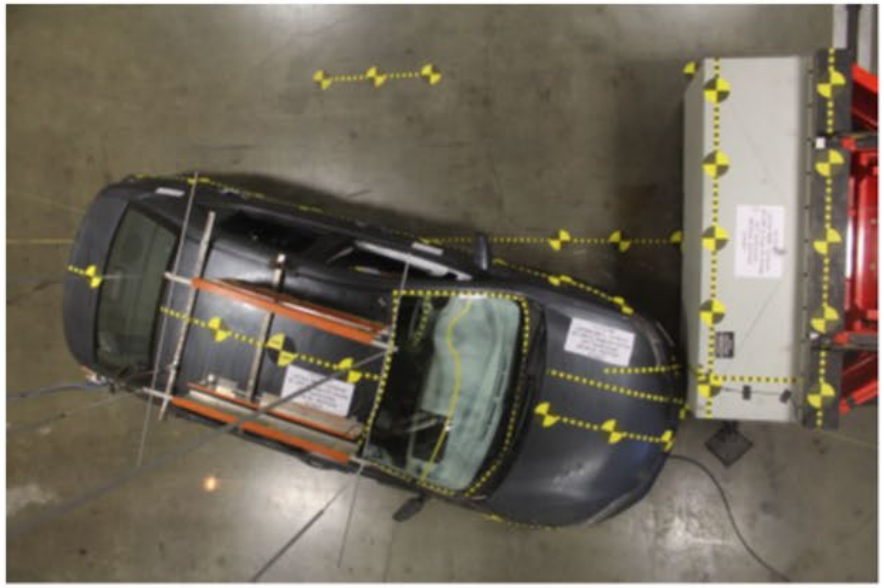
CAE Research on NHTSA's Offset Moving Deformable Barrier (OMDB)

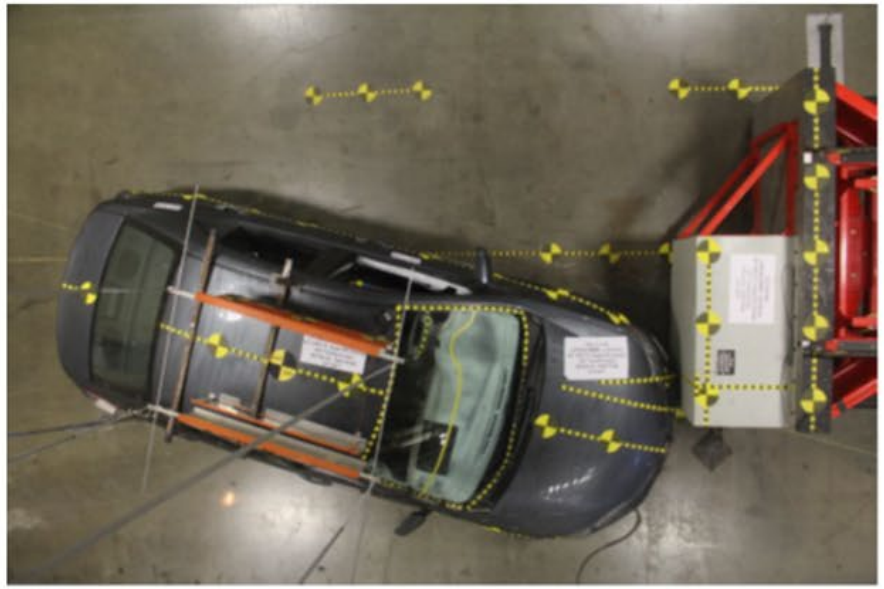
Rudolf Reichert / GMU

Background

A significant number of frontal-impact crashes occur on U.S. roads.

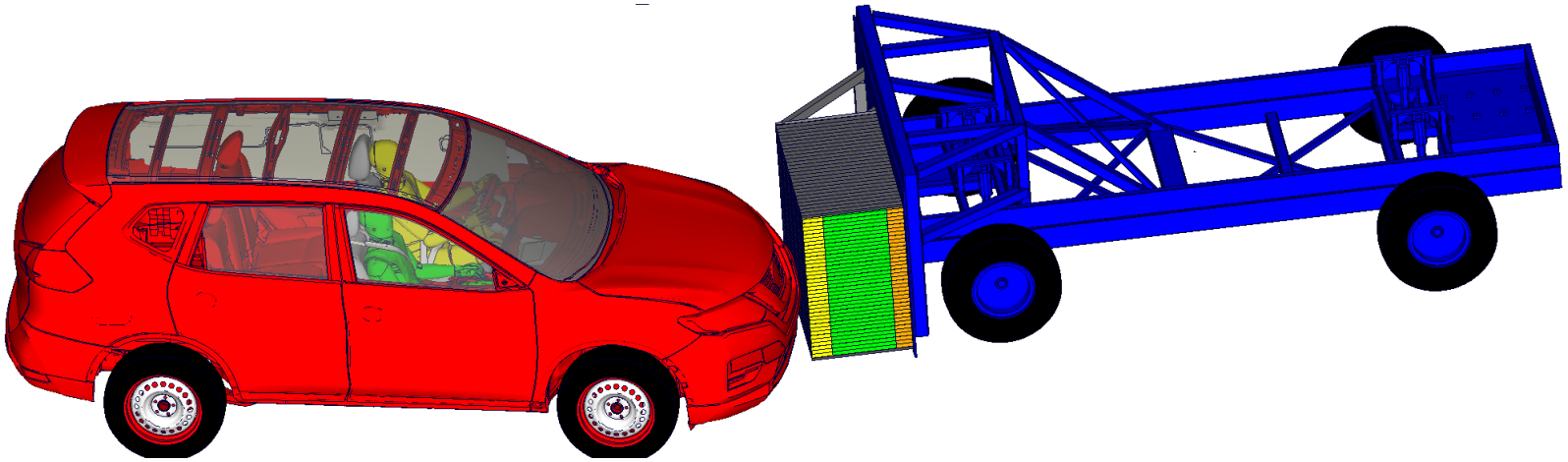
In 2015, NHTSA developed an oblique frontal offset crash research test procedure.





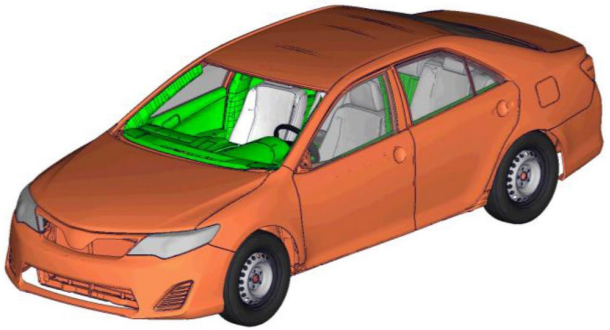
Objectives

1. Develop an adapted half-face OMDB.
2. Study the effect of the adapted half-face OMDB on the oblique impact test.
3. Verify that the current test procedure tolerances are adequate.



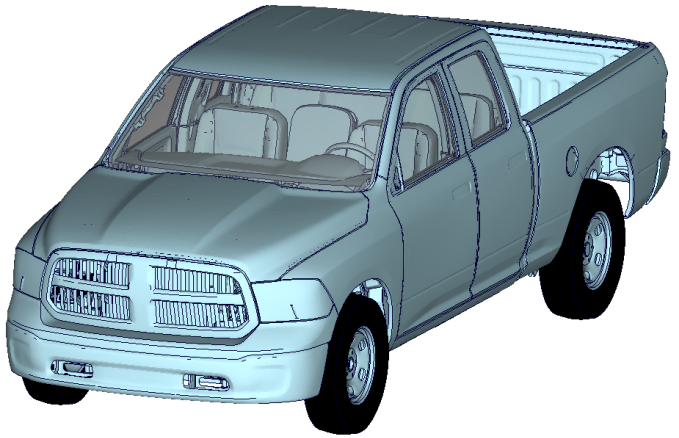
Methods – vehicles

Validated FE vehicle models representing the sedan, SUV, and pickup classes were used to develop the adapted half-face OMDB.



Sedan
2015 Toyota Camry

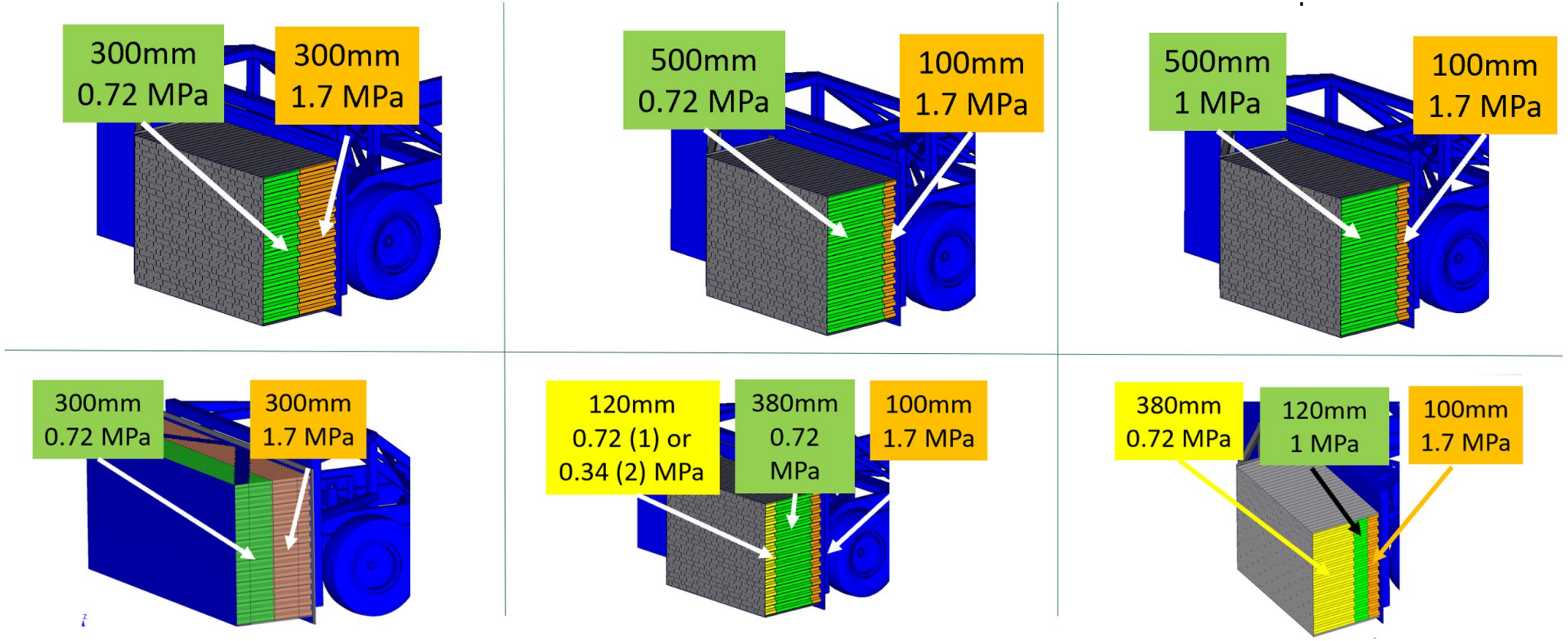
SUV
2020 Nissan Rogue



Pickup
2018 Dodge Ram

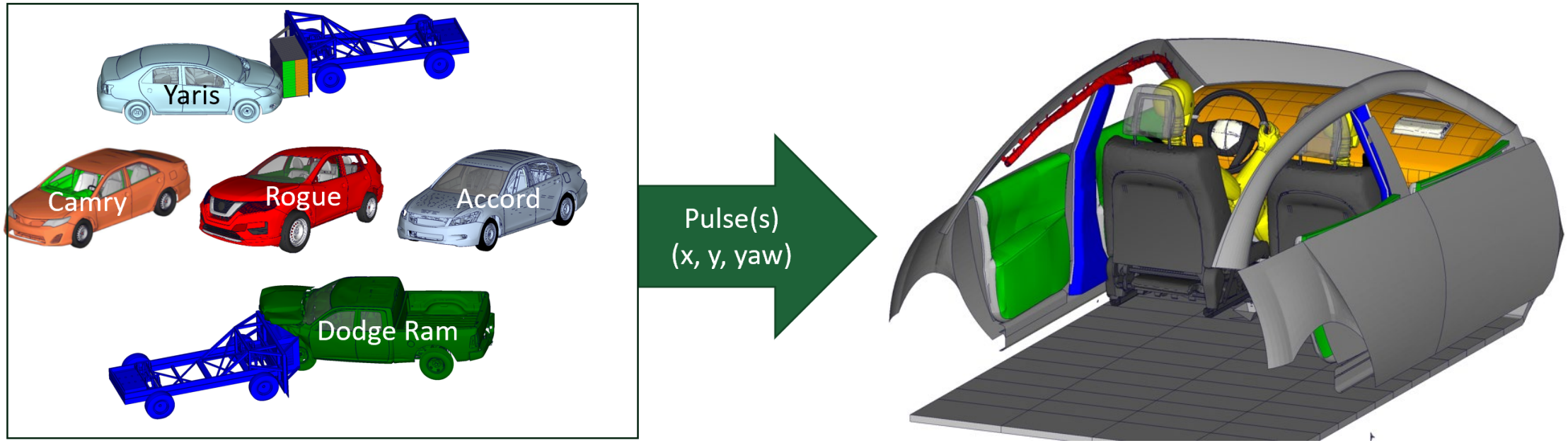
Methods – barriers

Candidate OMDB designs with different honeycomb blocks and strengths.



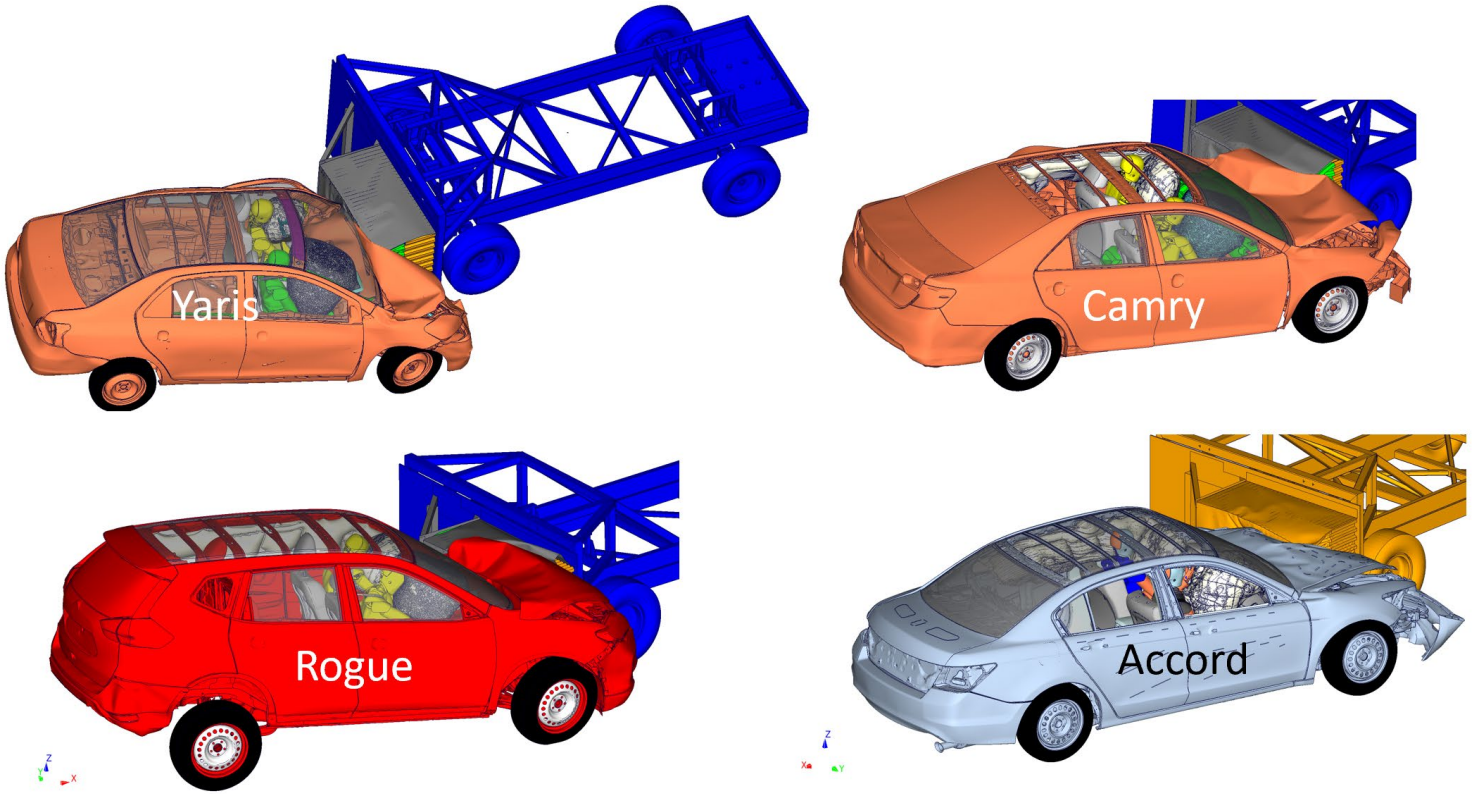
Methods – fleet study using generic sled with occupants

A generic sled model was used in combination with crash pulses from five vehicles to determine the effect of using the adapted OMDB.



Methods – fleet study using vehicles with occupants

Four vehicle FE models with two 50th percentile THOR dummies were used to determine the effect of using the adapted OMDB.

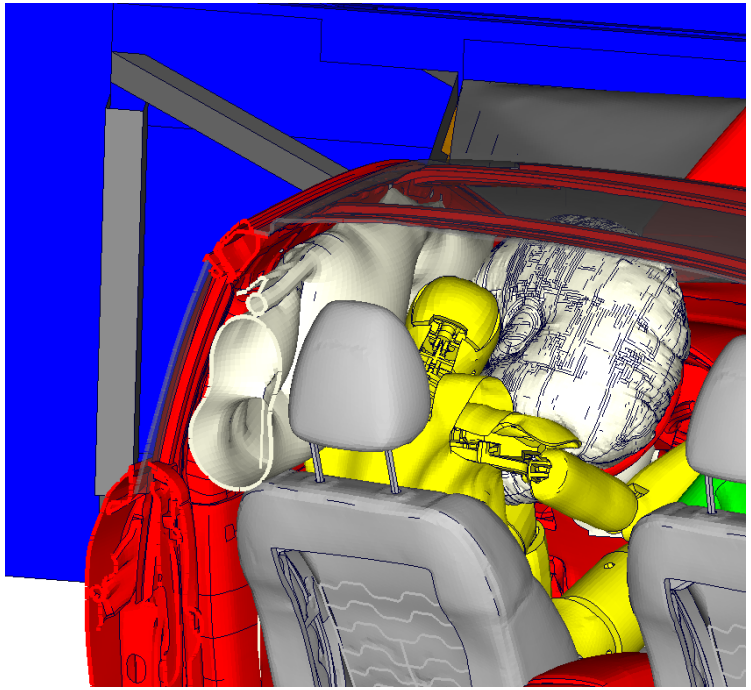


Methods – evaluation metrics

Occupants: kinematics, injury risk values, time histories, and 100-point scale

Vehicle: kinematics, pulse, deformation, and intrusion

Barrier: pulse and deformation

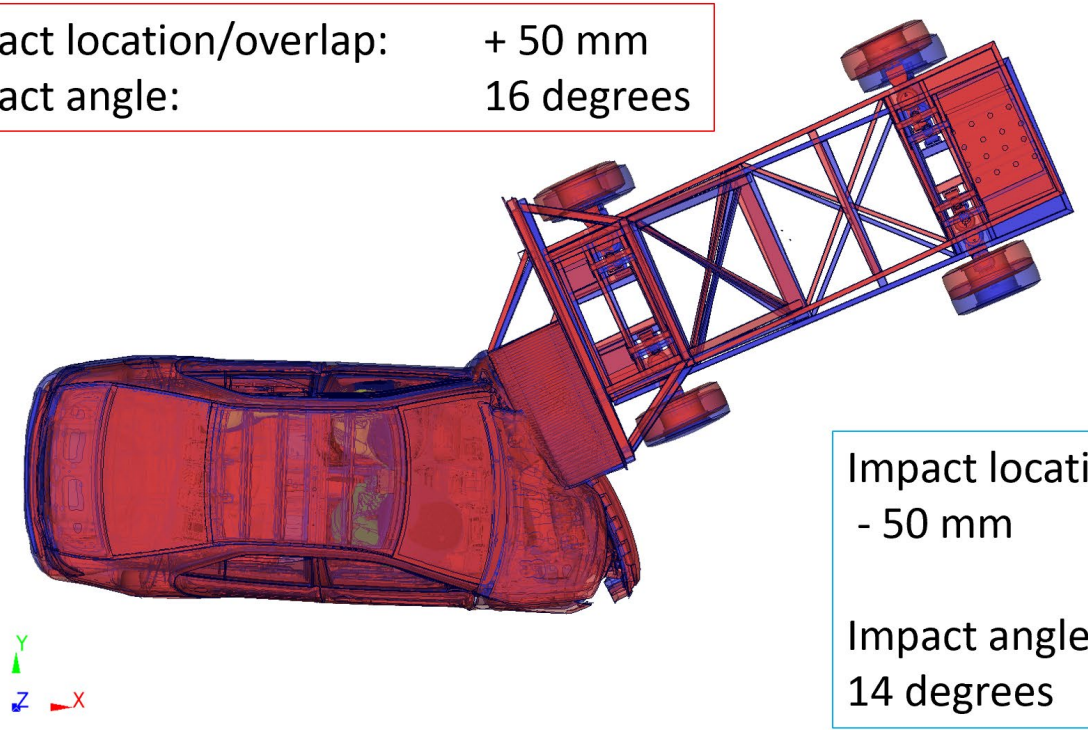


				Accord Driver sled baseline OMDB	Accord Driver sled adapted OMDB 3a2
HIC	500	700		298	309
BRIC	0.71	1.05		0.86	0.88
Ntf	0.39	0.85		0.27	0.19
Ncf	0.39	0.85		0.05	0.05
Nte	0.39	0.85		0.34	0.35
Nce	0.39	0.85		0.06	0.11
Chest-UL	37.9	52.3		42	43
Chest-UR	37.9	52.3		42	44
Chest-LL	37.9	52.3		16	24
Chest-LR	37.9	52.3		24	26
ABDO-LE	NA	88.6		64	65
ABDO-RI	NA	88.6		65	66
ACET-LE	2583	3486		1265	1292
ACET-RI	2583	3486		1240	1393
FEM-LE	5331	8558		633	669
FEM-RI	5331	8558		788	1201
FZ TI UL	4235	5577		396	547
FZ TI UR	4235	5577		483	570
FZ TI LL	3573	5861		2014	2282
FZ TI LR	3573	5861		2024	2287
MR TI UL	178	240		86	90
MR TI UR	178	240		105	149
MR TI LL	178	240		37	59
MR TI LR	178	240		61	86
Points				79	74

Methods – tolerance study

Design of Experiment and Coefficient of Variance were used to verify that the current test procedure tolerances were adequate.

Impact location/overlap:	+ 50 mm
Impact angle:	16 degrees



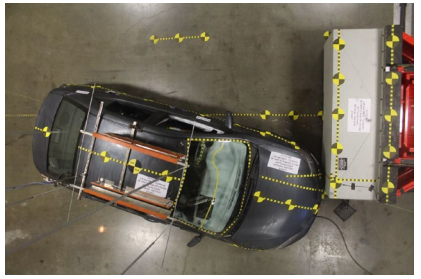
Impact location/overlap:
- 50 mm

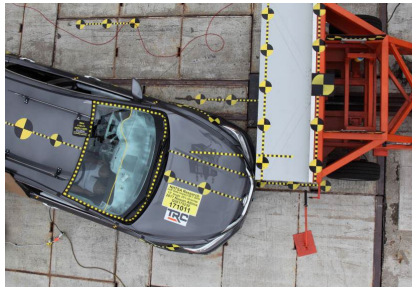
Impact angle:
14 degrees

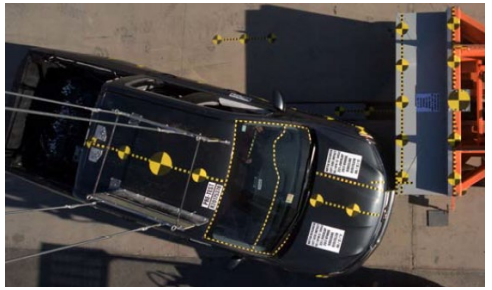
Methods – complementary full-scale test data

A full-scale test study (Saunders & Parent) was used as complementary data to evaluate the effect of the adapted half-face OMDB on the oblique impact test.

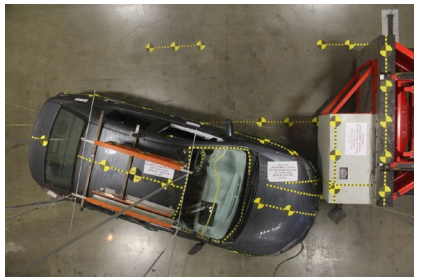
Full-face OMDB



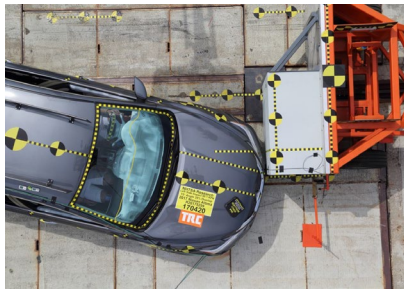




Baseline half-face OMDB



Toyota Corolla (small sedan)

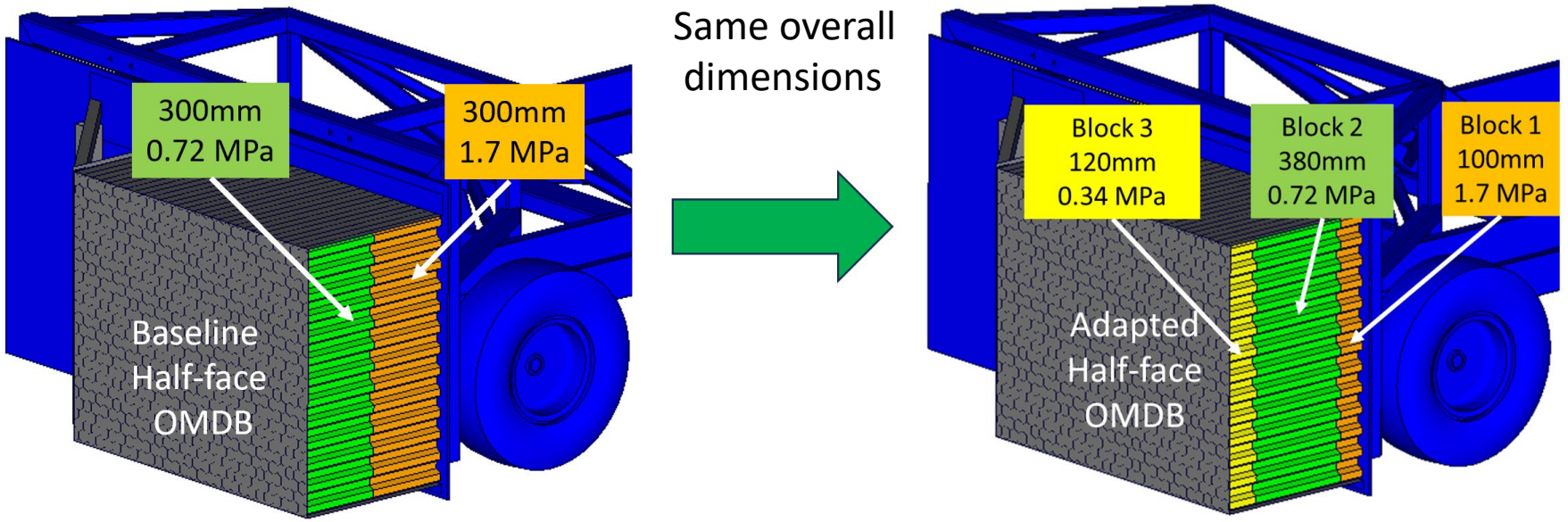


Nissan Altima (mid-size sedan)

Honda Ridgeline (large pickup)

Results – adapted half-face OMDB characteristics

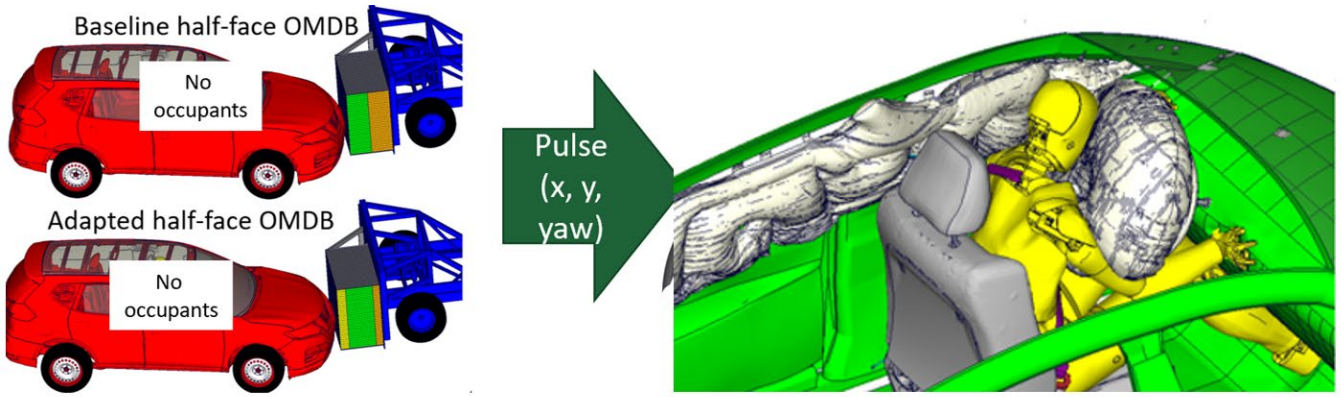
The adapted half-face OMDB selected consists of three honeycomb blocks of increasing strength.



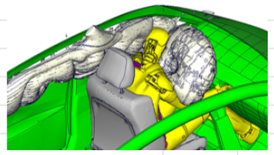
Results – fleet study (sled)

Generic sled model fleet study results indicated that the adapted half-face OMDB would provide at least equivalent injury assessment in oblique crash tests.

Example: Nissan Rogue driver



Vehicles studied 2010 Toyota Yaris, 2015 Toyota Camry, 2014 Honda Accord, 2020 Nissan Rogue (SUV), and 2018 Dodge Ram (Pickup)

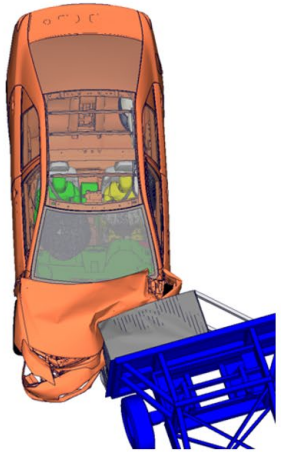


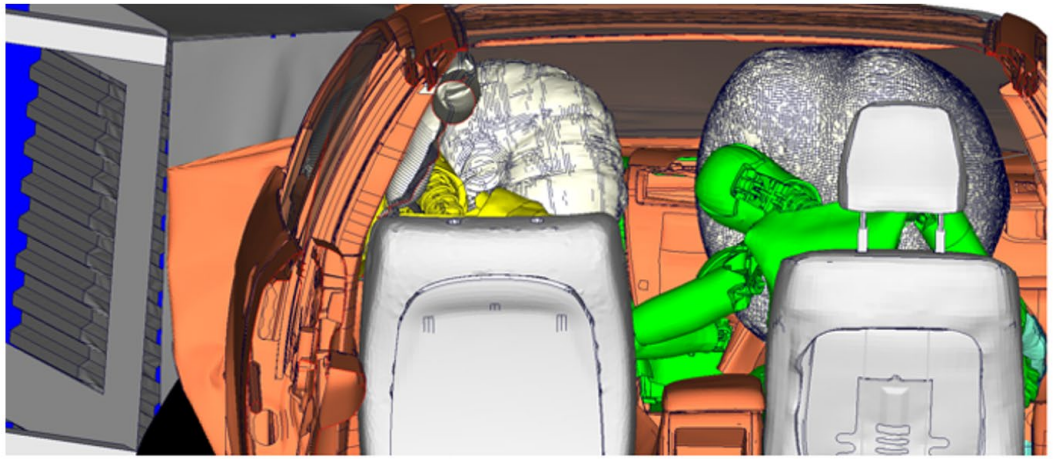
			Rogue Driver sled baseline OMDB	Rogue Driver sled adapted OMDB 3a2
HIC	500	700	413	387
BRIC	0.71	1.05	0.85	0.84
Ntf	0.39	0.85	0.28	0.28
Ncf	0.39	0.85	0.07	0.07
Nte	0.39	0.85	0.37	0.38
Nce	0.39	0.85	0.07	0.07
Chest-UL	37.9	52.3	44	45
Chest-UR	37.9	52.3	39	41
Chest-LL	37.9	52.3	20	18
Chest-LR	37.9	52.3	31	27
ABDO-LE	NA	88.6	66	65
ABDO-RI	NA	88.6	67	65
ACET-LE	2583	3486	823	900
ACET-RI	2583	3486	930	853
FEM-LE	5331	8558	716	748
FEM-RI	5331	8558	673	986
FZ TI UL	4235	5577	506	416
FZ TI UR	4235	5577	590	595
FZ TI LL	3573	5861	1995	1726
FZ TI LR	3573	5861	2248	1851
MR TI UL	178	240	76	83
MR TI UR	178	240	91	74
MR TI LL	178	240	64	42
MR TI LR	178	240	73	57
Points			76	75

Results – fleet study (vehicle)

Vehicle fleet study results indicated that the adapted half-face OMDB would provide at least equivalent intrusions and injury risk in oblique crash tests.

Example: Toyota Camry





Vehicles studied: 2010 Toyota Yaris, 2015 Toyota Camry, 2014 Honda Accord, and 2020 Nissan Rogue (SUV)

Driver			Baseline Half-face OMDB	Adapted Half-face OMDB
Camry			Half-face	Half-face
HIC	500	700	303	284
BRIC	0.71	1.05	0.83	0.83
Ntf	0.39	0.85	0.35	0.35
Ncf	0.39	0.85	0.29	0.25
Nte	0.39	0.85	0.3	0.36
Nce	0.39	0.85	0.09	0.13
Chest-UL	37.9	52.3	33	32
Chest-UR	37.9	52.3	49	49
Chest-LL	37.9	52.3	29	31
Chest-LR	37.9	52.3	35	37
ABDO-LE	NA	88.6	68	67
ABDO-RI	NA	88.6	67	64
ACET-LE	2583	3486	627	718
ACET-RI	2583	3486	1592	1911
FEM-LE	5331	8558	3149	3042
FEM-RI	5331	8558	1945	2223
FZ TI UL	4235	5577	1082	1188
FZ TI UR	4235	5577	1078	1003
FZ TI LL	3573	5861	3700	4911
FZ TI LR	3573	5861	4616	4315
MR TI UL	178	240	182	166
MR TI UR	178	240	114	114
MR TI LL	178	240	115	125
MR TI LR	178	240	112	93
Points			63	61

Results – tolerance study

Results showed good repeatability when using the adapted half-face OMDB within the defined test procedure tolerances.

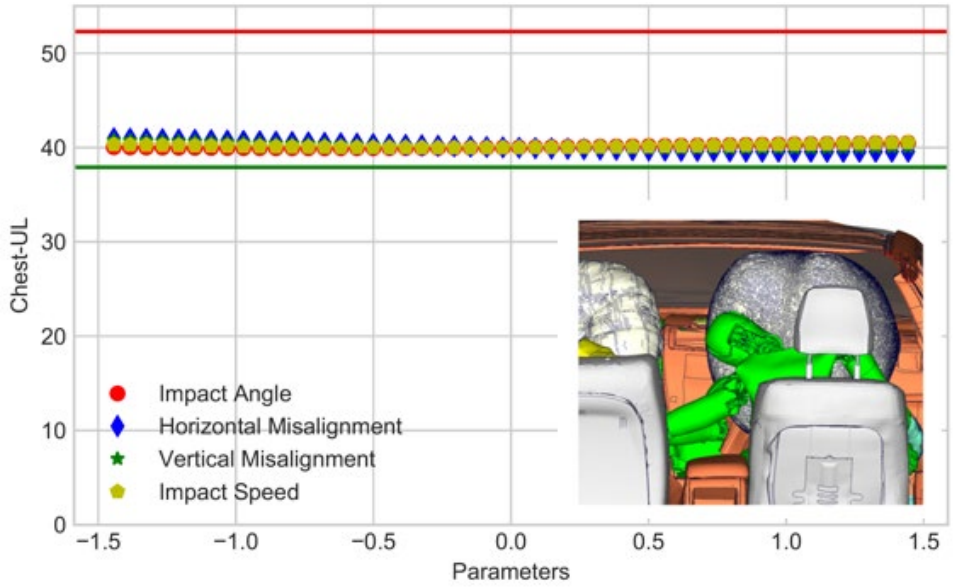
Test procedure tolerances

- Impact location (vertical): baseline +/- 50mm
- Impact location (horizontal/overlap): 35% overlap +/- 50mm
- Impact angle: 15 +/- 1 degree
- Impact speed: 90 +/- 1km/h

Example: SUV driver

	Baseline	Minimum DOE	Maximum DOE	CV [%]
BRIC	0.79	0.74	0.85	3
Chest [mm]	43	40	45	3
Femur [N]	5269	4389	6715	11
Max. toe-pan intrusion [mm]	114	103	135	8

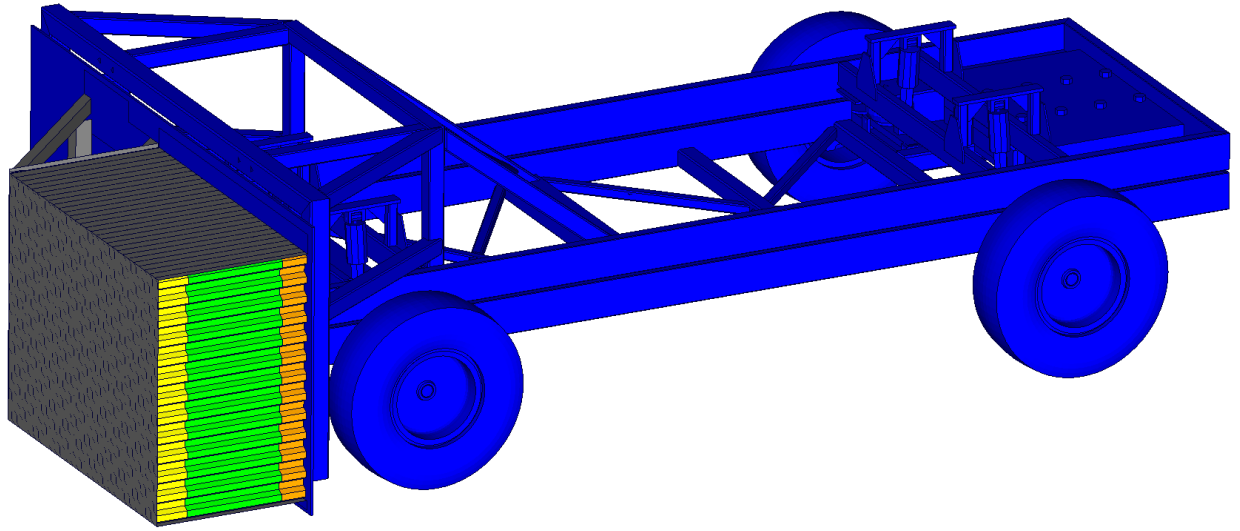
Example: sedan driver chest



The tolerance study was conducted on the Toyota Camry sedan and the Nissan Rogue SUV.

Conclusion

1. An adapted half-face OMDB was developed.
2. It is expected to produce at least equivalent THOR driver and passenger results compared to NHTSA's current frontal oblique impact configuration.
3. The tolerances of the current test procedure, which were developed for the full-face OMDB, were found to be adequate for the adapted half-face OMDB as well.



Acknowledgment

Thank You

Rudolf Reichert
George Mason University
4087 University Drive, Fairfax VA 22030
(703) 993 4565
reichert@gmu.edu