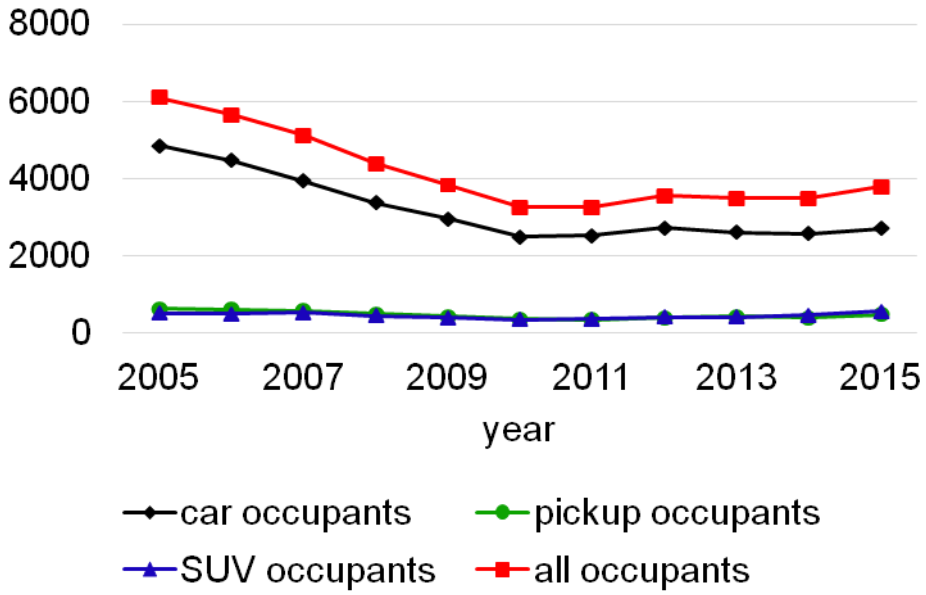
IIHS Side Impact Evaluations

Sonja Arnold-Keifer – 10/15/2018
15th German LS-DYNA Forum

University of Stuttgart
Germany

Motivation

- Passenger deaths in the US per year in multiple-vehicle side impact crashes:



[IIHS2015_1]

IIHS side impact evaluation - Outline

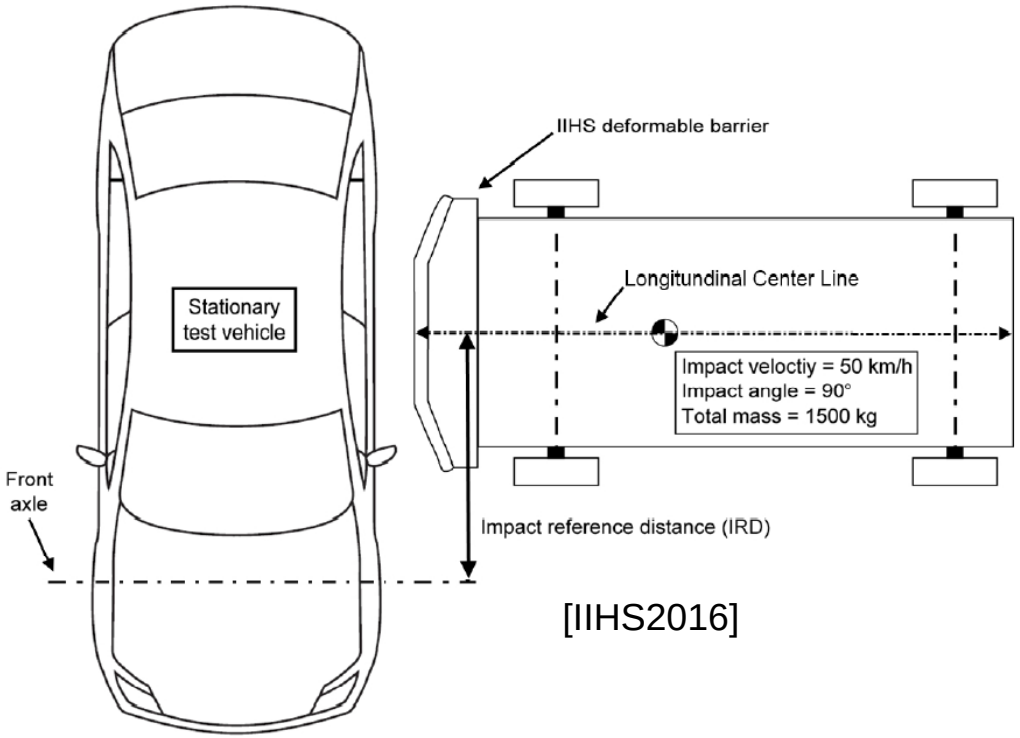
1. IIHS side impact crash test
2. FE-simulations
3. Influences

    Increased velocity
    Increased weight
    Increased height
    Different impact location

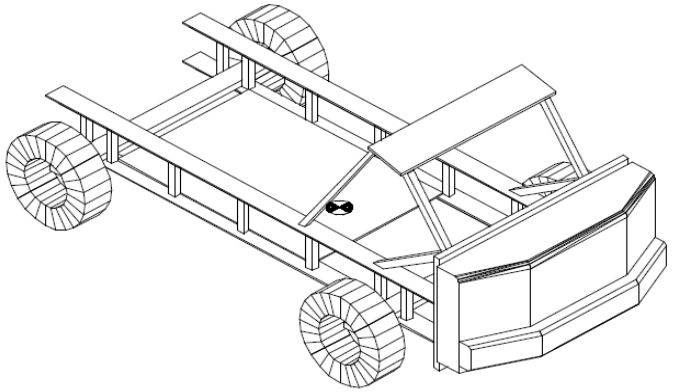
4. Summary

1. IIHS side impact crash test

- Insurance Institute for Highway Safety (IIHS) started its side impact crash test in 2003



[IIHS2016]



Moving Deformable Barrier (MDB)

IIHS side impact evaluation - Outline

1. IIHS side impact crash test
2. FE-simulations
3. Influences

    Increased velocity
    Increased weight
    Increased height
    Different impact location

4. Summary

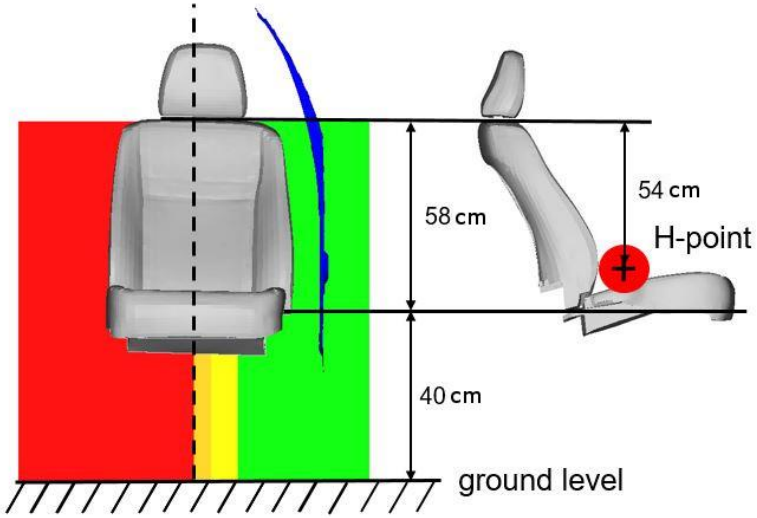
2. FE simulations

- Target vehicle: 2015 Toyota Camry
- Striking barrier and vehicles:

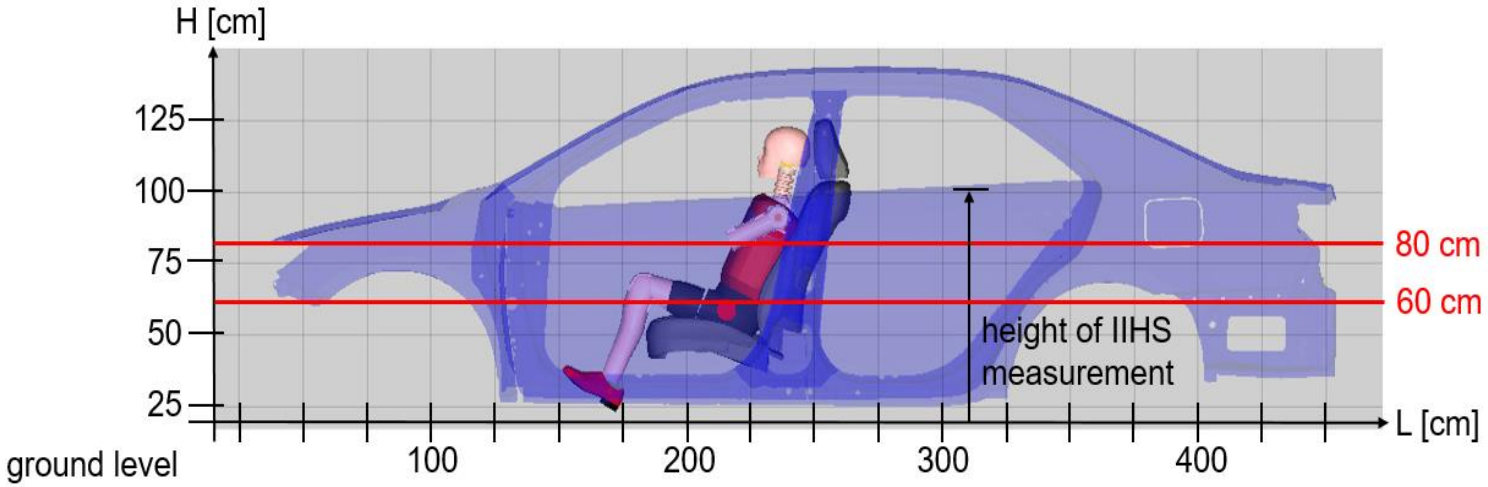
FE-model	IIHS MDB	2015 Toyota Camry	2010 Toyota Yaris	2003 Ford Explorer	2007 Chevrolet Silverado	1998 Chevrolet s10 pickup
						
mass	1510.8 kg	1526.7 kg	1253.7 kg	2244 kg	2271 kg	1418 kg to 2118 kg

2. FE simulations

- max. intrusion =
  min. distance between
  b-pillar and seat-centerline



Boundary line	Good	Acceptable	Marginal	Poor
B-pillar to driver seat centerline distance (cm)	12.5	5.0	0.0	



IIHS side impact evaluation - Outline

1. IIHS side impact crash test

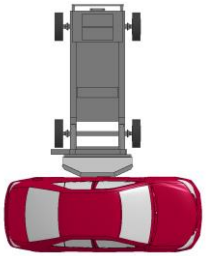
2. FE-simulations

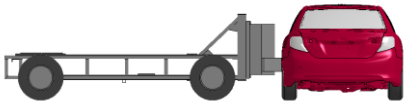
3. Influences

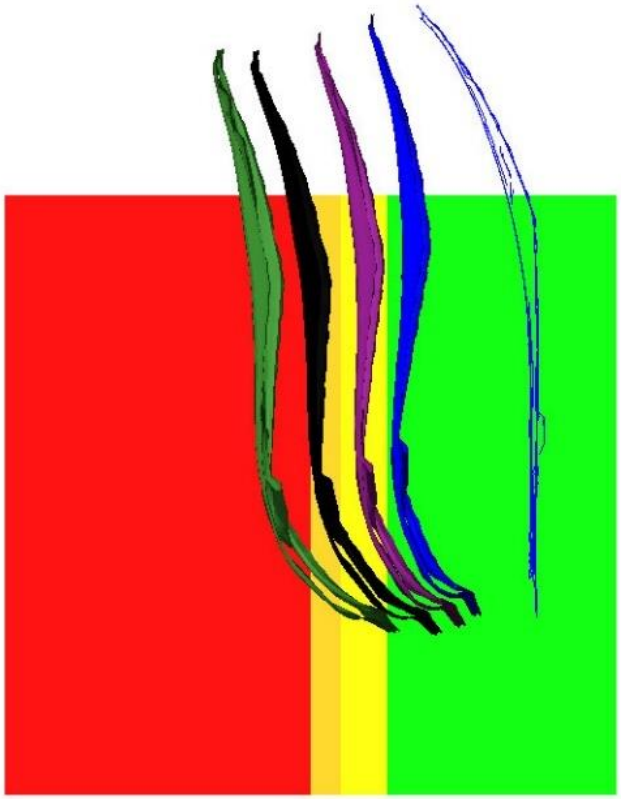
    Increased velocity
    Increased weight
    Increased height
    Different impact location

4. Summary

3. Increased Velocity – MDB-to-Camry







measured distance between b-pillar and seat-centerline:	
50 km/h	13.2 cm ★
60 km/h	7.2 cm
70 km/h	-4 cm ★
80 km/h	-11.7 cm ★

Undeformed

50 km/h

70 km/h

60 km/h

80 km/h

★ similar result compared to IIHS test result of 12.5 cm [IIHS2015_2]

★ negative sign indicates overrun of seat-centerline

3. Increased Velocity

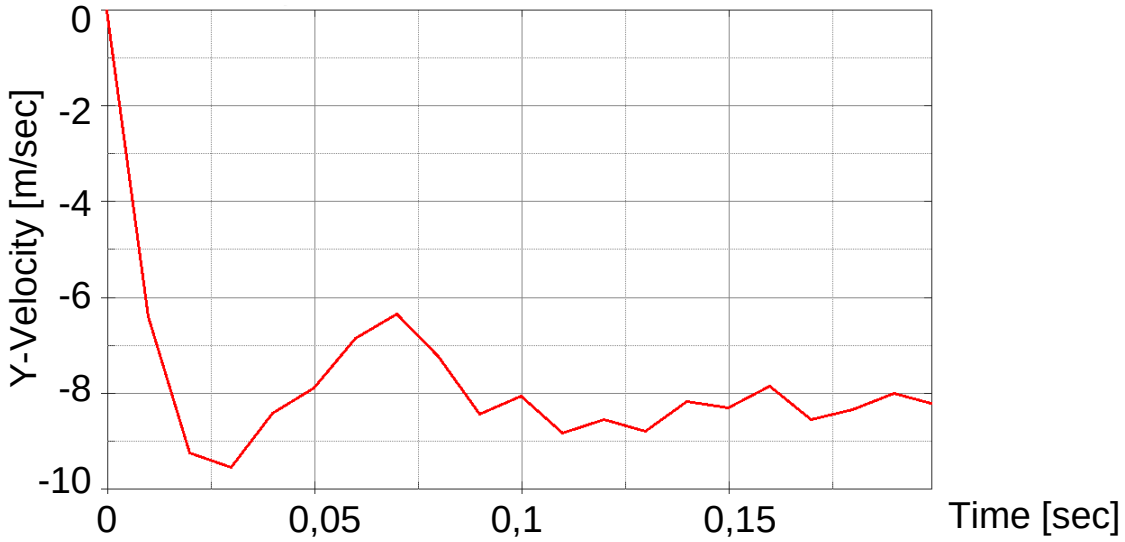
	Impact velocity	50 km/h	60 km/h	70 km/h	80 km/h
IIHS	MDB-to-Camry	12.5 cm			
CAE evaluation	MDB-to-Camry	13.2 cm	7.2 cm	- 4 cm ★	- 11.7 cm ★
	Camry-to-Camry	21.3 cm	15.25 cm	8.75 cm	1 cm
	Yaris-to-Camry	23 cm	16.5 cm	7.7 cm	- 3.5cm ★
	Explorer-to-Camry	11 cm	2.6 cm		
	Silverado-to-Camry	7.5 cm	- 0.7 cm ★		
	Chevy-to-Camry	11.5 cm	1 cm		

★negative sign indicates overrun of seat-centerline

- Explorer, Silverado, Chevy show more severe test results for 50 km/h compared to MDB

3. Increased Velocity - Velocity of b-pillar

MDB-to-Camry
(50 km/h)



Impact velocity	50 km/h (= 13.89 m/s)	60 km/h (= 16.67 m/s)
MDB-Camry	9.53 m/s	11.9 m/s
Camry-Camry	9.12 m/s	10.8 m/s
Yaris-Camry	8.43 m/s	10.1 m/s
Explorer-Camry	10.8 m/s	12.4 m/s
Silverado-Camry	10.2 m/s	12.3 m/s
Chevy-Camry	10.4 m/s	11.1 m/s

IIHS side impact evaluation - Outline

1. IIHS side impact crash test

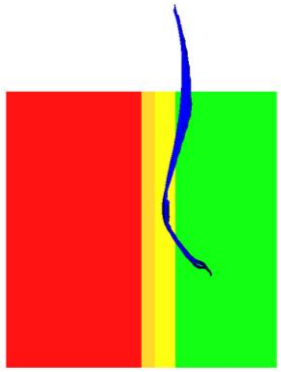
2. FE-simulations

3. Influences

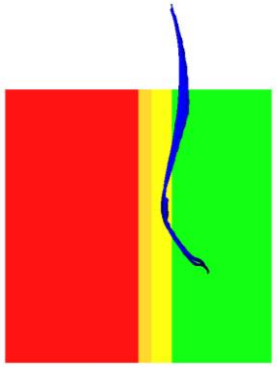
    Increased velocity
    Increased weight
    Increased height
    Different impact location

4. Summary

3. Increased weight - Silverado

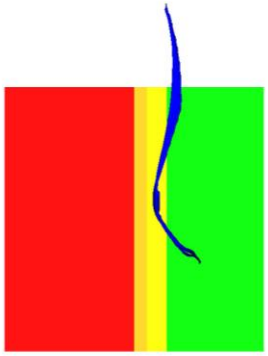


Baseline: 2271 kg
Distance
seat-center: 7.6 cm

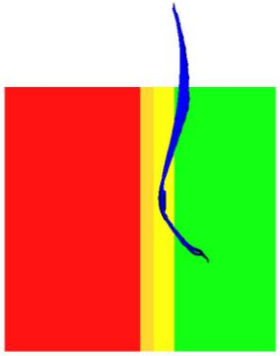


-222.3 kg: 2048.7 kg
Distance
seat-center: 8.5 cm

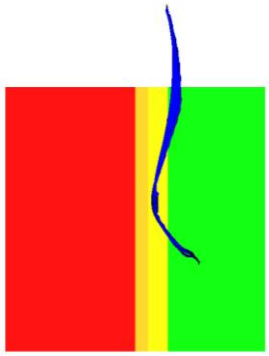
50 km/h



+100 kg: 2371 kg
Distance
seat-center: 7.1 cm



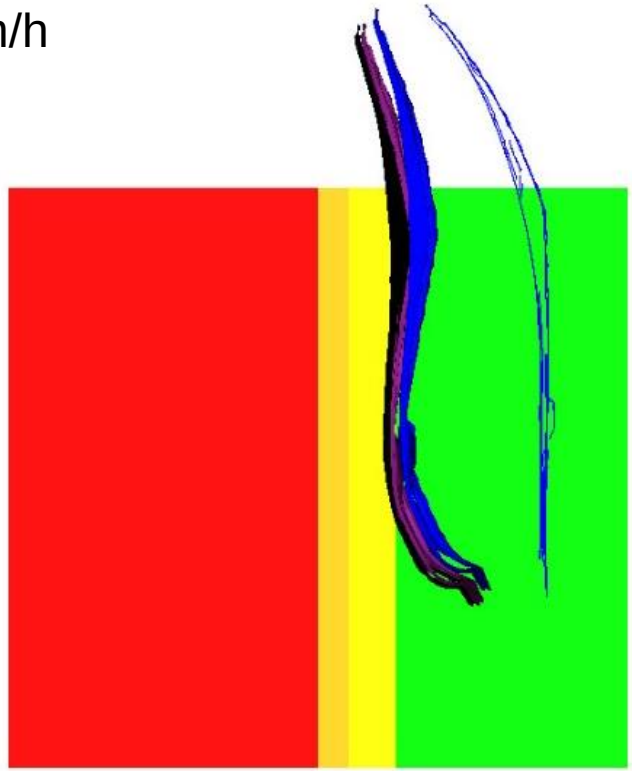
+200 kg: 2471kg
Distance
seat-center: 6.7 cm

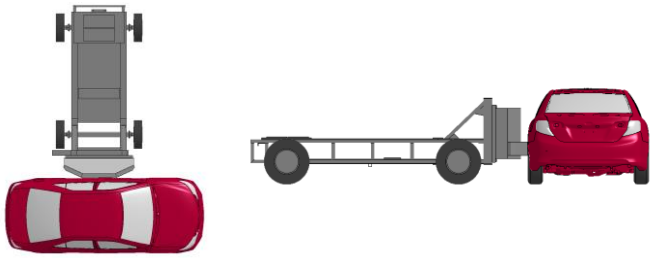


+300 kg: 2571 kg
Distance
seat-center: 6.2 cm

3. Increased weight – MDB

50 km/h





measured distance between b-pillar and seat centerline:	
Baseline (1500kg)	13.2 cm
+ 500 kg	11.1 cm
+ 750 kg	10.5 cm

Undeformed

Baseline

Weight MDB + 500 kg

Weight MDB + 750 kg

IIHS side impact evaluation - Outline

1. IIHS side impact crash test

2. FE-simulations

3. Influences

   Increased velocity
   Increased weight
   Increased height
   Different impact location

4. Summary

3. Increased height – Explorer

Undeformed

Baseline

Height Explorer + 100 mm

Height Explorer + 200 mm

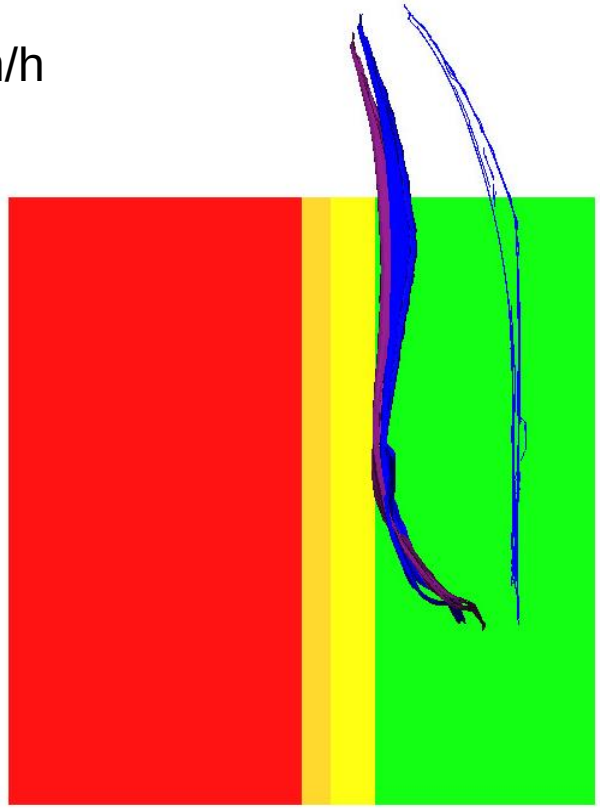
Height Explorer + 300 mm

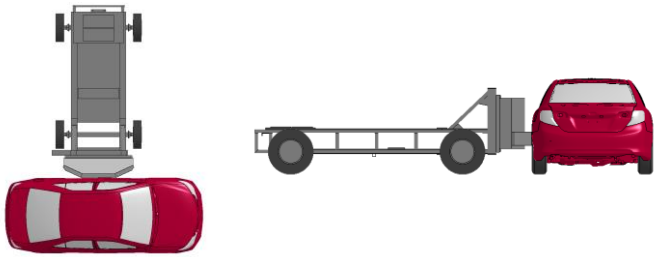
Height Explorer + 400 mm

measured distance between b-pillar and seat centerline:	
Baseline	11 cm
+ 100 mm	7.2 cm
+ 200 mm	7.1 cm

3. Increased height - MDB

50 km/h





measured distance between b-pillar and seat centerline:	
Baseline	13.2 cm
+ 100 mm	11.8 cm

Undeformed

Baseline

Height MDB
+ 100 mm

IIHS side impact evaluation - Outline

1. IIHS side impact crash test

2. FE-simulations

3. Influences

   Increased velocity
   Increased weight
   Increased height
   Different impact location

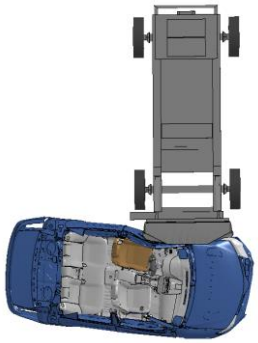
4. Summary

3. Different impact location

b-pillar:

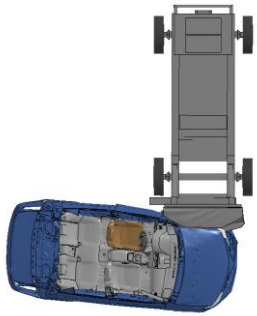
158.6 cm rearward to front axle

between a- and b-pillar:
94.6 cm rearward to front axle



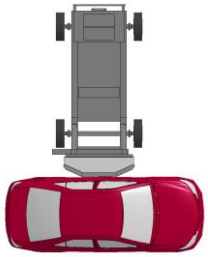
a-pillar:

30.6 cm rearward to front axle

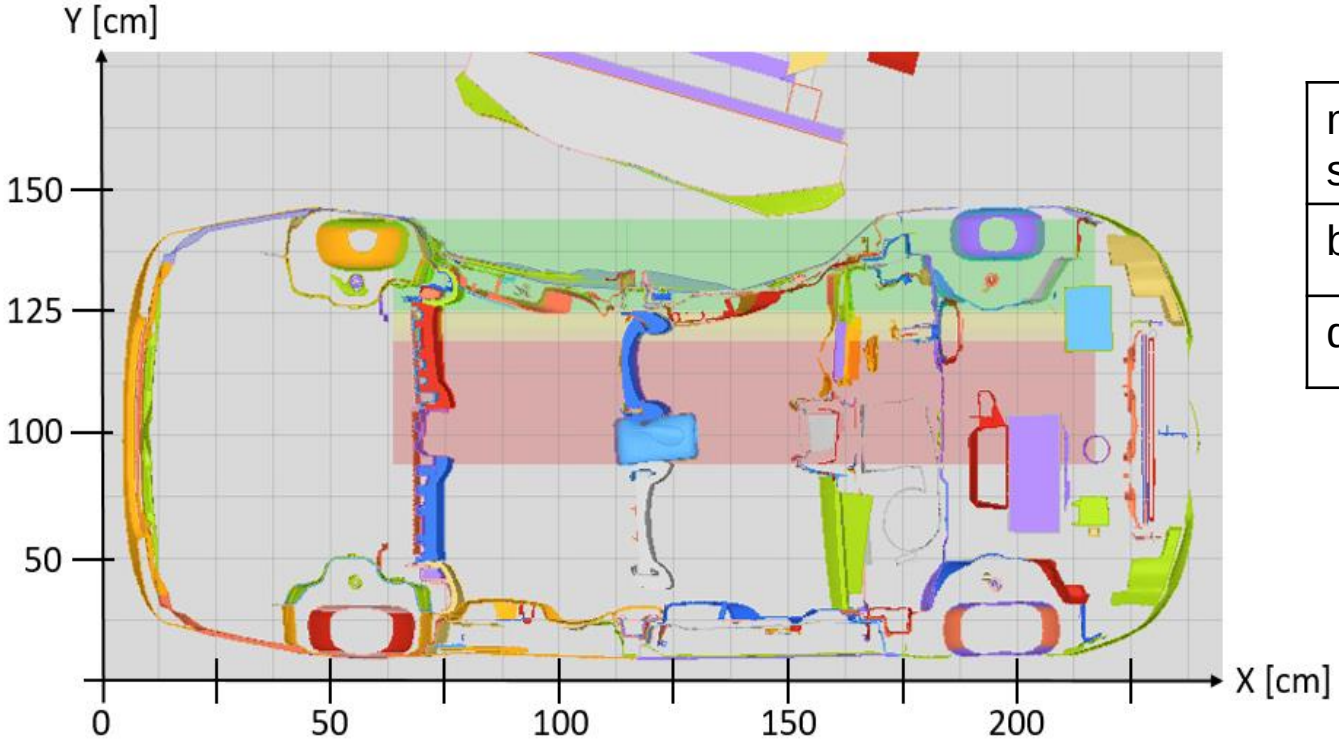


forward to a-pillar:
24 cm forward to front axle

3. Different impact location



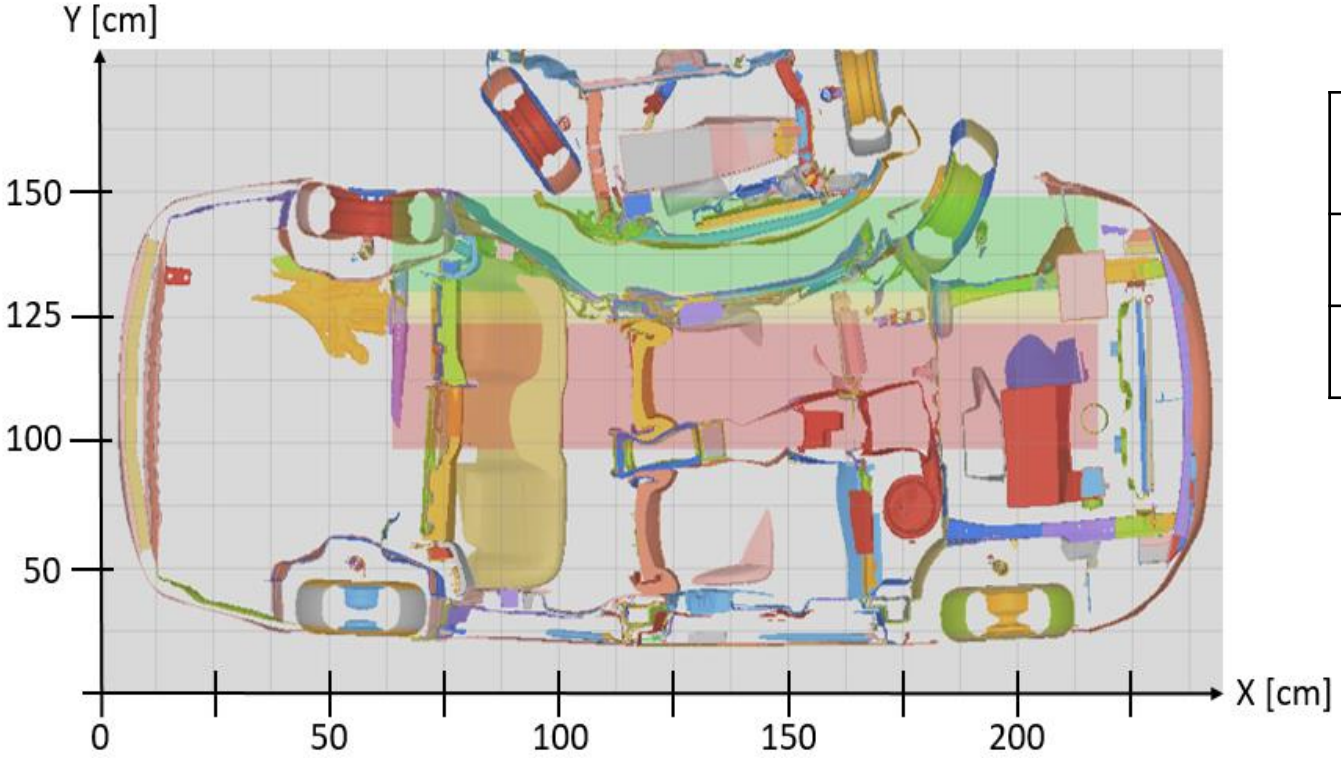
- MDB (50 km/h)-to-Camry (0 km/h)
- impact location: b-pillar (158.6 cm rearward front-axle)
- cross-section: 60 cm above ground level



measured distance to seat centerline from:	
b-pillar	13.25 cm
door outer	21 cm

3. Different impact location

- Yaris (80 km/h)-to-Camry (32 km/h)
- Impact location: between a- and b-pillar (94.6 cm rearward front-axle)
- cross-section: 60 cm above ground level



measured distance to seat centerline from:	
b-pillar	1.5 cm
door outer	10 cm

3. Different impact location: measured 60 cm above ground level

Impact location		b-pillar (158.6 cm rearward front-axle)	between a- and b-pillar (94.6 cm rearward front-axle)	a-pillar (30.6 cm rearward front-axle)	24 cm forward front-axle
	minimum distance between b-pillar or outer door to seat-centerline: 60 cm above ground level (mid-door-height)				
MDB (50 km/h) - to - Camry (0 km/h)					
	b-pillar	13.25 cm	21.5 cm	35.5 cm	35.7 cm
	door outer	21 cm	25.5 cm	31.5 cm	36 cm
Silverado (50 km/h) - to - Camry (0 km/h)					
	b-pillar	7.5 cm	13.0 cm	35.0 cm	35.5cm
	door outer	11.5 cm	17.5 cm	26.0 cm	35.0 cm
Yaris (80 km/h) - to - Camry (32 km/h)					
	b-pillar	14.5 cm	1.5 cm	25.5 cm	34.5 cm
	door outer	20.0 cm	10.0 cm	13.0 cm	31.5 cm

- pelvis–height of occupant (60 cm off the ground level) at a higher risk for injuries

IIHS side impact evaluation - Outline

1. IIHS side impact crash test

2. FE-simulations

3. Influences

    Increased velocity
    Increased weight
    Increased height
    Different impact location

4. Summary

4. Summary: Influences on IIHS side impact crash test

- Influences:
- Severity: Explorer, Silverado, Chevy show more severe test results for 50 km/h compared to MDB
- Weight: Increasing weight is directly related to an increasing intrusion of the b-pillar;

  MDB lighter than all other examined vehicles
- Height: Increasing height of MDB has minor influence
- Impact location: greatest intrusion between the a- and b-pillar

- Modifications: weight and severity

- Future research: Including injury measurements of the dummies

Thank you very much for your attention

Sonja Arnold-Keifer

Rudolf Reichert, Steve Kan
(George Mason University, USA)
Prof. Dr.-Ing. Stefan Weihe, Florian Panzer
(IMWF, University of Stuttgart)

References

[IIHS2015_1]: Insurance Institute for Highway Safety: General statistics; Fatality facts. http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/passenger-vehicles/2015#Crash-types, access date 6/25/2017

[IIHS2016]: Insurance Institute for Highway Safety: Side Impact Crashworthiness Evaluation; Crash Test Protocol (Version IX) (2016)

[IIHS2015_2]: 2015 Toyota Camry – IIHS test result. http://www.iihs.org/iihs/ratings/vehicle/v/toyota/camry-4-door-sedan/2015