

CHALLENGES AND OPPORTUNITIES IN THE OBLIQUE IMPACT

Kurt Fischer, ZF TRW



Challenges and Opportunities in the Oblique Impact Project Acknowledgement

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Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

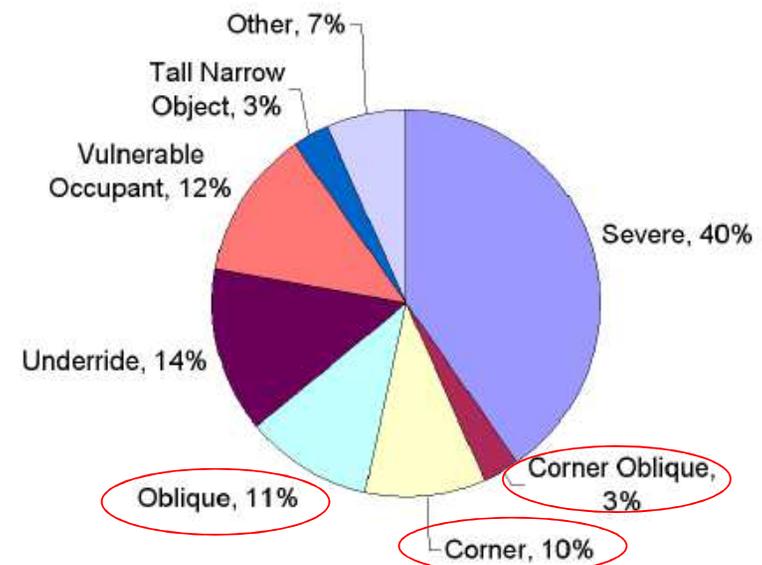
Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Project Definition

Why do fatalities continue to occur despite the use of air bags and seat belts?

- The NHTSA Published Report (Sept 2009), Fatalities in frontal crashes despite seat belts and air bags, concluded that aside from exceedingly severe crashes, impacts that had poor structural engagement (corner impacts, oblique crashes, impacts with narrow objects, and heavy vehicle under-rides) had a high fatality rate.



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2000-2007 NASS fatalities for model year vehicles 2000+ where occupant was restrained

Challenges and Opportunities in the Oblique Impact Project Definition

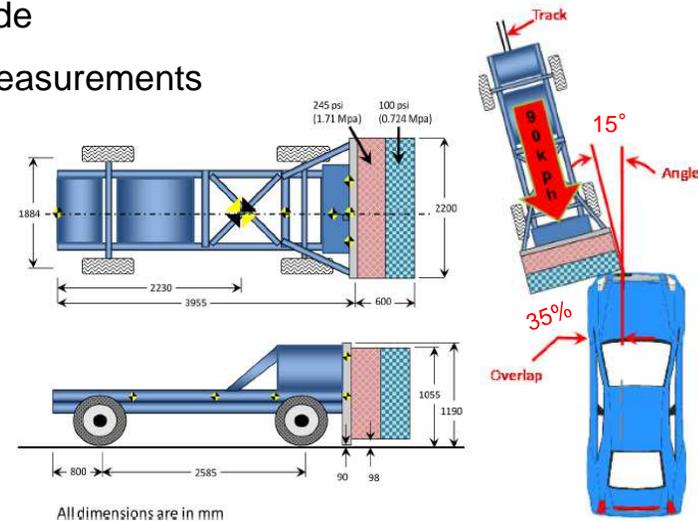
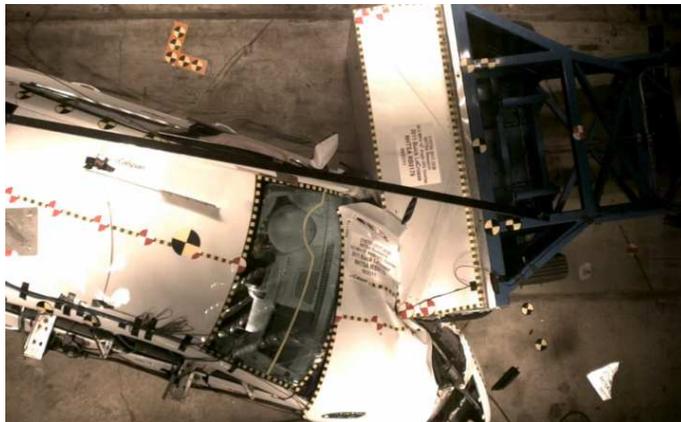
Objective:

- To develop and demonstrate occupant restraint systems for both the driver and right front passenger that can provide improved safety performance for the 50th percentile male THOR dummy in both the left and right oblique crashes

Challenges and Opportunities in the Oblique Impact Project Definition

Load Case Definition

- Movable Deformable Barrier (~2490 kg / 90 km/h)
- Impact angle 15° - Overlap 35%
- THOR dummy on driver and passenger side
- IAVs like BrIC, Multiple chest deflection measurements



Challenges and Opportunities in the Oblique Impact Project Definition

Evaluate vehicles that meet the following requirements:

- Small and midsize cars
- Good or acceptable small overlap structural rating
- FMVSS 226 Capable Curtain Air Bag

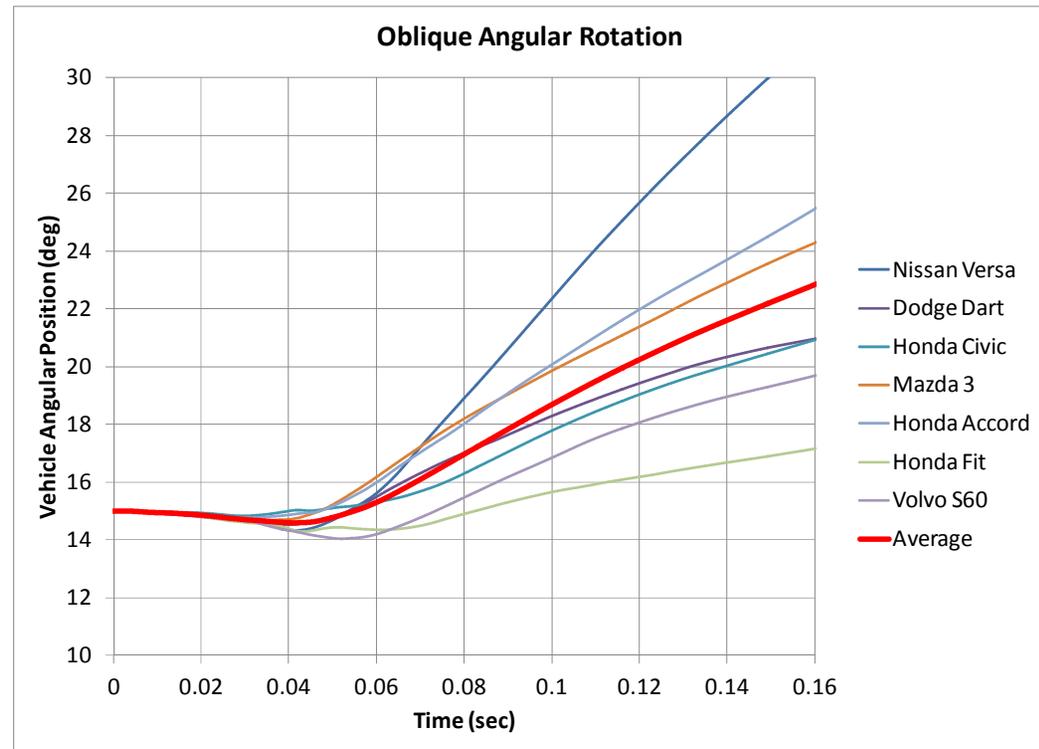
Seven vehicles met the requirements

- Nissan Versa
- Dodge Dart
- Honda Accord
- Mazda 3
- Honda Civic
- Honda Fit
- Volvo S60

Challenges and Opportunities in the Oblique Impact Project Definition

Vehicle Kinematic Comparison

- Seven small to midsize cars
- Vehicle rotation compared
- Average determined

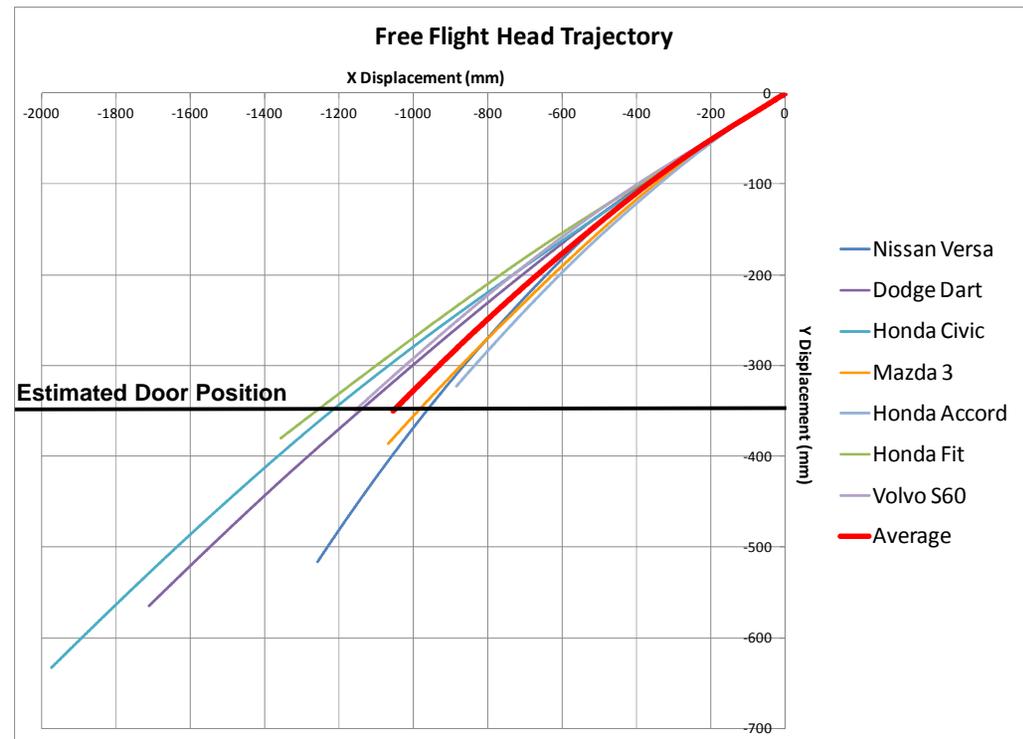


Challenges and Opportunities in the Oblique Impact Project Definition

Free Flight Head Trajectory

- Seven small to midsize cars
- Linear regression calculated
- Average determined

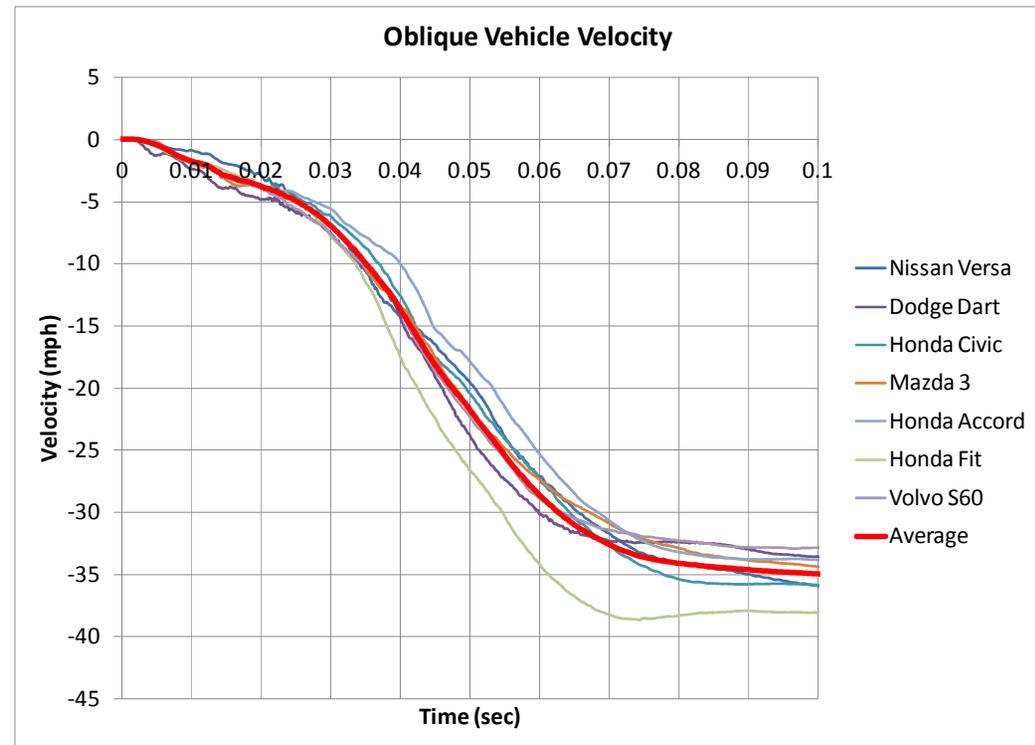
Vehicle	Free Flight Head Traj (R ²)
Mazda 3	19.16° (0.9932)
Honda Accord	19.24° (0.9927)
Volvo S60	16.19° (0.9957)
Nissan Versa	20.51° (0.9821)
Dodge Dart	17.77° (0.9955)
Honda Fit	15.45° (0.9988)
Honda Civic	17.12° (0.9959)
Average*	17.92



Challenges and Opportunities in the Oblique Impact Project Definition

Vehicle Velocity Comparison

- Seven small to midsize cars
- Vehicle velocity compared
- Average determined



Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Driver Near Side Impact

Baseline Sled Performance

- Seven small to midsize cars
- Key injury criteria compared
- Kinematic comparison

Kinematic and injury values are comparable, or higher, between the oblique sled test and fleet of small to mid-size cars.

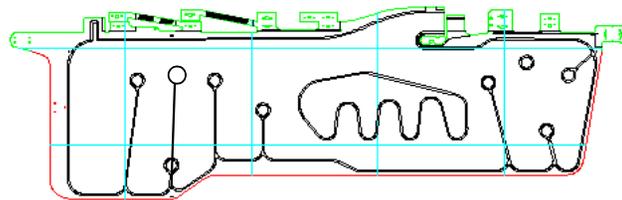
Vehicle	HIC	BrIC	Nij	Max Chest Comp (mm)	Head Contact	Roll off bag
Mazda 3	267	1.19	0.30	41	Door	Yes
Honda Accord	185	0.61	0.26	49	None	Yes
Volvo S60	151	1.10	0.29	37	Door	Yes
Nissan Versa	137	0.89	0.29	36	Door	Yes
Dodge Dart	313	0.73	0.35	49	Header	No
Honda Fit	264	1.10	0.42	52	Door	Yes
Honda Civic	201	0.85	0.32	43	Door	Yes
Average	217	0.92	0.32	44	Door	Yes
ZF TRW Sled 0001-07	447	1.04	0.56	48	Door	Yes

Challenges and Opportunities in the Oblique Impact Driver Near Side Impact

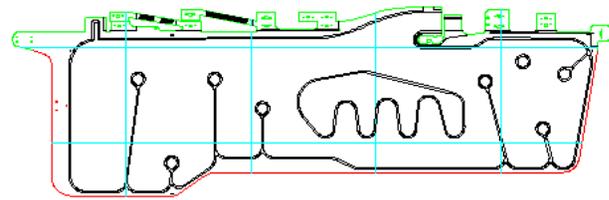
Curtain Air Bag Comparison

- Head contact eliminated
- BrIC reduced
- Neck loading reduced

Hardware	Baseline Test	Countermeasure
Driver Air Bag	Baseline	Baseline
Knee Air Bag	Baseline	Baseline
Curtain Air Bag	3 Small Chambers	2 Medium Chambers
Seat Belt	Baseline	Baseline



Three Small Chambers

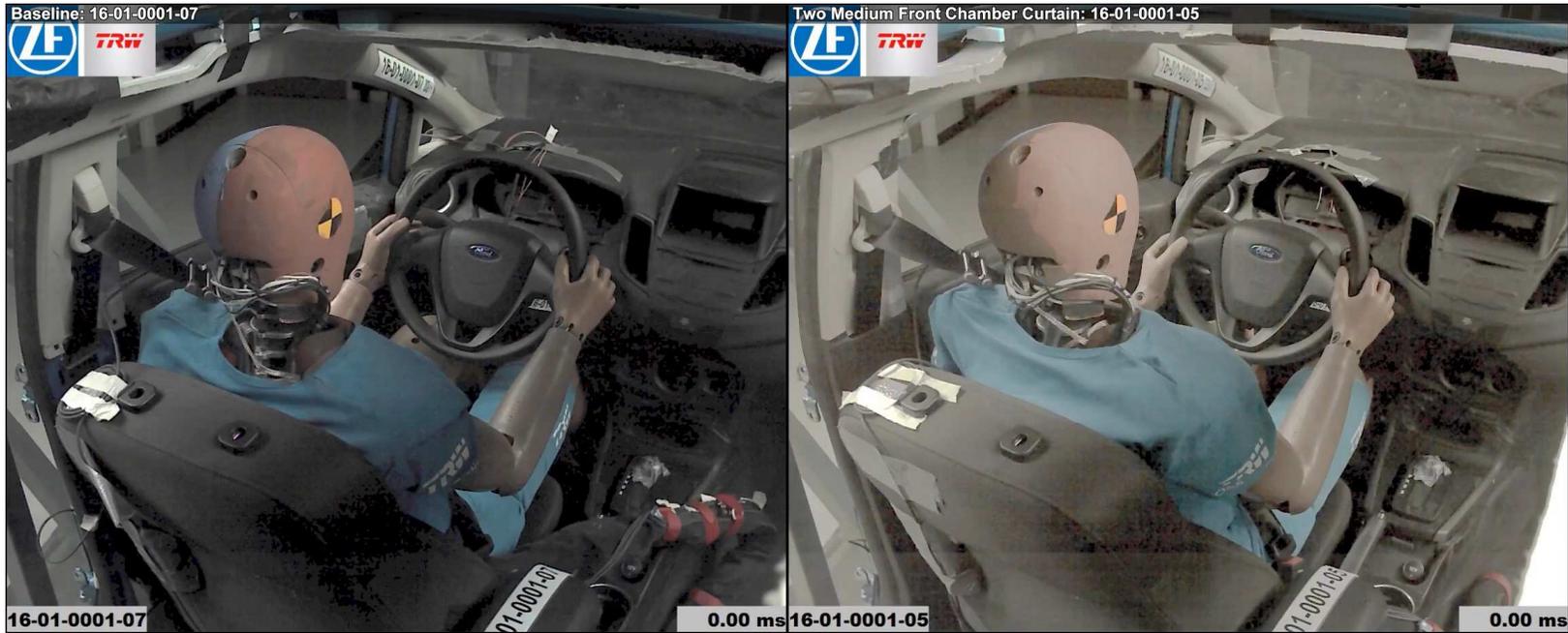


Two Medium Chambers

Full Credit
Partial Credit
No Credit

Test Mode	HIC	BrIC	Nij	Rmax (mm)	Abd. (mm)	Acet. (N)	Femur (N)
Baseline	447	1.05	0.56	48	76	2065	3920
Two Medium Front Chambers Curtain	527	0.69	0.43	49	72	1604	3890

Challenges and Opportunities in the Oblique Impact Driver Near Side Impact



Baseline

Two Medium Chamber Curtain Air Bag

Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Driver Far Side Impact

Baseline Sled Performance

- Three small to midsize cars
- Key injury criteria compared
- Kinematic comparison

Kinematic and injury values are comparable, or higher between the oblique sled test and fleet of small to mid-size cars.

Vehicle	HIC	BrIC	Nij	Max Chest Comp (mm)	Head Contact	Belt Rollout
Mazda 3	747	1.48	0.46	41	IP	Yes
Honda Accord	416	1.78	0.55	44	IP	Yes
Nissan Versa	645	1.00	Lost	40	IP	Yes
Average	603	1.42	0.51	42	IP	Yes
ZF TRW Sled 0001-08	496	1.73	0.58	44	IP/Hand	Yes

Challenges and Opportunities in the Oblique Impact Driver Far Side Impact

Relocated Retractor (i.e. Seat Integrated)

- Relocated retractor prevented instrument panel contact
- HIC and BrIC remained similar
- Chest compression reduced



Relocated Retractor 3-Point Belt (i.e. Seat Integrated)

Hardware	Baseline Test	Countermeasure
Driver Air Bag	Baseline	Baseline
Knee Air Bag	Baseline	Baseline
Seat Belt	Pillar mount w/ D-Ring	Relocated Retractor

Full Credit
Partial Credit
No Credit

Test Mode	HIC	BrIC	Nij	Rmax (mm)	Abdomen (mm)	Adetabulum (N)	Femur (N)
Baseline	496	1.73	0.58	44	74	2476	3350
Relocated Retractor	517	1.80	0.48	33	64 (lost)	2400	3560

Challenges and Opportunities in the Oblique Impact Driver Far Side Impact



Baseline

Relocated Retractor

Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Passenger Far Side Impact

Baseline Sled Performance

- Seven small to midsize cars
- Key injury criteria compared
- Kinematic comparison

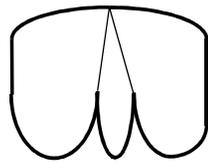
Kinematic and injury values are lower between the oblique sled test and fleet of small to mid-size cars. However, the Nij and chest compression are higher.

Vehicle	HIC	BriC	Nij	Chest Comp	Head Contact	Belt Rollout
Mazda 3	806	1.12	0.31	38	IP	Yes
Honda Accord	935	1.46	0.41	39	IP	Yes
Volvo S60	223	1.46	0.22	31	IP	Yes
Nissan Versa	543	1.91	0.63	41	IP	Yes
Dodge Dart	113	2.21	0.26	35	Header/ IP	Yes
Honda Fit	908	2.23	0.63	56	IP	Yes
Honda Civic	272	2.81	0.39	42	IP	Yes
Average	543	1.89	0.41	40	IP	Yes
ZF TRW Sled 0001-03	332	1.55	0.47	48	IP	Yes

Challenges and Opportunities in the Oblique Impact Passenger Far Side Impact

Countermeasure Evaluation

- Reduced angular head rotation velocity (BrIC)
- HIC increased



Parallel Cell PAB

Hardware	Baseline Test	Countermeasure
Passenger Air Bag	Baseline	Parallel Cell PAB
Seat Belt	Baseline	Baseline

Full Credit
Partial Credit
No Credit

Test Mode	HIC	BrIC	Nij	Rmax (mm)	Abdomen (mm)	Acetabulum (N)	Femur (N)
Baseline	332	1.55	0.47	48	82	4430	3010
Parallel Cell Bag	667	0.81	0.45	53	67	4268	3730

Challenges and Opportunities in the Oblique Impact Passenger Far Side Impact



Baseline

Parallel Cell Bag

Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Passenger Near Side Impact

Baseline Sled Performance

- Three small to midsize cars
- Key injury criteria compared
- Kinematic comparison

Kinematic and injury values are comparable, or higher, between the oblique sled test and fleet of small to mid-size cars.

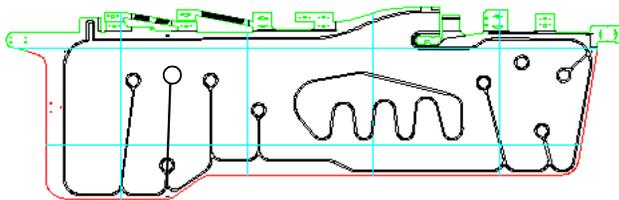
Vehicle	HIC	BrIC	Nij	Chest Comp	Head Contact	Roll off bag
Mazda 3	356	0.83	0.44	56	None	Yes
Honda Accord	189	0.94	0.30	58	None	Yes
Nissan Versa	824	1.01	0.45	42	Door	Yes
Average	456	0.93	0.40	52	None	Yes
ZF TRW Sled 0001-10	770	0.97	0.71	58	Door	Yes

Challenges and Opportunities in the Oblique Impact Passenger Near Side Impact

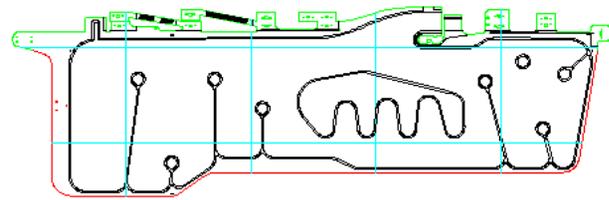
Countermeasure Evaluation

- Head contact eliminated
- HIC & BrIC reduced
- Nij reduced

Hardware	Baseline Test	Countermeasure
Passenger Air Bag	Baseline	Baseline
Curtain Air Bag	Baseline	2 Medium
Seat Belt	Baseline	Baseline



Three Small Chambers

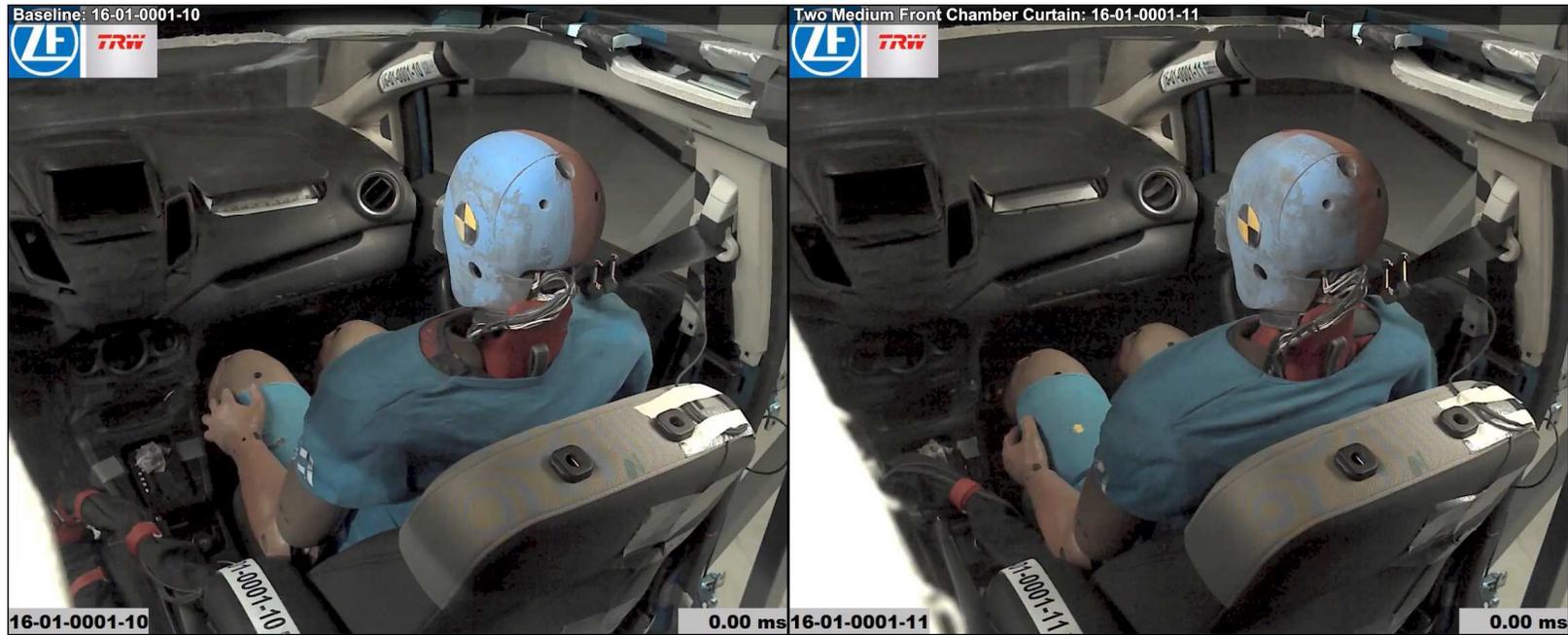


Two Medium Chambers

Full Credit
Partial Credit
No Credit

Test Mode	HIC	BrIC	Nij	Rmax (mm)	Abd. (mm)	Acet. (N)	Femur (N)
Baseline	770	0.97	0.71	58	76	2841	2090
Two Medium Front Chambers Curtain	549	0.75	0.51	60	84	3430	1220

Challenges and Opportunities in the Oblique Impact Passenger Near Side Impact



Baseline

Two Medium Chamber Curtain Air Bag

Challenges and Opportunities in the Oblique Impact Agenda

Project Definition

Driver – Near Side

Driver – Far Side

Passenger – Far Side

Passenger – Near Side

Summary

Challenges and Opportunities in the Oblique Impact Summary

- On both the driver and passenger near side impacts, the two medium chamber curtain bag lowered the BrIC and Nij while eliminating the head contact to the door.
- On the driver far side impact, the relocated retractor (simulating a Seat Integrated Seat Belt) reduced the chest compression and a slight reduction in BrIC.
- On the passenger far side impact, the Parallel Cell Bag reduced the BrIC.

Challenges and Opportunities in the Oblique Impact Summary

Thank you for your attention

