Research to Support a Far-side NCAP Test

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George Washington University

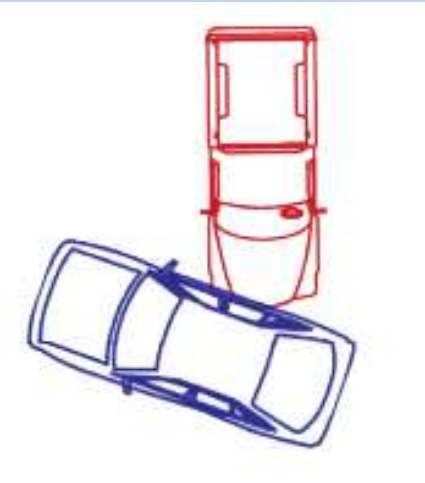
NHTSA Meeting June 9, 2015

Outline

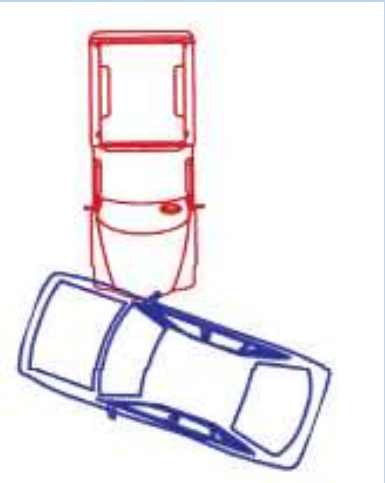
- Far-side Crash Tests Conducted by GWU
- Application of the Far-side International Collaborative Research a Far-side NCAP and Safety Standard – Dummy Suitability
- Injury Criteria for Far-side Evaluations
- Conclusions

Far-side Tests Conducted at FOIL by GWU

Two Far-side Tests at FOIL – 1996 Explorer into Ford Taurus -62 kph (38.5mph)

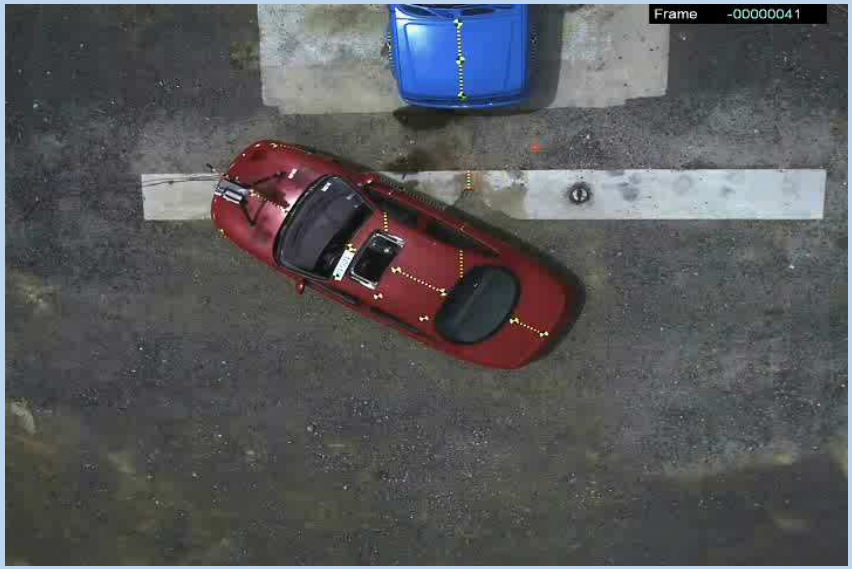


Test 10010 60^{o} B-pillar Impact



Test 10016 60^{o} A-pillar Impact

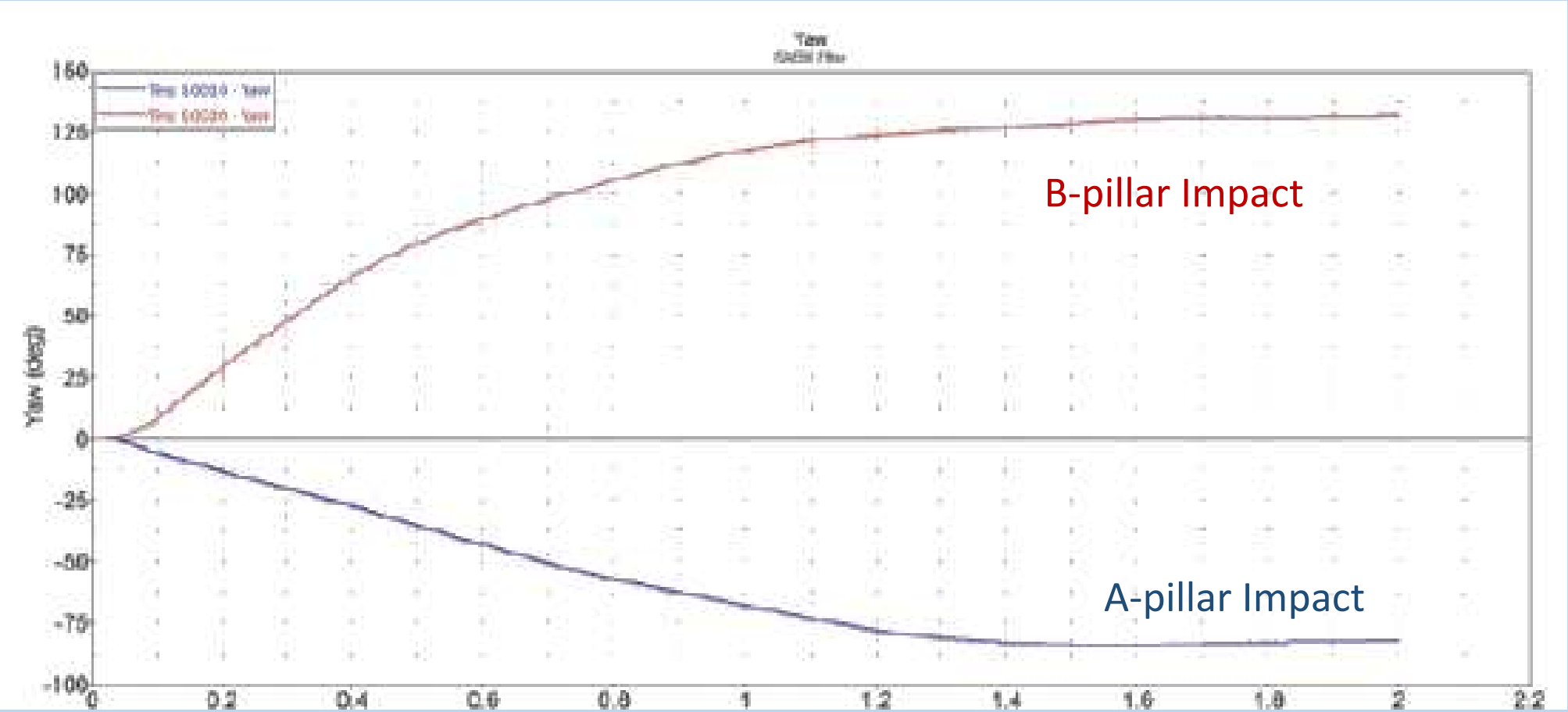
Far-side Tests at FOIL – 1996 Explorer into Ford Taurus -62 kph (38.5 mph) - Videos



Test 10010 60° B-pillar Impact, 1997 Taurus

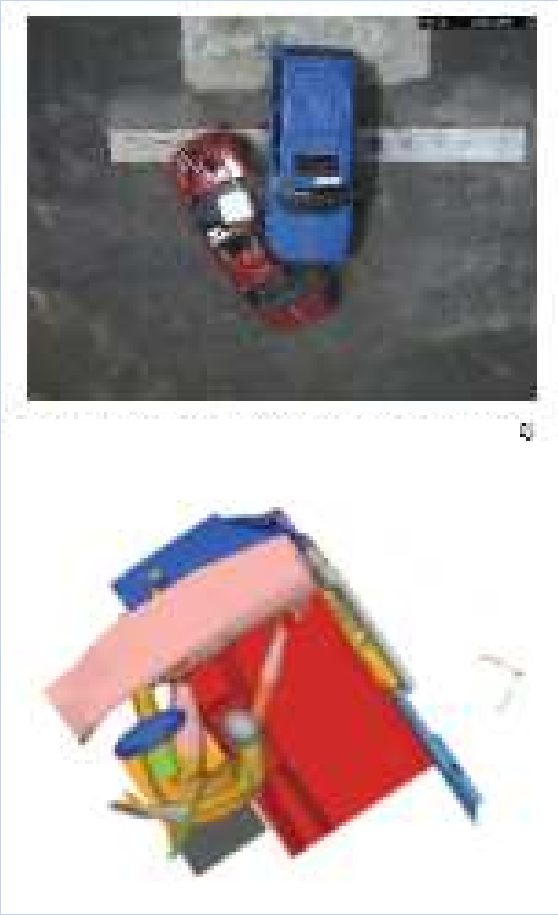
Test 10016 60° A-pillar Impact, 2002 Taurus

Vehicle Rotation – Yaw vs Time



B-pillar Far-side Test at FOIL – 1996 Explorer into 1997 Taurus -62 kph (38.5 mph)

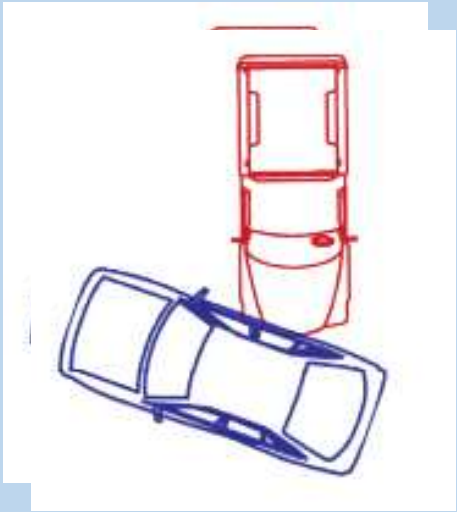
Test 10010 60º B-pillar Impact Test



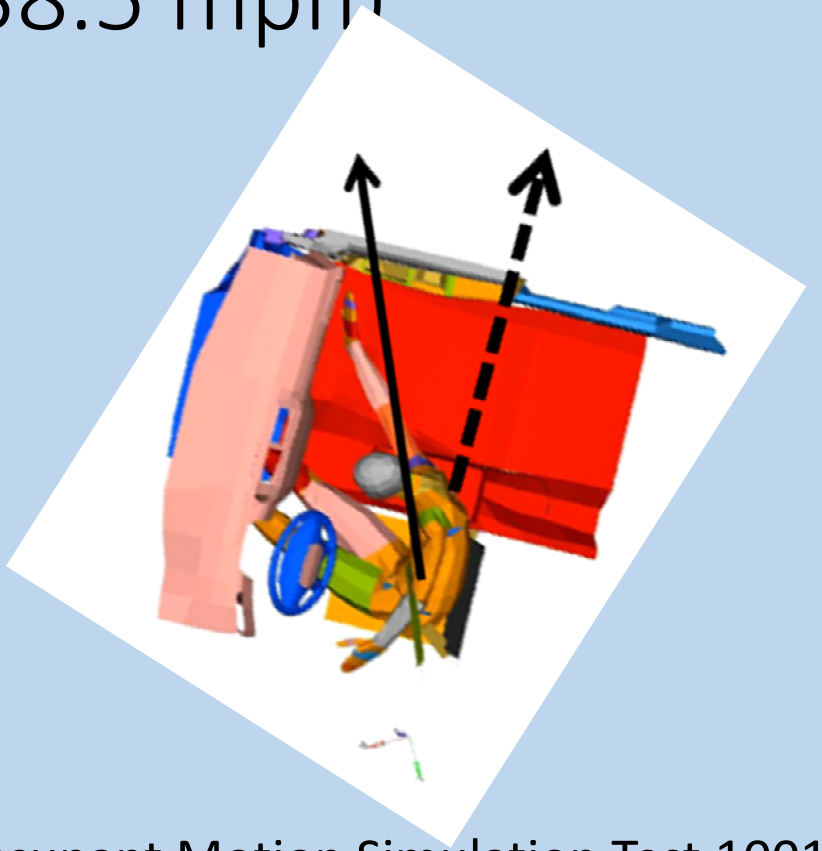
Test 10010
60º B-pillar Impact Test
200 ms.

Occupant Modeling by Sean Haight

B-pillar Far-side Test at FOIL – 1996 Explorer into 1997 Taurus -62 kph (38.5 mph)

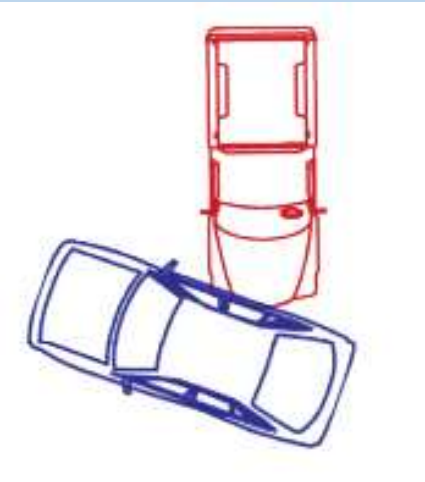


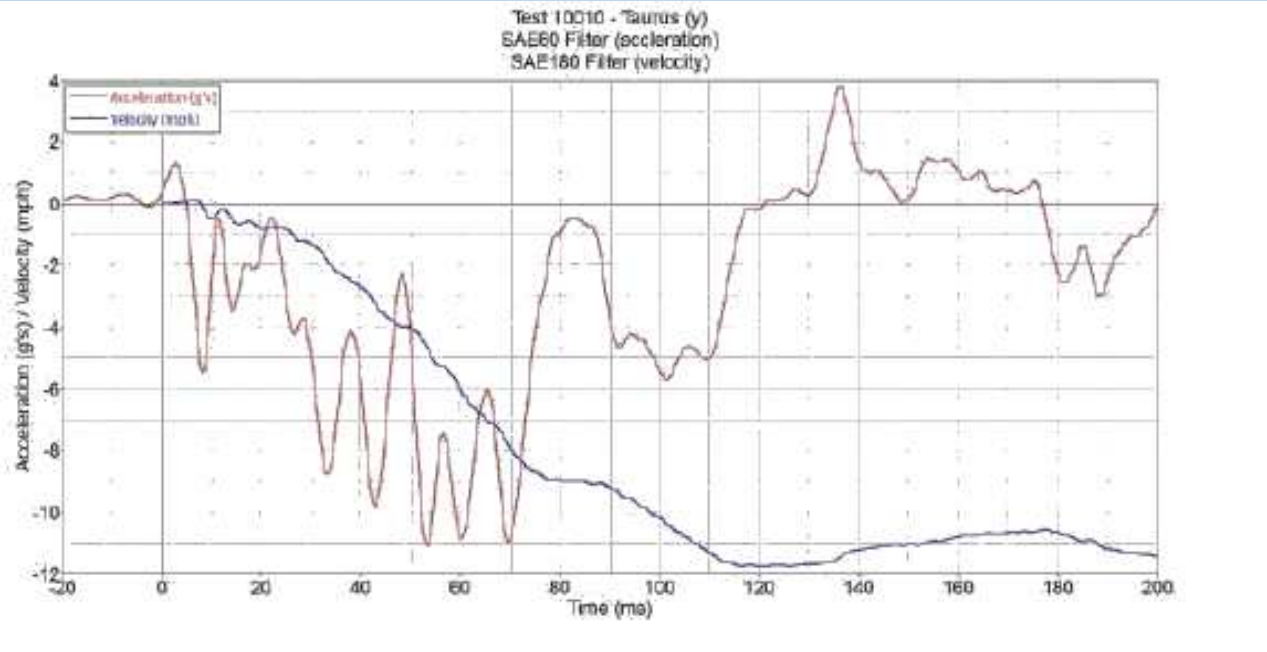
Test 10010 60^{o} B-pillar Impact



Occupant Motion Simulation Test 10010
19 kph

B-pillar Far-side Test at FOIL – 1996 Explorer into 1987 Taurus -62 kph (38.5mph)

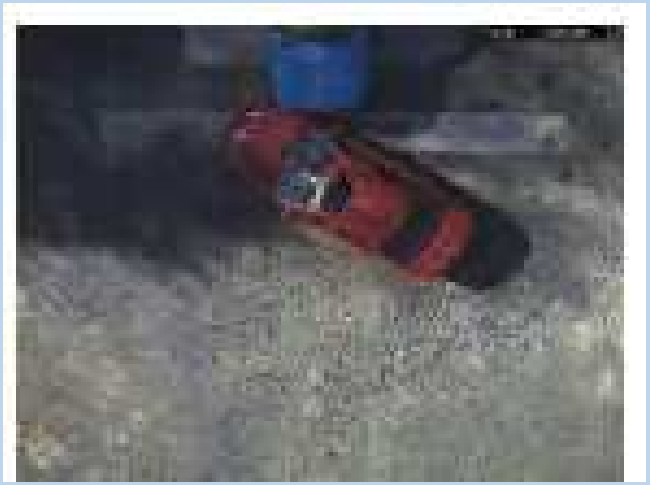




Test 10010 60^{o} B-pillar Impact

Max G = 11 @ 52 ms; Crash pulse 115 ms
DeltaV 19 kph

A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5mph)

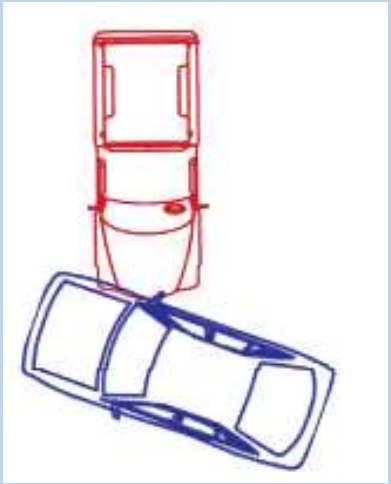


Test 10016 60° A-pillar Impact

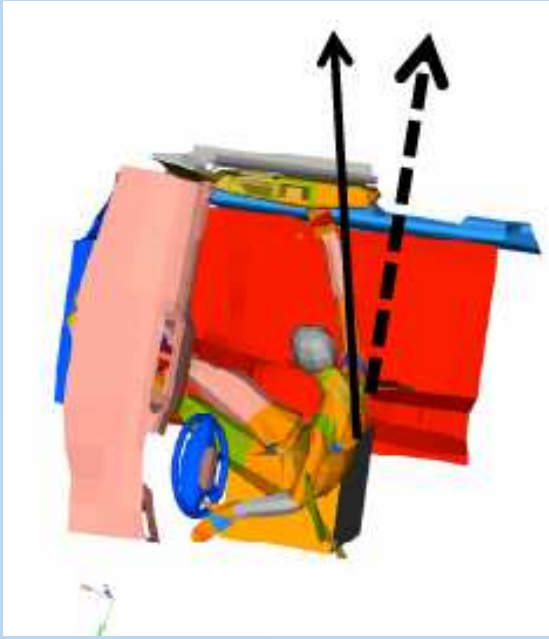
Occupant Modeling by Sean Haight

Test 10016
60° A-pillar Impact
200 ms

A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5 mph)

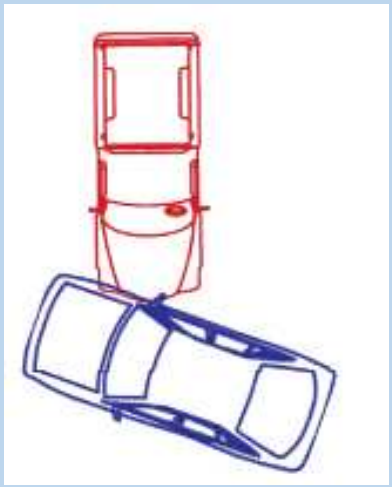


Test 10016 60^{o} A-pillar Impact

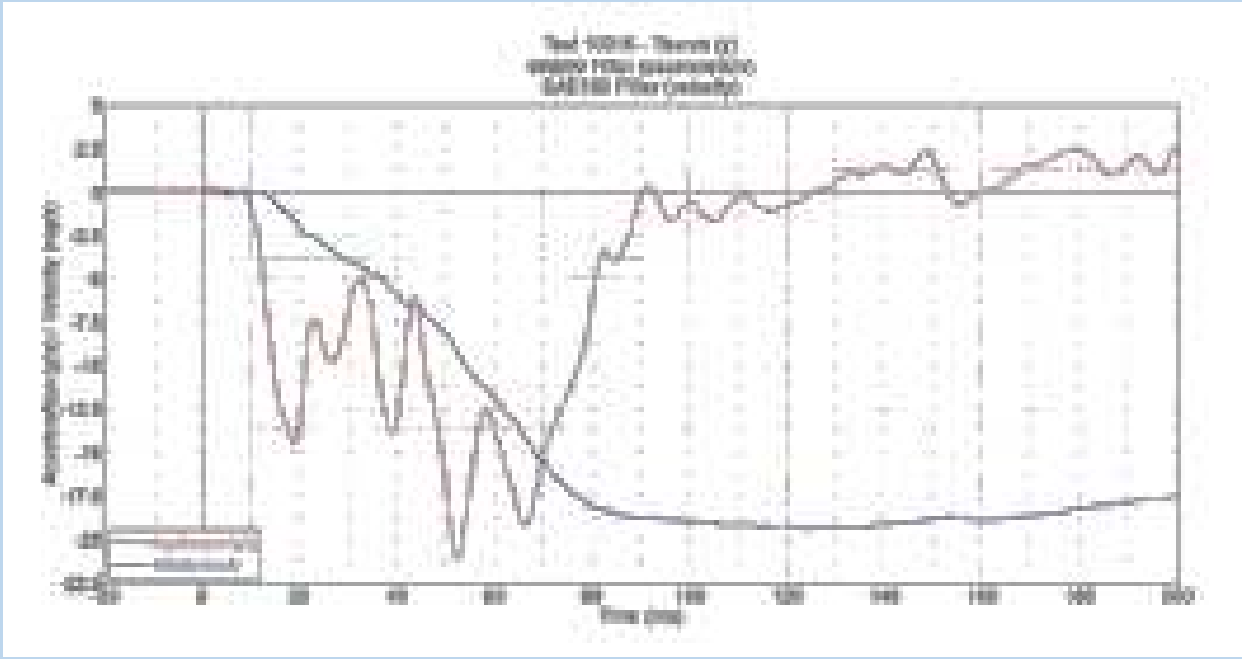


Occupant Motion Simulation Test 10016

A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5mph)

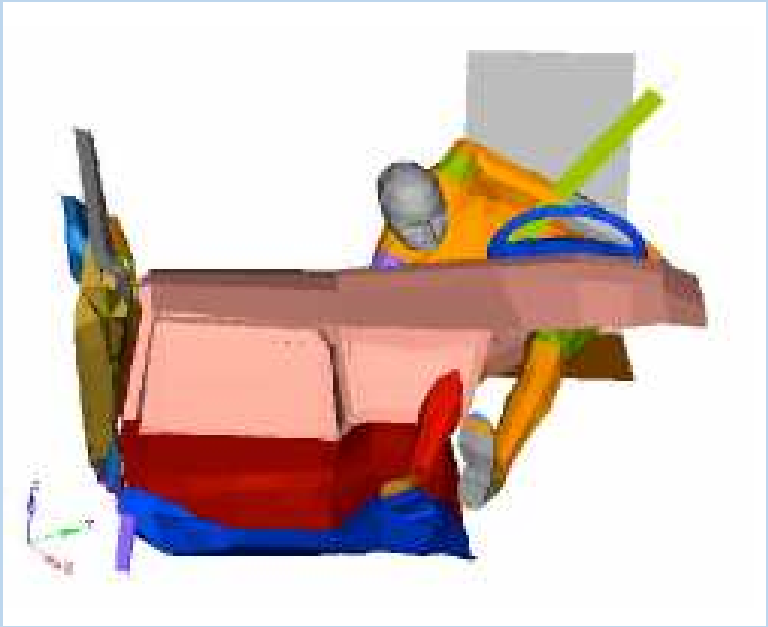


Test 10016 60^{o} A-pillar Impact

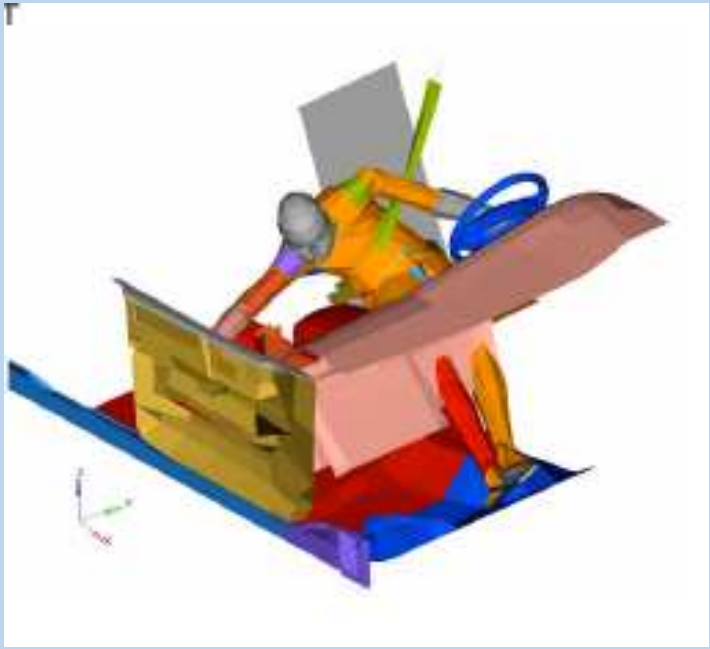


Max G = 21 @ 52 ms; Crash pulse 80 ms
DeltaV 30 kph

Occupant Simulations Showing Upper Body Excursion and Unfavorable Belt Loading



Simulation - Test 10010 60° B-pillar Impact 200 ms



Simulation Test 10016 60° A-pillar Impact 200 ms

Observations

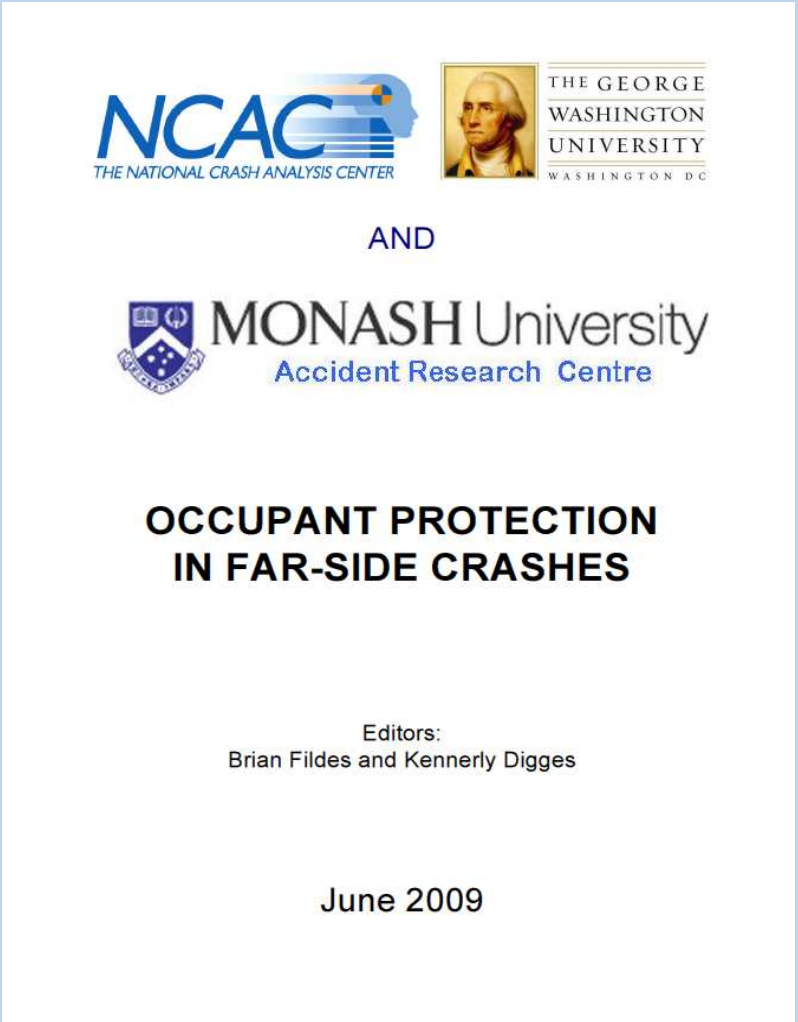
- Restraint loading unfavorable when shoulder belt releases upper body
- Large upper body excursion possible before contact with far-side
- Chest/back contact with seatback and console can occur with lower excursion
- Vehicle crash pulse and rotation vary with crash impact location
- Delta-V and crash severity vary with crash impact location
- Occupant kinematics and belt loading vary with impact location
- Sled tests may be suitable to evaluate far-side safety – variations in crash direction desirable to evaluate restraint systems

Far-side International Collaborative Research Project - Participants

- *Monash University*- B. Fildes (co-chair), C. Douglas, M. Fitzharris, A. Linder and T. Gibson
- *George Washington University* – K. Digges (co-chair), B. Alonso, P. Mohan, R. Morgan, and C. Escemendia
- *Medical College of Wisconsin* - F. Pintar, N. Yoganandan, K. Brazel, G. Stinson, M. Steinman and T. Generelli;
- *Va. Tech/Wake Forest* - S. Duma, C. Gabler, S. Gayzik, and J. Stitzel;
- *University of Miami School of Medicine* - J. Augenstein;
- *Wayne State University* – K. Yang;
- *Autoliv*; O. Bostrom, O. Ortenwall;
- *GM Holden* - L. Sparke and S. Smith; *General Motors* – R. Lange;
- *Ford* – S. Rouhana;
- *MoT, Australia* - C. Newland.

Final Report on Collaborative Far-side Research Project

- Results include:
  - THOR or WorldSID adequately mimic cadaver response in far-side crashes of 10 and 30 KPH
  - Chest/abdominal injury criteria is available for WorldSID
  - Suitable computer models and sled test conditions are available



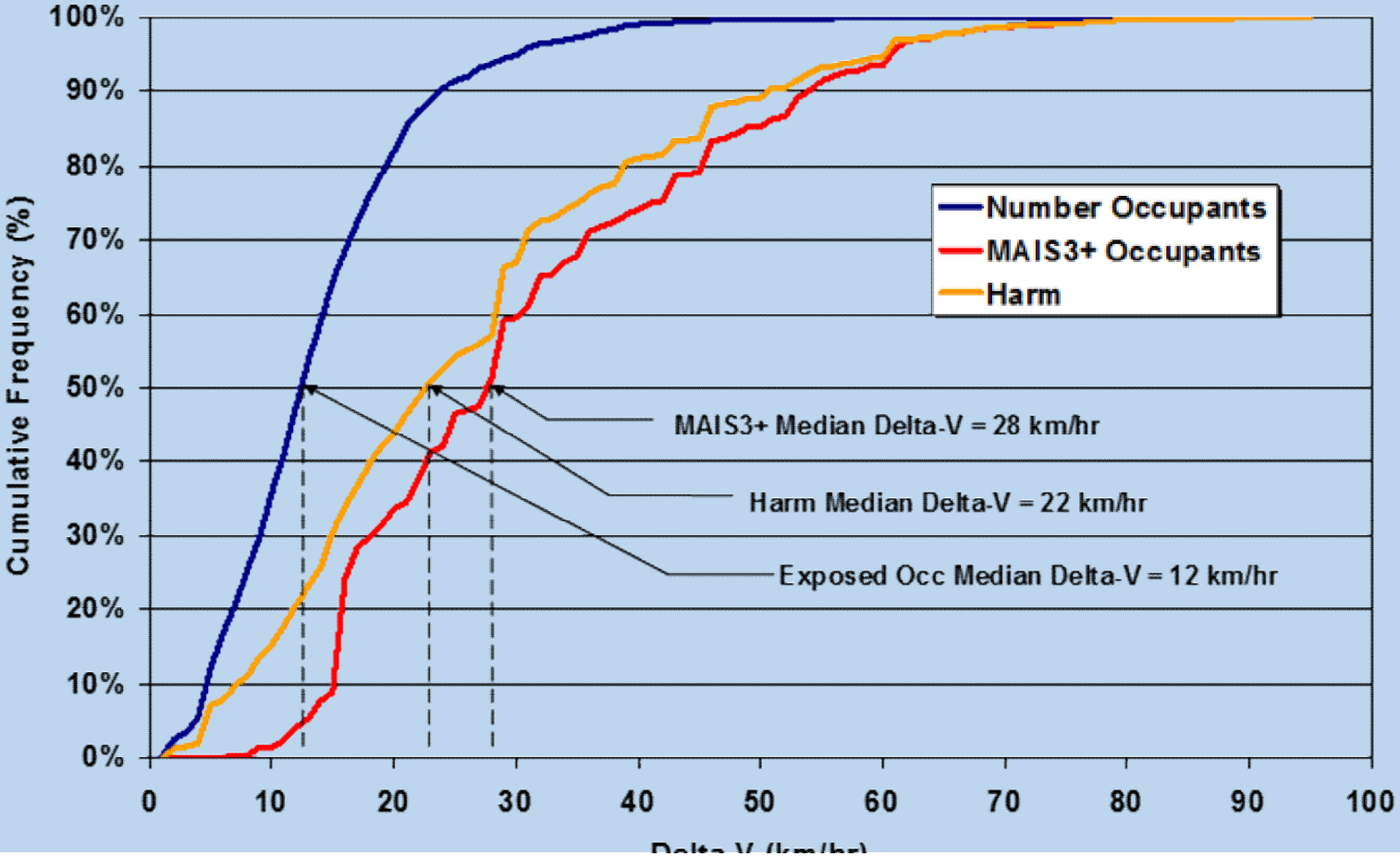
Results of Cadaver and Dummy Far-side Tests

Either WorldSID or THOR dummy would be suitable for Far-side safety evaluation

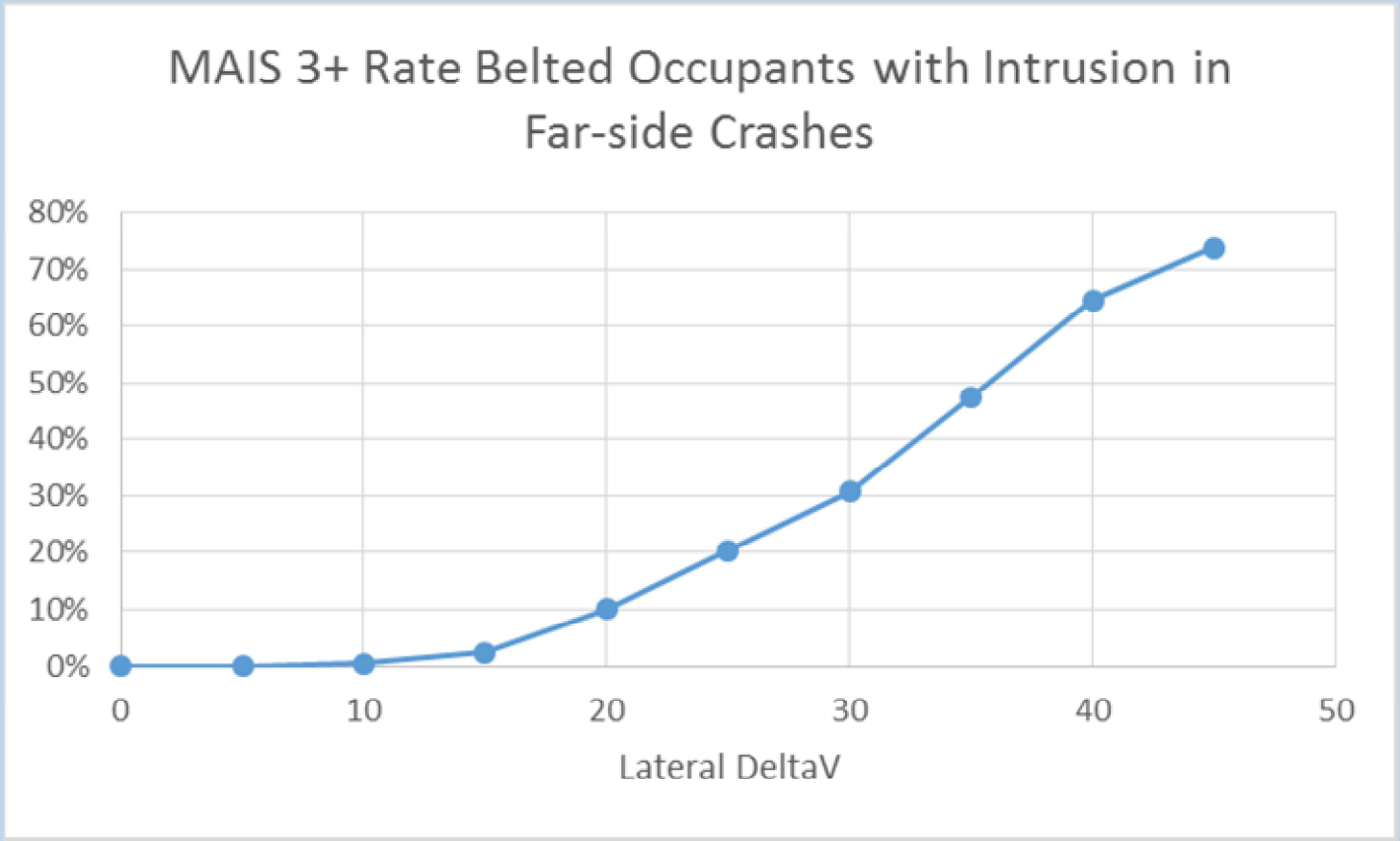
What Injury Criteria to Use for a Far-side Test?

- Head Excursion - to be discussed here
- Chest deflection/V*C on WorldSID
- Abdominal deflection on WorldSID
- Neck Tension on WorldSID
- Carotid Artery Extension (Using FEM Model) See 2009 Final Report

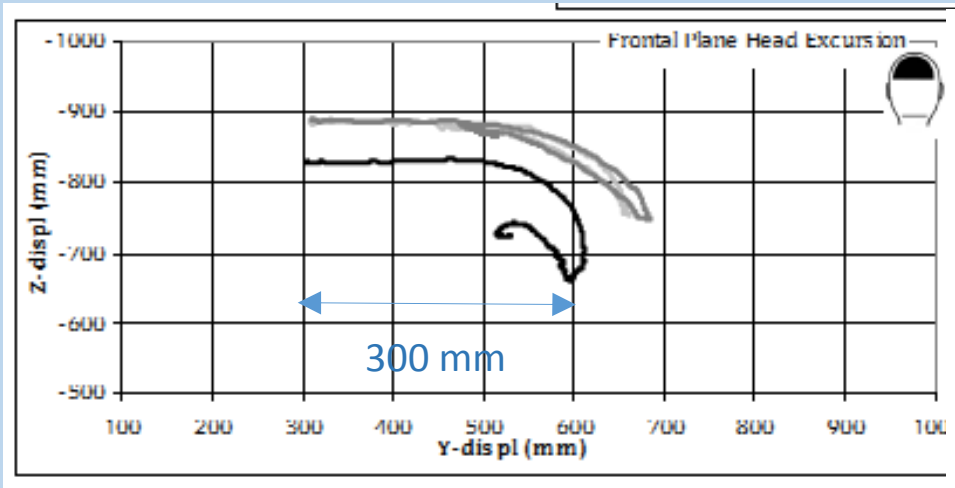
Cumulative Exposure, 3+ Injuries and Harm vs. Lateral Delta V (Gabler SAE 2005)



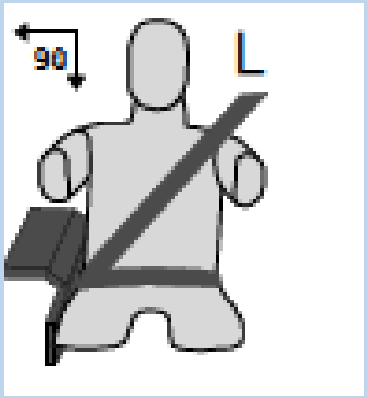
Example of Injury Rate from NASS Data

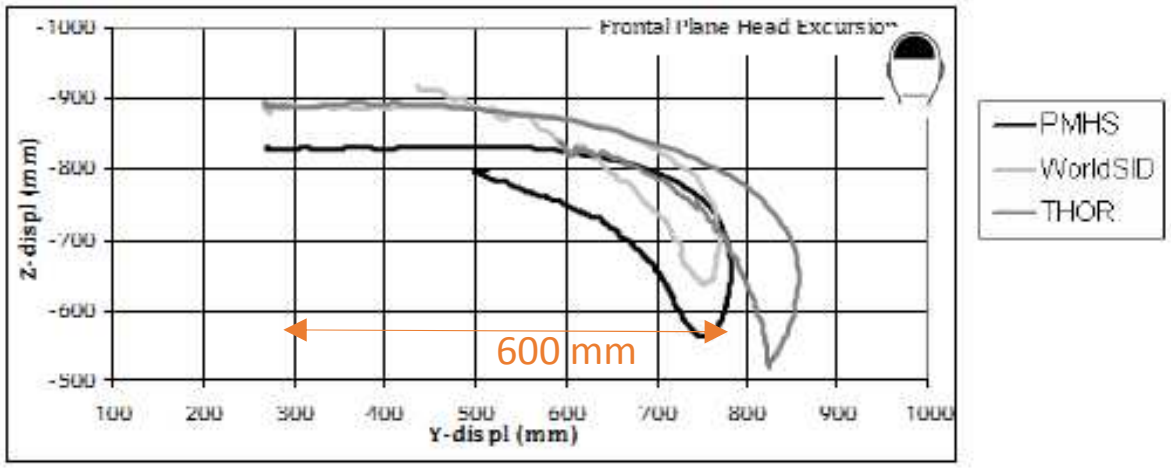


Far-side Tests of Dummies and Cadavers – Lateral Head Excursion in 3-point Belts



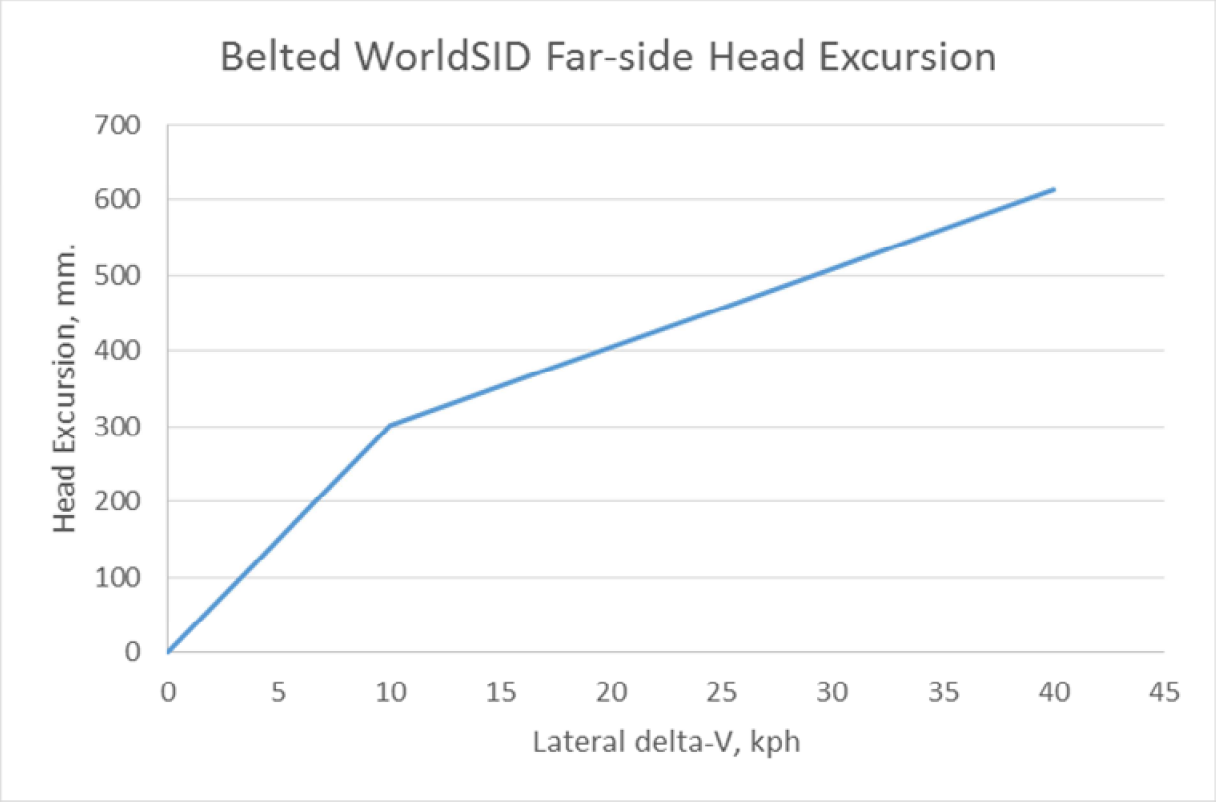
10 kph Lateral DeltaV



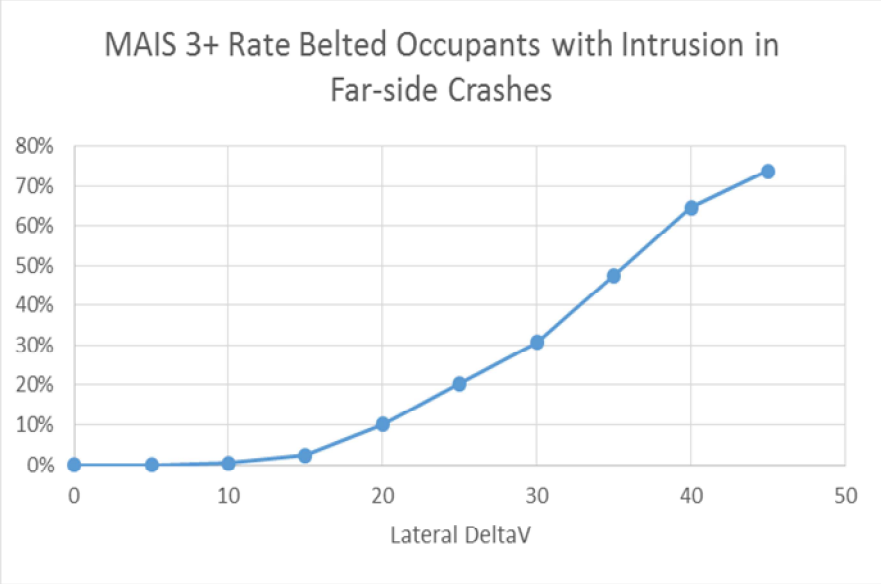


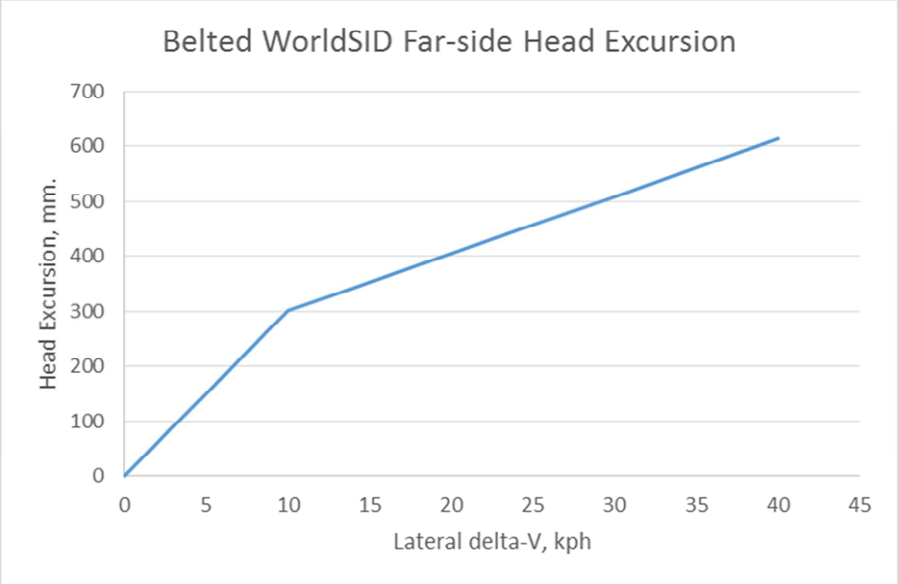
30 kph Lateral DeltaV

Example of Head Excursion vs Delta V based on Test Data

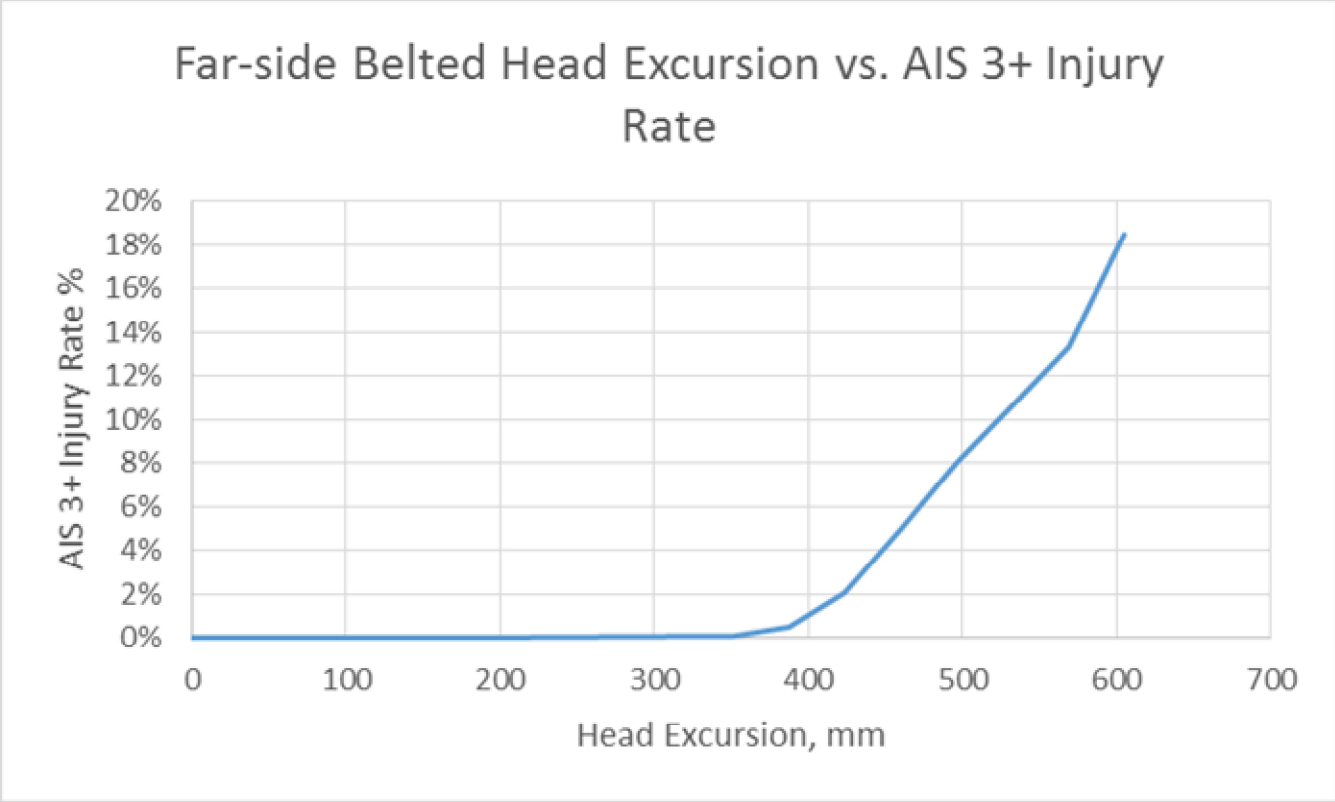


Injury Rate and Head Excursion vs Delta V

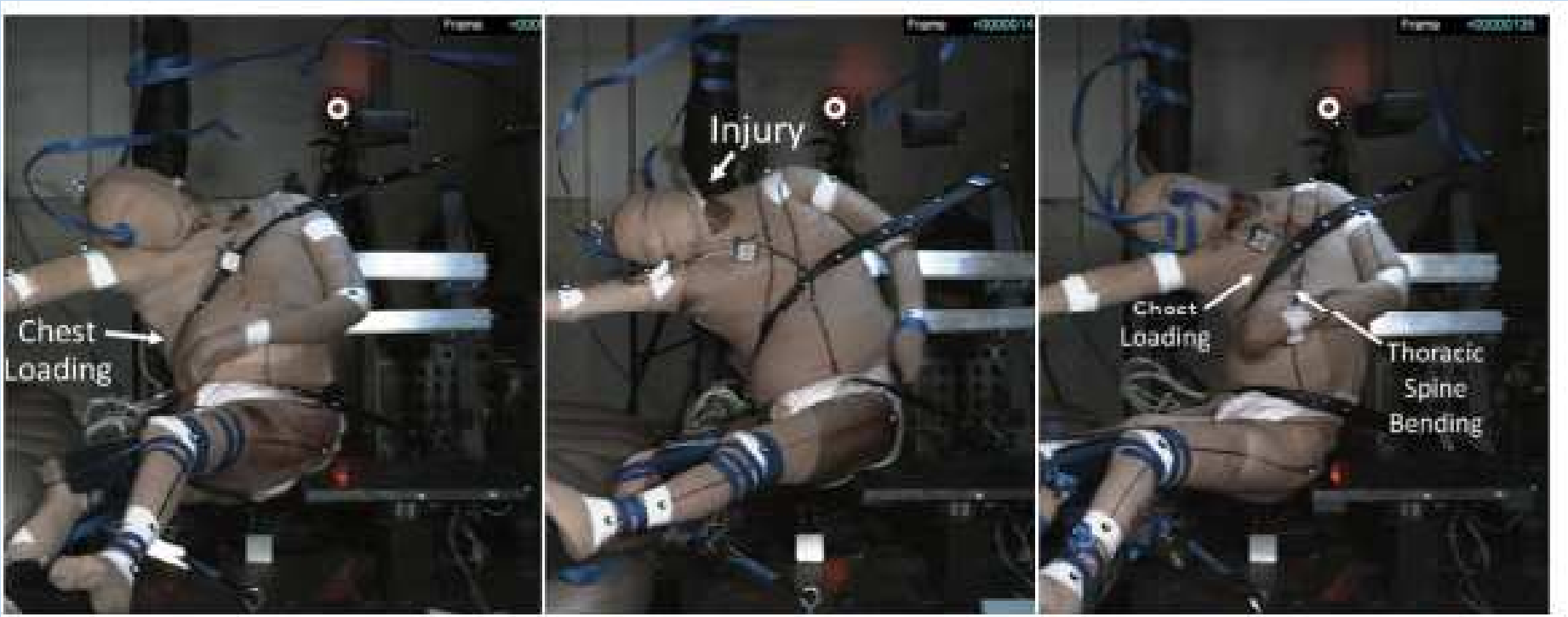




Head Excursion Rating System (example)



Far-side Tests by Kent (ESV 2013)

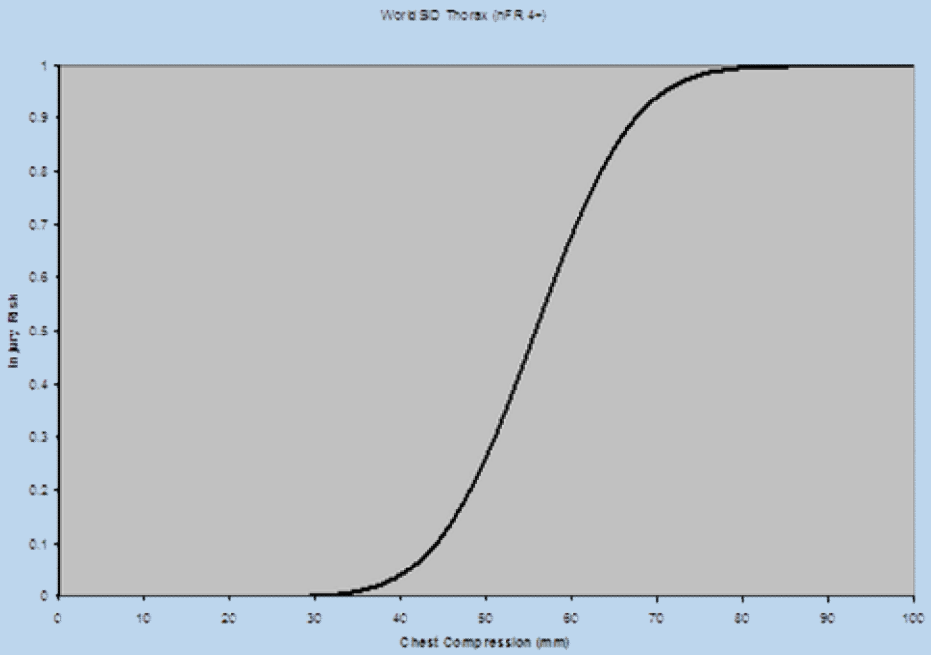


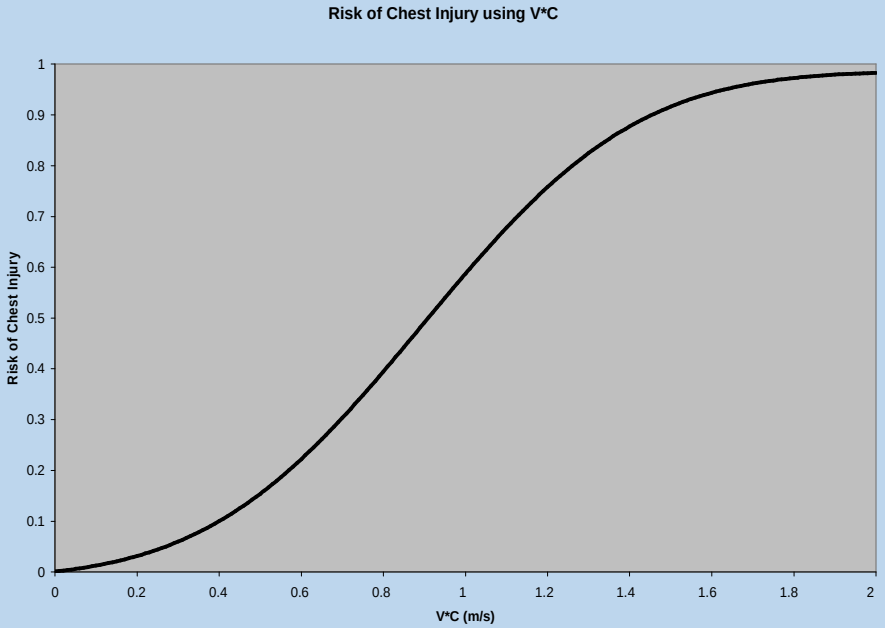
Subject 557 (26 rib fx) Subject 551 (3 rib fx, c-spine) Subject 559 (24 rib fx, t-spine)

Reduced Head Excursion may increase Chest, C-spine and T-spine Injuries

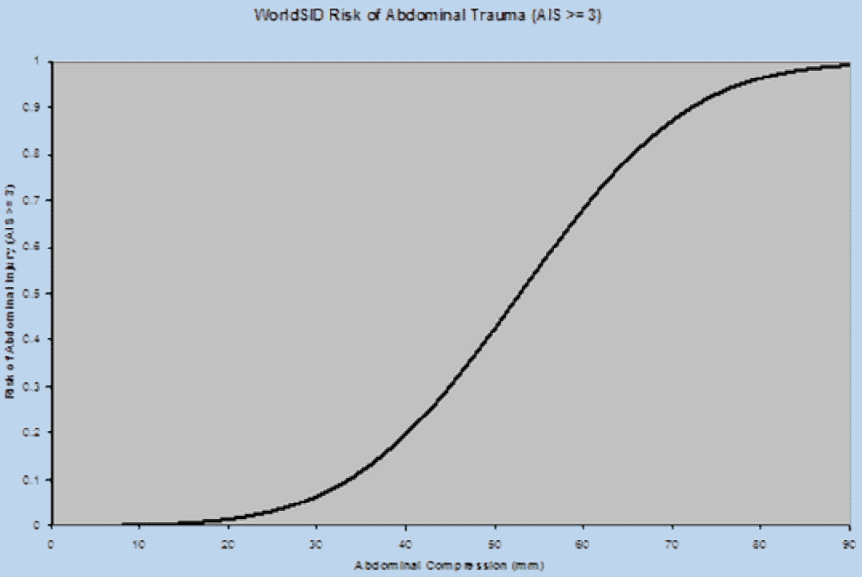
Need to control Chest/Abdominal Loads

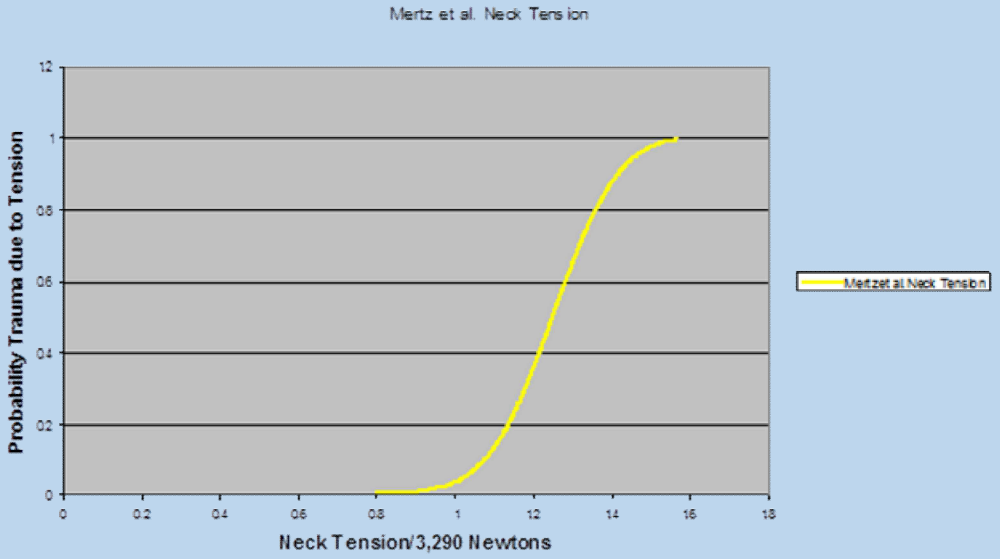
Chest Injury Criteria for WorldSID – Deflection and V*C





Abdominal Deflection and Neck Tension Injury Criteria for WorldSID





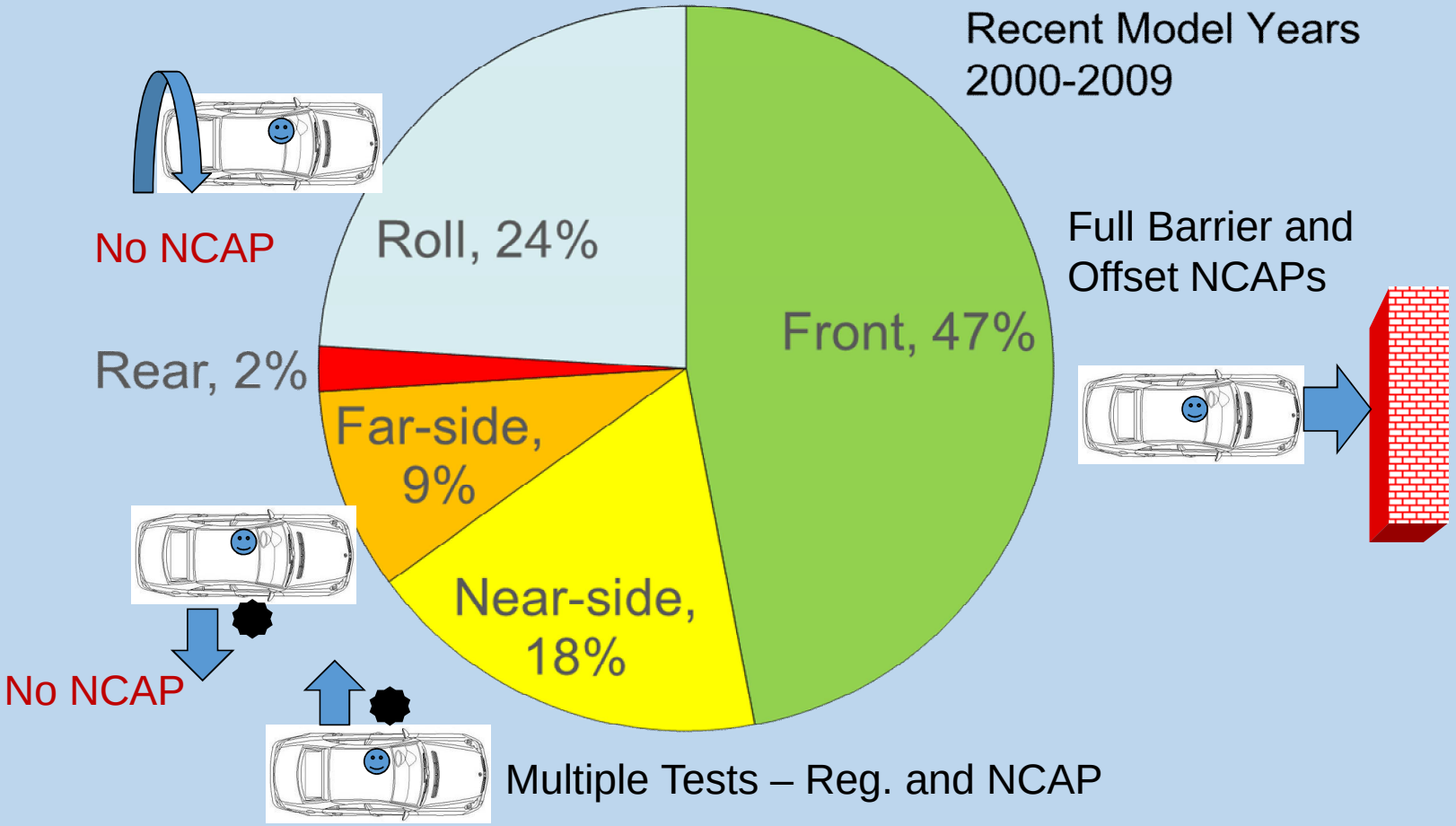
Issue: What to do next to improve safety?

One of TR's Mottos:

"Do what you can,
with what you've got,
where you are"

Theodore Roosevelt

NCAP for Far-side and Rollover



Conclusions

- Far-side safety countermeasures present an untapped area for injury reduction
- The growing aging population are more likely to be cause increased exposure due to their vulnerability in making left hand turns
- Dummies (THOR and WorldSID) and criteria (WorldSID criteria + head excursion) are available to permit far-side NCAP testing
- Use of head excursion criteria would permit sled-test compliance since head impact is not a compliance criteria
- Testing for several far-side impact scenarios would be possible at low cost