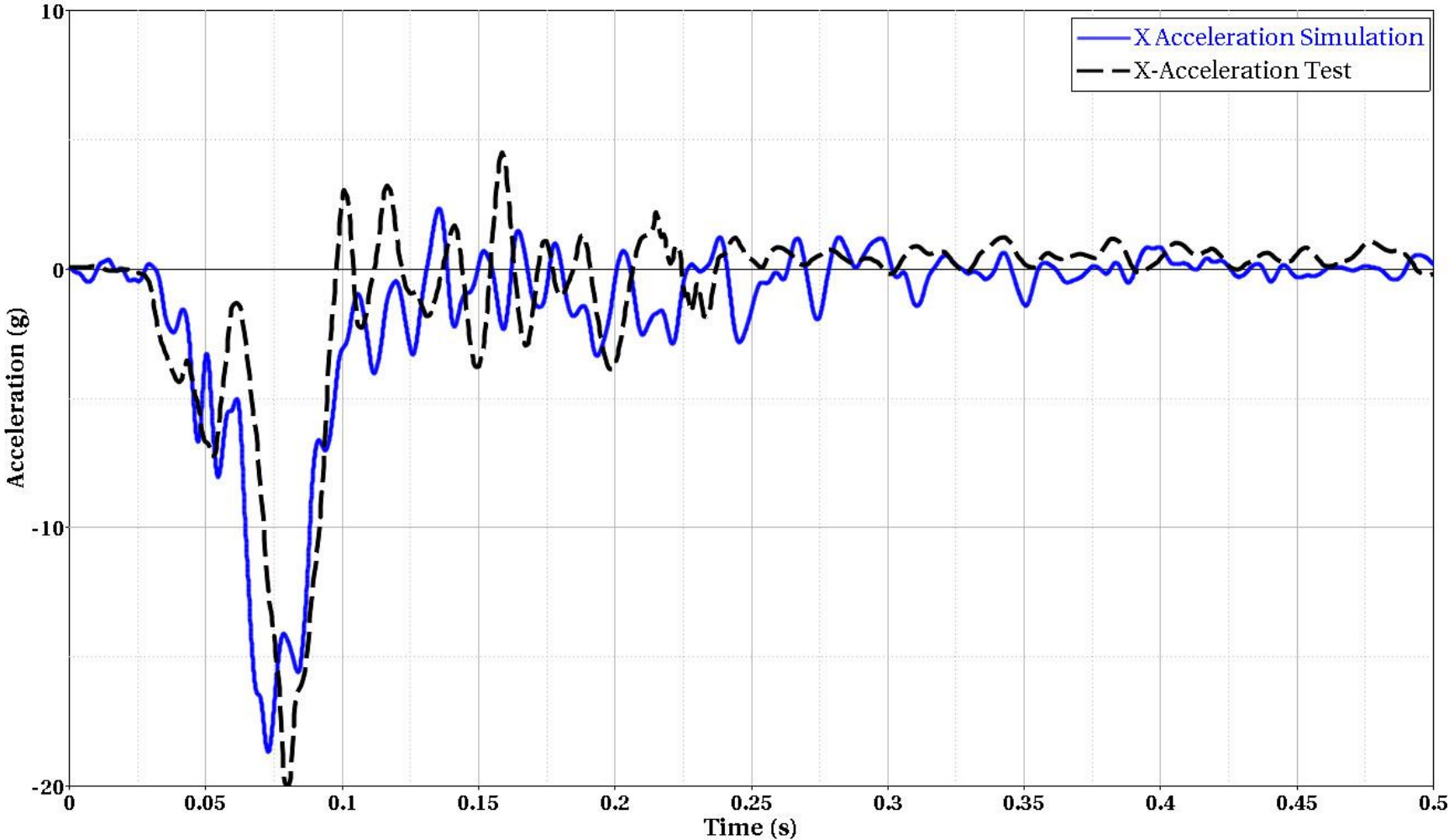




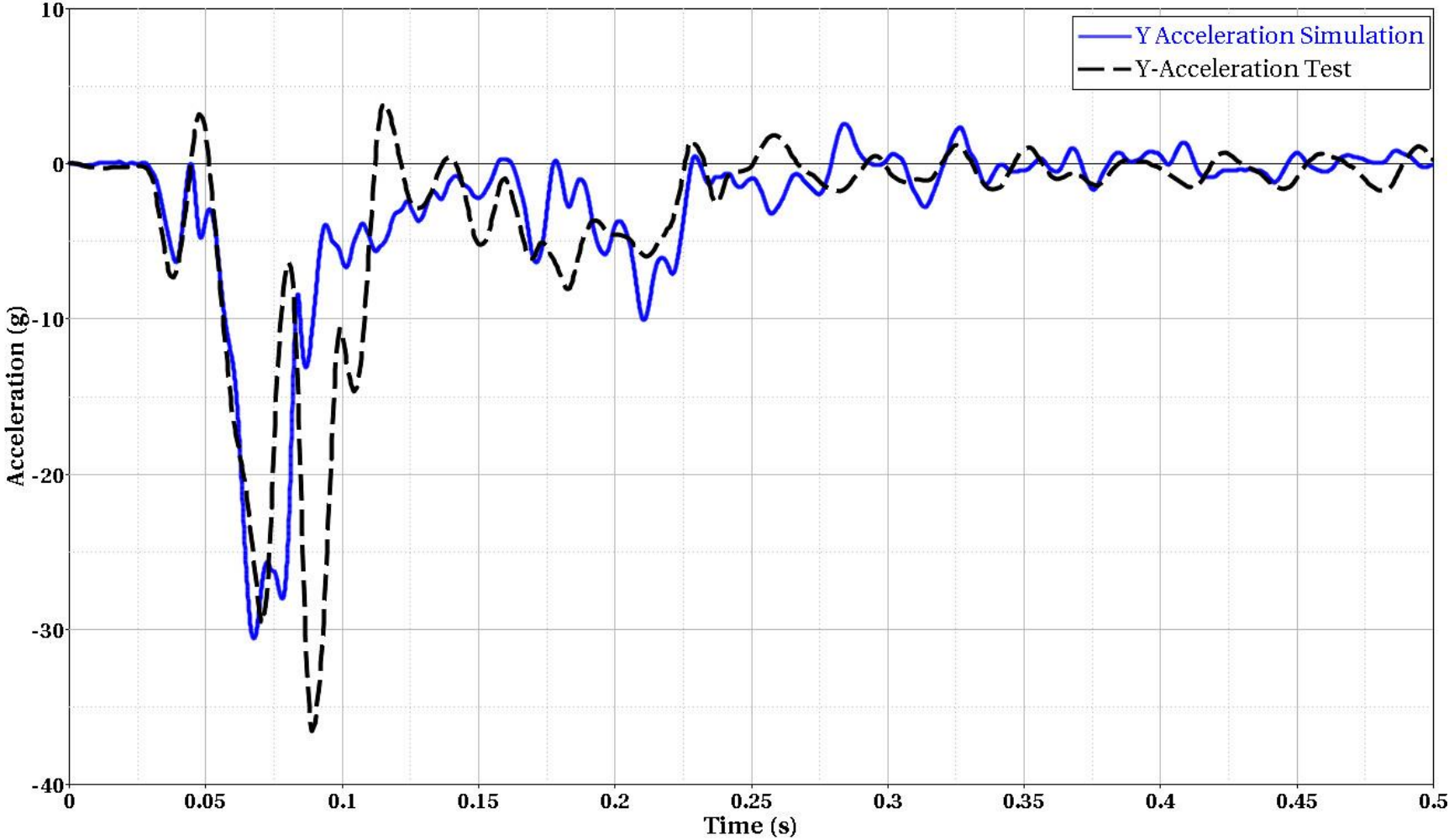
# Yaris / NJ CMB - Roll, Pitch, and Yaw



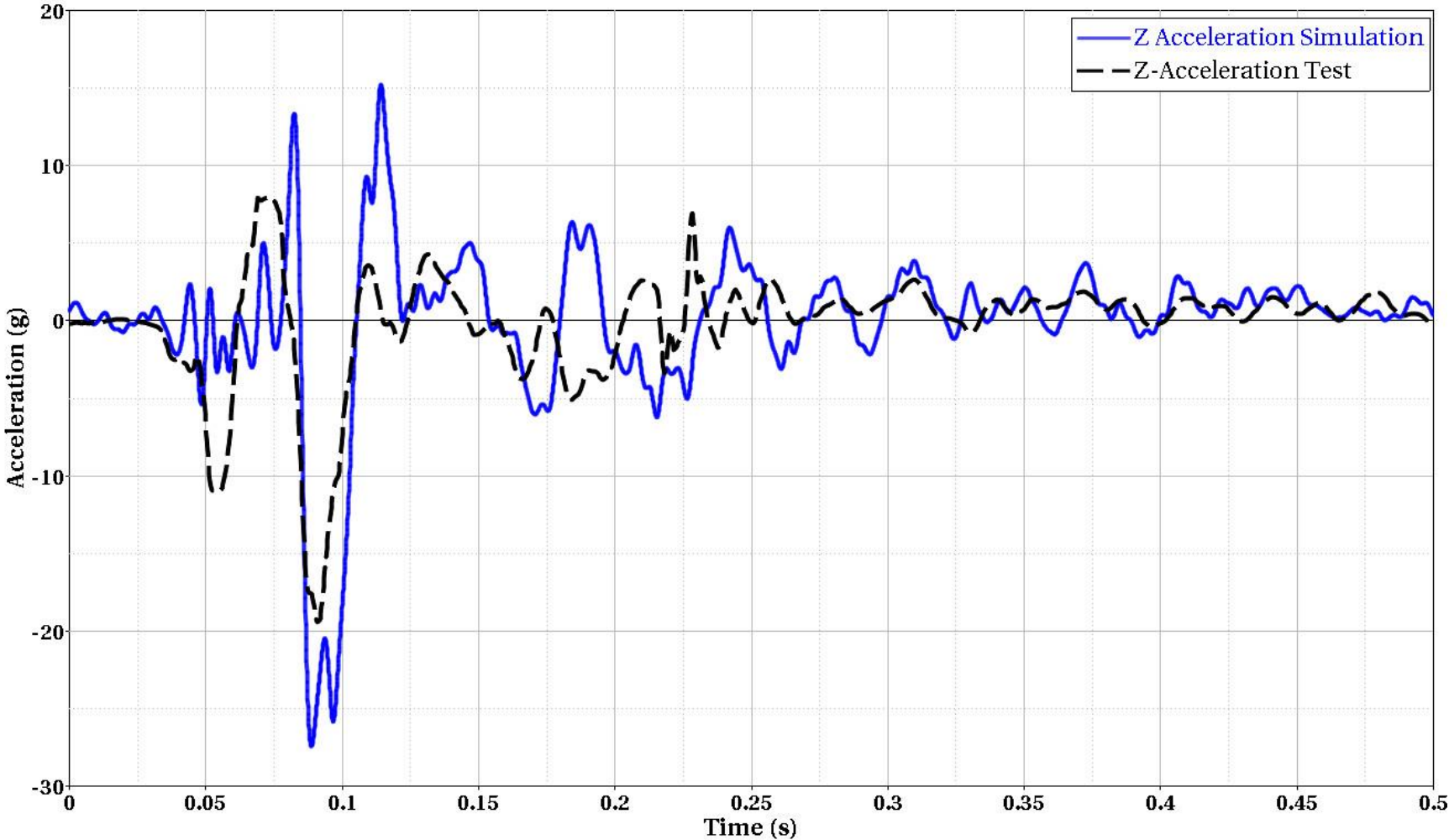
# Yaris / NJ CMB – X - Acceleration



# Yaris / NJ CMB – Y - Acceleration

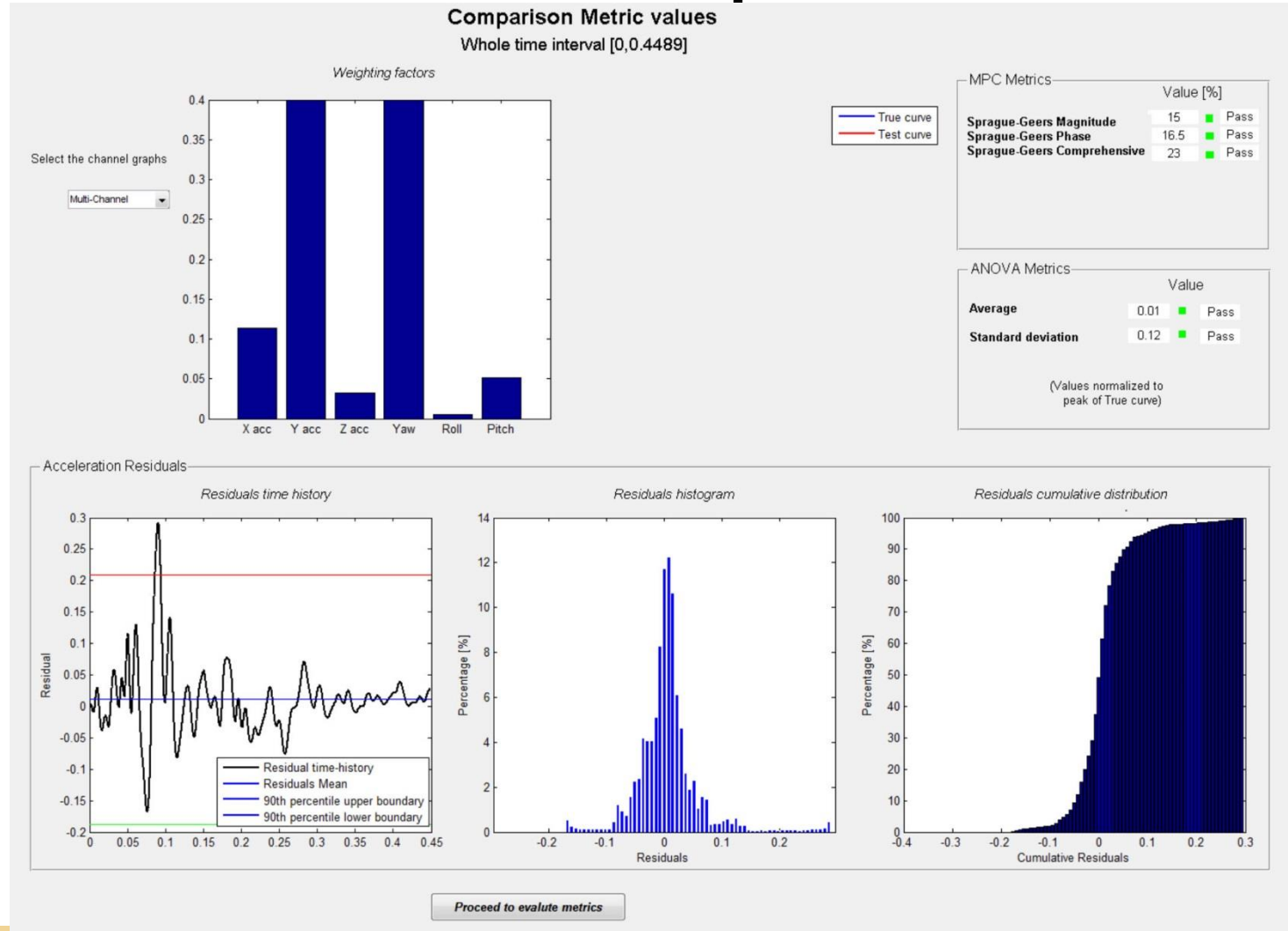


# Yaris / NJ CMB – Z - Acceleration

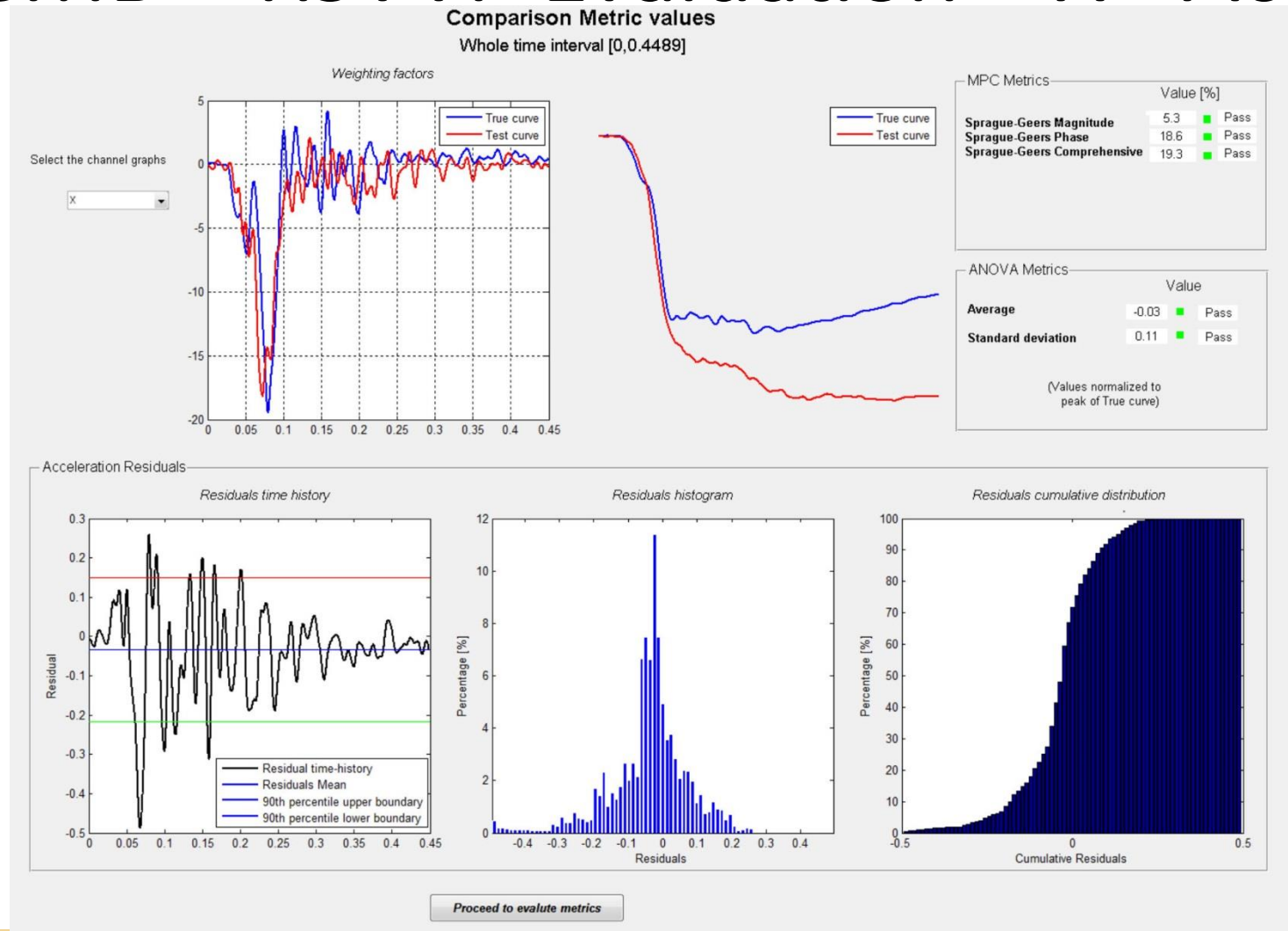




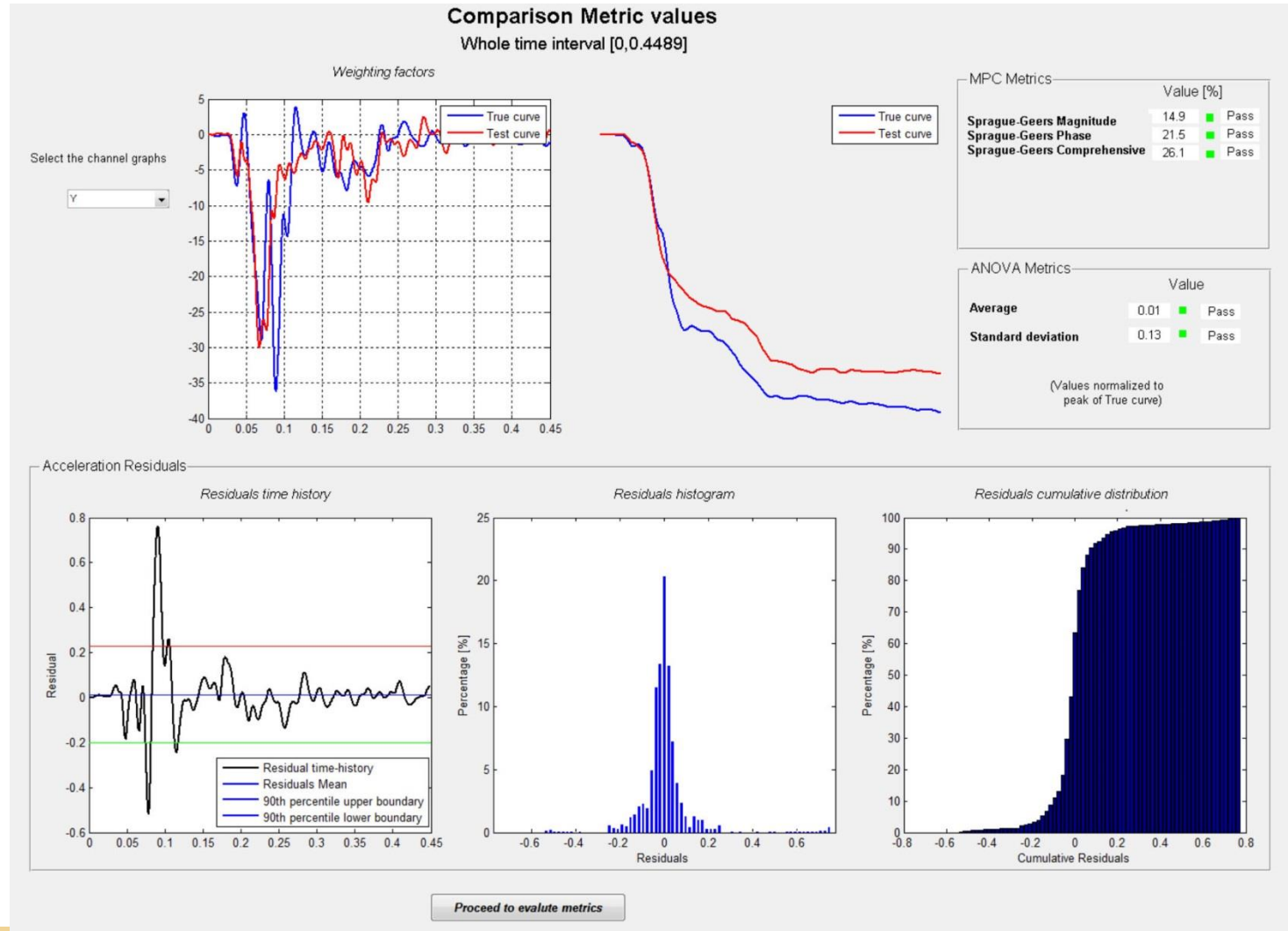
# Yaris / NJ CMB – RSVVP Comparison Metrics



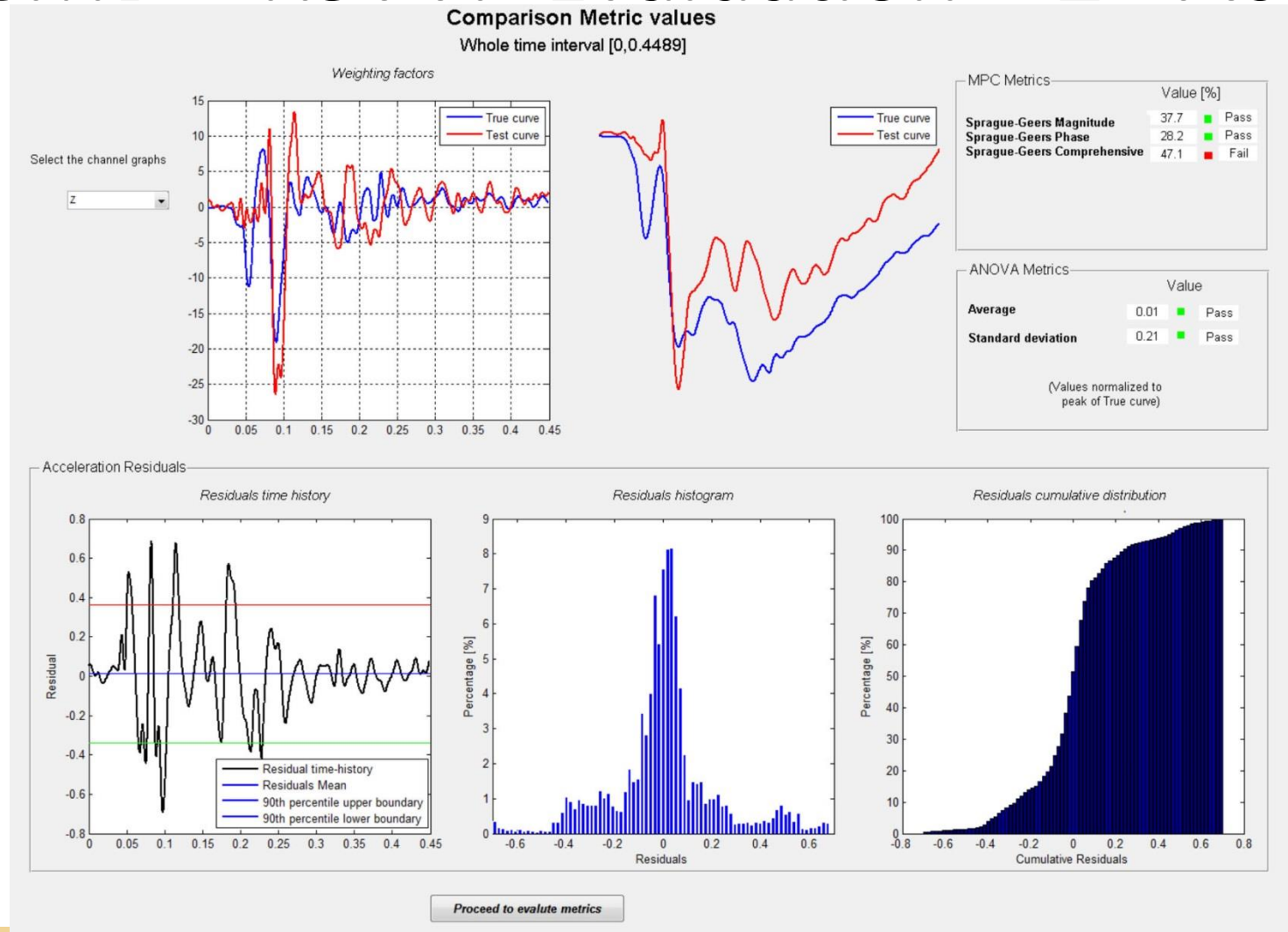
# Yaris / NJ CMB – RSVVP Evaluation – X - Acceleration



# Yaris / NJ CMB – RSVVP Evaluation – Y - Acceleration

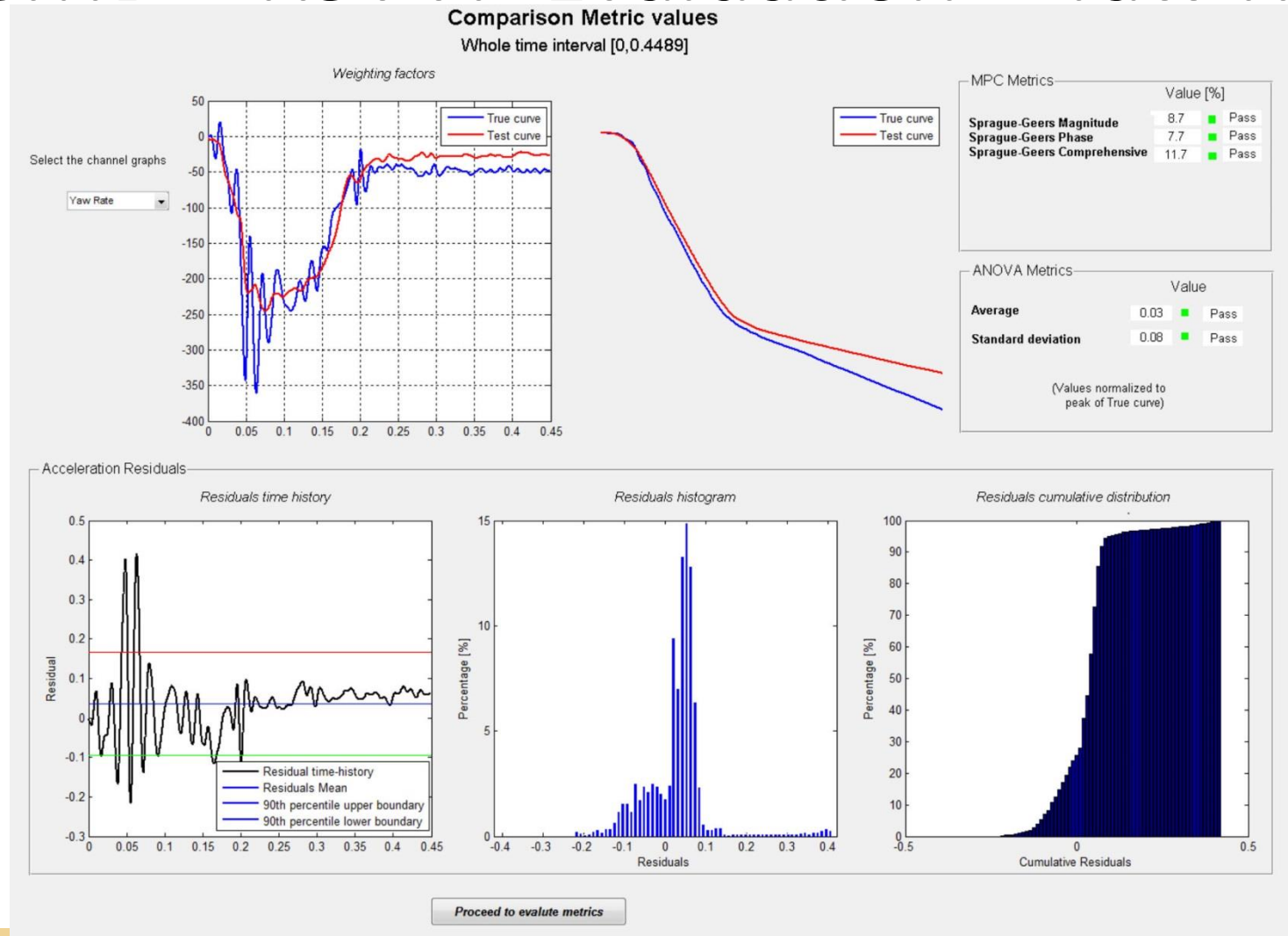


# Yaris / NJ CMB – RSVVP Evaluation – Z - Acceleration

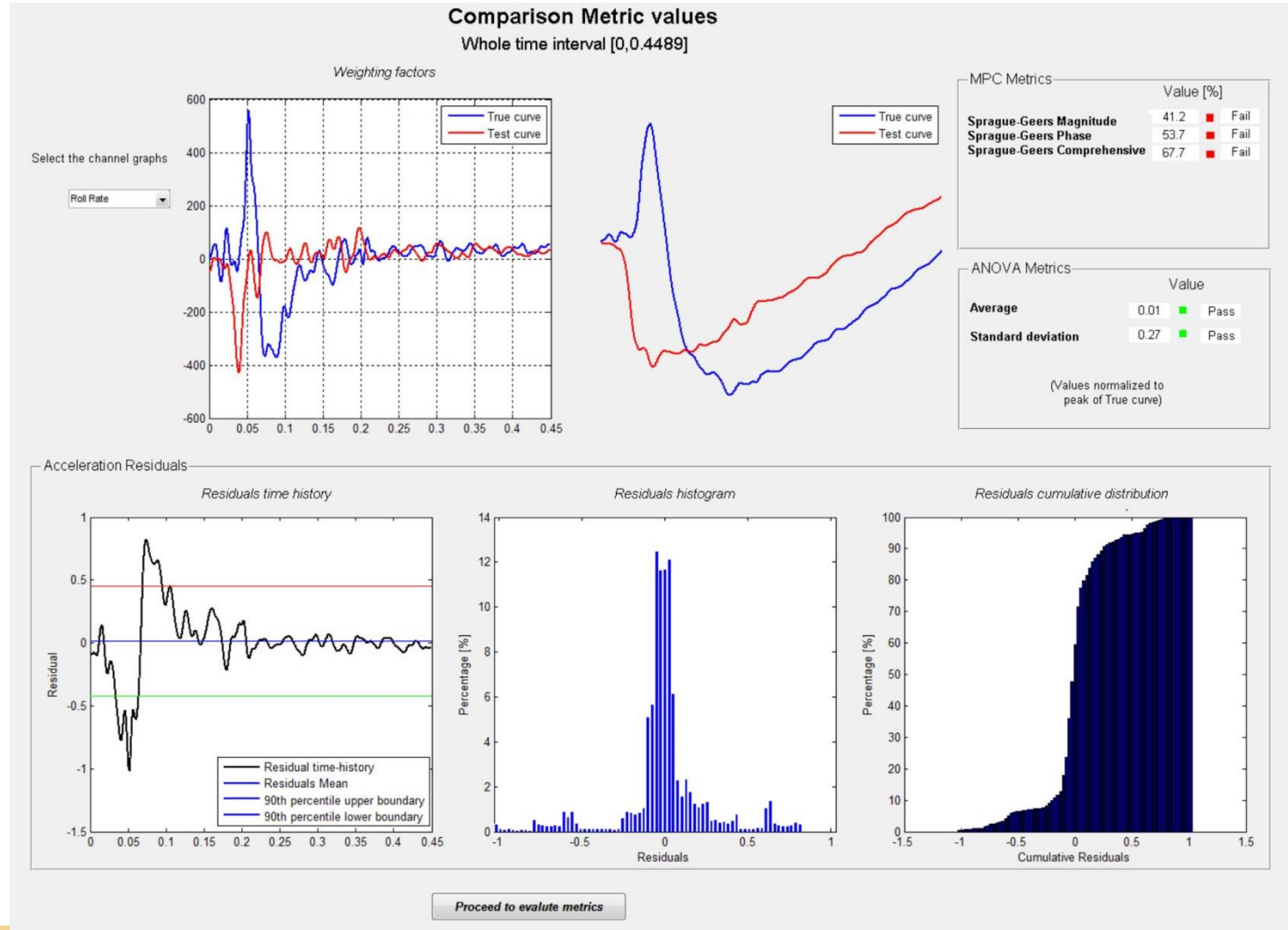




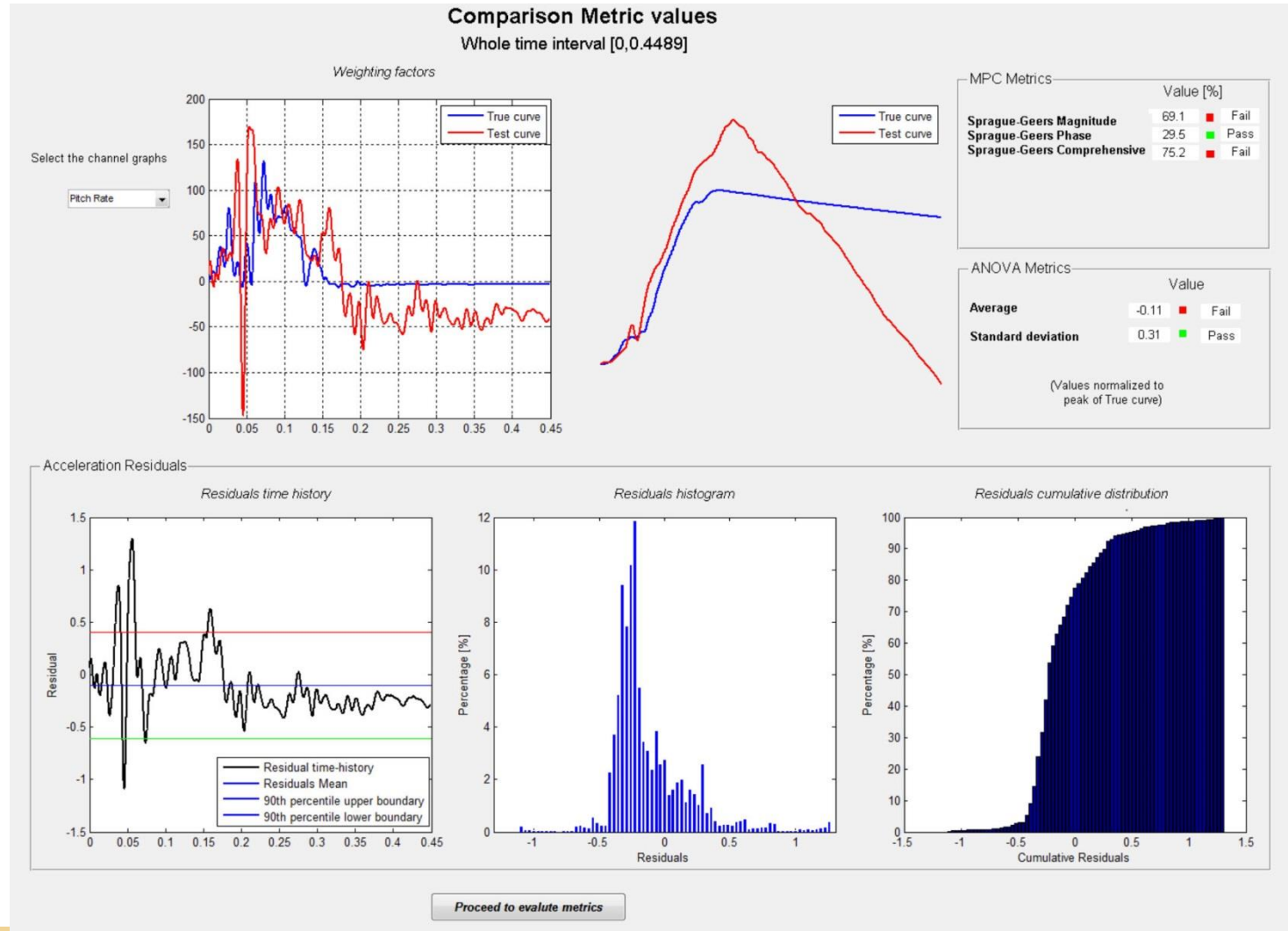
# Yaris / NJ CMB – RSVVP Evaluation – Yaw Rate



# Yaris / NJ CMB – RSVVP Evaluation – Roll Rate



# Yaris / NJ CMB – RSVVP Evaluation – Pitch Rate



# Summary

- **Model verified in 56 km/hr and 40 km/hr full frontal impacts (NHTSA tests 5677, 6221, and 6069)**
- **Model verified in 64 km/hr frontal offset impact (IIHS test CEF0610)**
- **Model verified in NHTSA and IIHS side impacts (NHTSA tests 5679, 6220, 6558, 6585 and IIHS tests CES50638 CES0639)**
- **Model Validated in NJ shape concrete barrier impact (MwRSF Test 2214NJ-1, Kia Rio vehicle)**