An Update on NHTSA's Small Overlap/Oblique Research Program

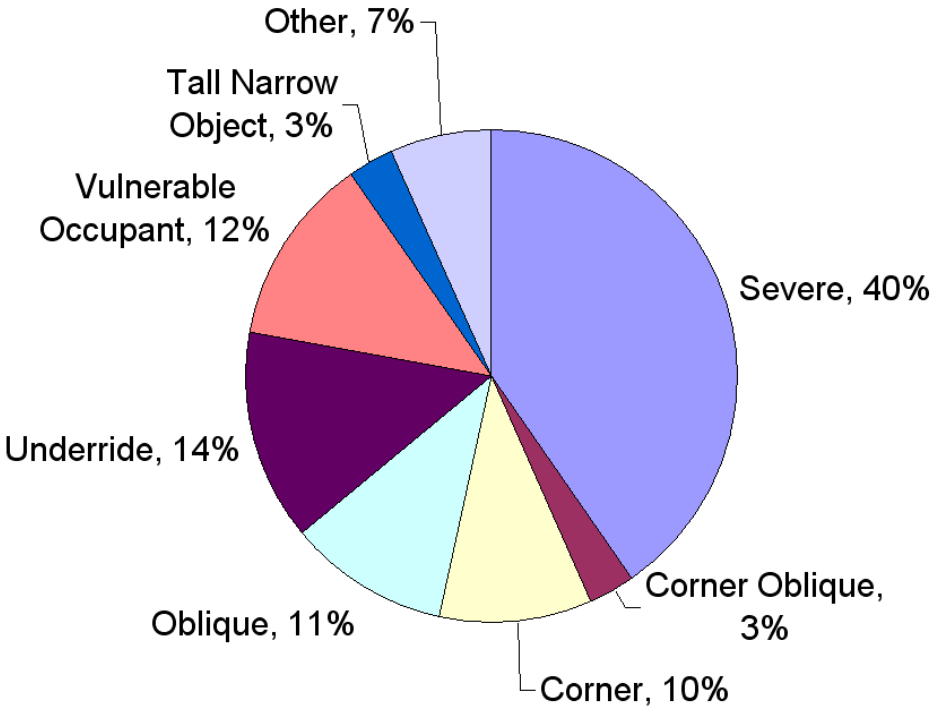
James Saunders, NHTSA

Presentation Order

- Background
- Vehicle selection
- Constant-energy RMDB-to-vehicle test results
  - Small Overlap Impact (SOI)
  - Oblique
  - Compare SOI to Oblique

Background

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



Vehicle Selection

- Vehicles introduced or redesigned in 2010-2011
- Good structural rating from IIHS
- Different classes of vehicles ranging from the lightest to the heaviest
- Compare heavy vehicle with body-on-frame and uni-body design
- 8 SOI and 7 Oblique

Constant-energy test procedure

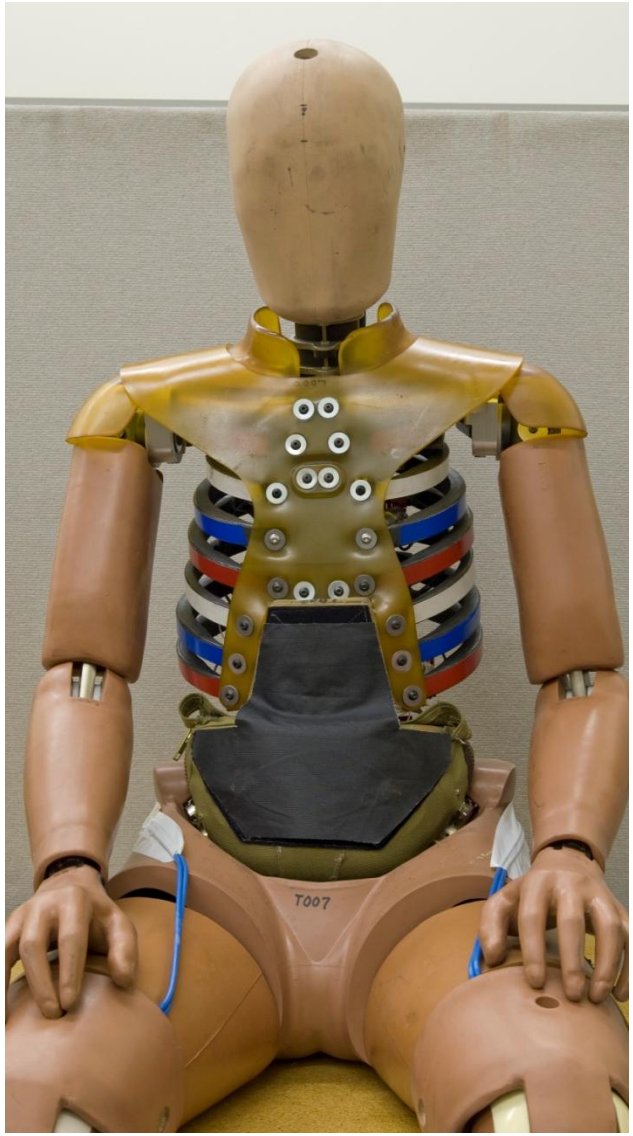
- Moving deformable barrier impacts each vehicle at the same velocity
  - Compare results across the fleet
  - Procedure is more severe for smaller cars
  - Potential to drive convergence of vehicle front-end stiffness

SOI: Test Setup

	Small Overlap (SOI)	Rationale
Barrier Closing Speed	56 mph	Achieve 35mph Delta-V in average-mass passenger car
Overlap	20%	Engage structure outboard of longitudinal rail for most vehicles
Angle Relative to Track	7 degrees	0 degrees bounced off 15 degrees deformed rail inboard

Occupant Response Assessment: THOR ATD

- THOR-NT with Mod Kit
  - Improvements to biofidelity, repeatability, durability, usability
- Designed to demonstrate improved biofidelic kinematics vs. Hybrid III
  - Flexible joints in thoracic, lumbar spine
  - Improved restraint interaction
- Increased measurement capability vs. Hybrid III
  - Thorax: 4-point, 3-dimensional chest deflection
  - Abdomen: 2-point, 3-dimensional lower abdomen deflection
  - Knee-thigh-hip: Acetabulum load cells
  - Lower Extremity: Upper, lower tibia loads; ankle rotations
- Provisional Injury Assessment Reference Values (IARVs)



SOI: Compact Vehicle Top View

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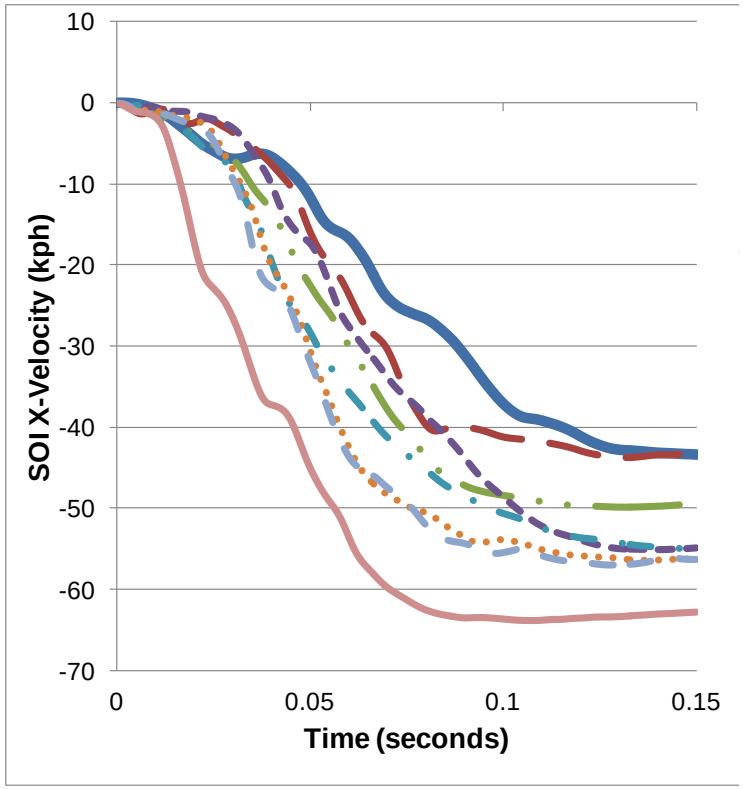
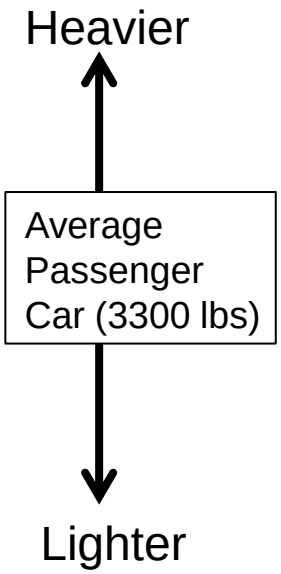
SOI: Compact Dummy Kinematics

SOI: Change in Velocity

- Fixed-mass, fixed-velocity RMDB-to-vehicle impact results in responses sensitive to vehicle mass
  - Lighter vehicles
  - Earlier velocity onset
  - Larger total Delta-V



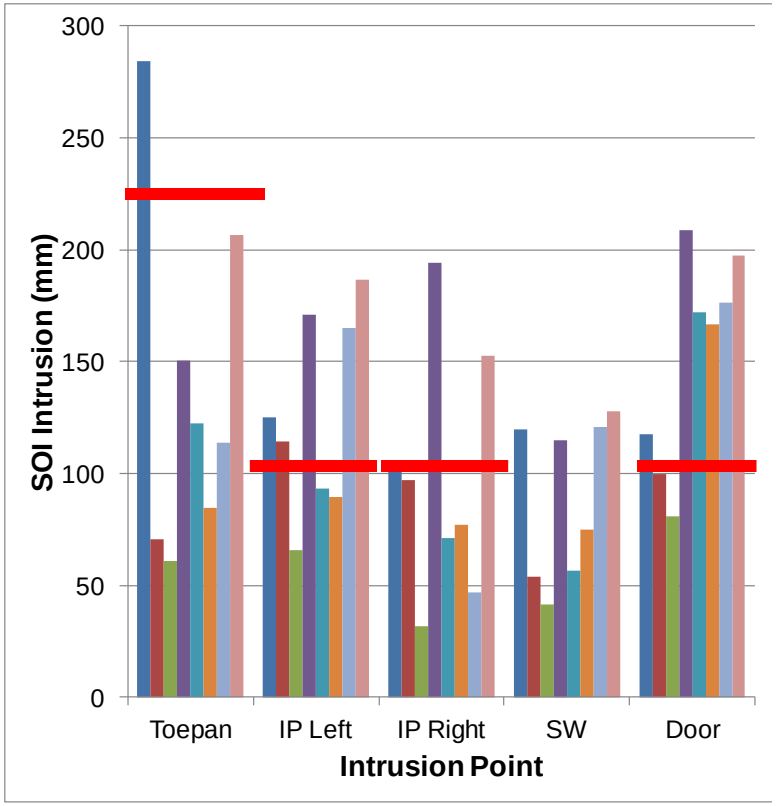


SOI: Intrusion

IIHS Structural Rating In ODB Procedure

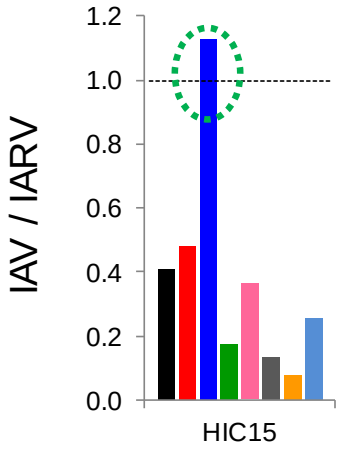
Marginal or Poor

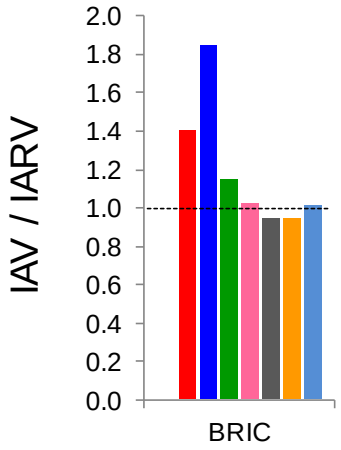
Acceptable or Good

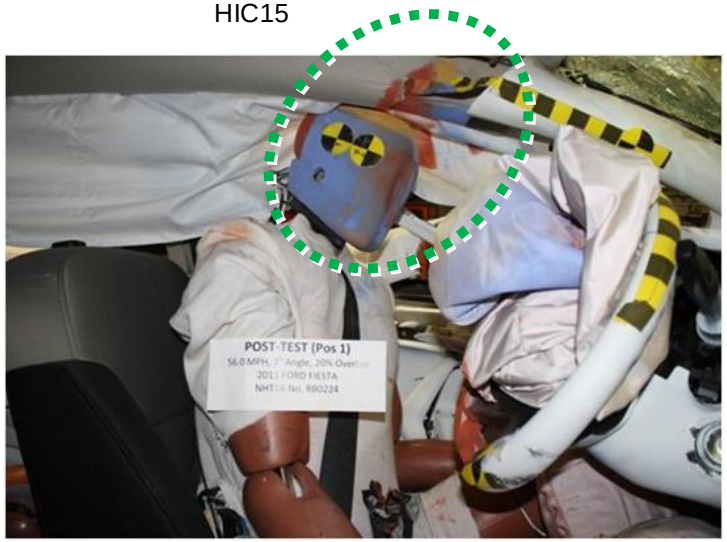


- No apparent trend in intrusion vs. vehicle mass
- Toepan
  - Highest intrusion in heaviest vehicle
- Door
  - In most cases, door frame intrusion → door panel outward deformation

SOI: Head Response







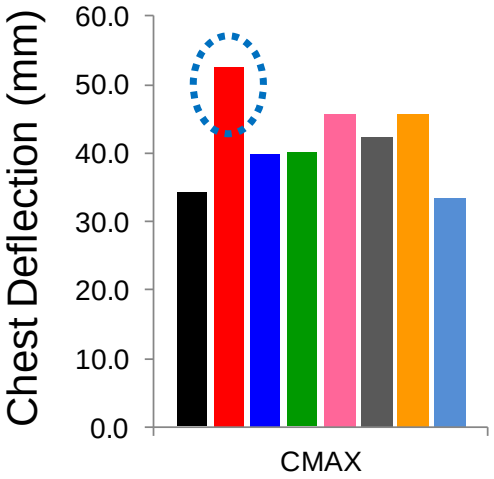
Test: Head Contact Locations

Vehicle	Airbag	Side Curtain	Roof Rail	Door Panel	IP
1	X				
2	X		X	X	X
3	X	X	**X**		
4	X	X			
5	X				
6	X	X			
7	X	X			
8	X				
Field Injury Source (Rudd, 2011)	4%		28%		12%

SOI: Chest Deflections

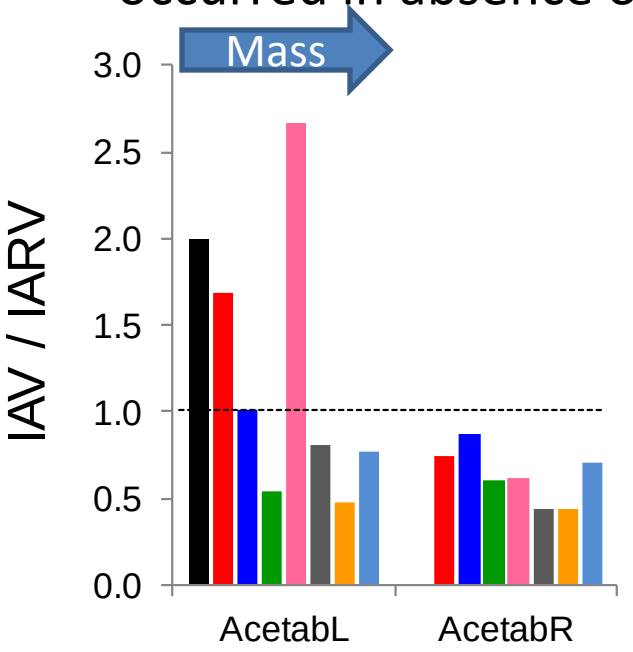
- NASS/CIREN SOI: Chest injury sources
  - Belt: 38%
  - Door: 32%
  - Steering wheel: 16%

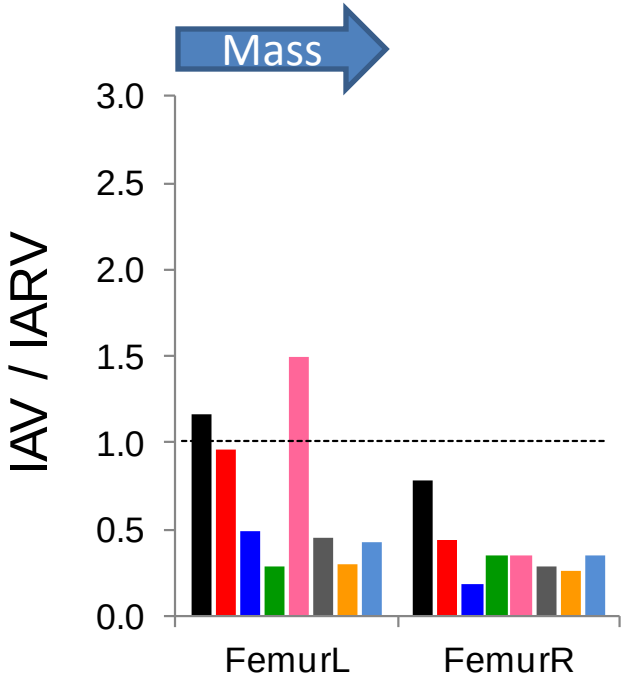
- SOI Tests: Chest deflection sources
  - Primarily belt interaction
  - No evidence of door contact
  - Door often deformed outward
  - Evidence of steering wheel interaction in smaller vehicles



SOI: Knee-Thigh-Hip

- 4 test exceeded acetabulum IARV
- 2 tests exceeded femur IARV
- 2 tests that exceeded acetabulum IARV did not exceed femur IARV
  - Rudd (2011) showed that over half of acetabulum injuries occurred in absence of femur injury





SOI: Summary

- Delta-V sensitive to vehicle mass
  - Lighter vehicles show higher DV
  - DV range: 44-64 kph (27-40 mph)
- Large toepan, IP, and steering wheel intrusion
- Some vehicles showed high Injury risk in KTH, chest, head, lower extremity

Oblique: Test Setup

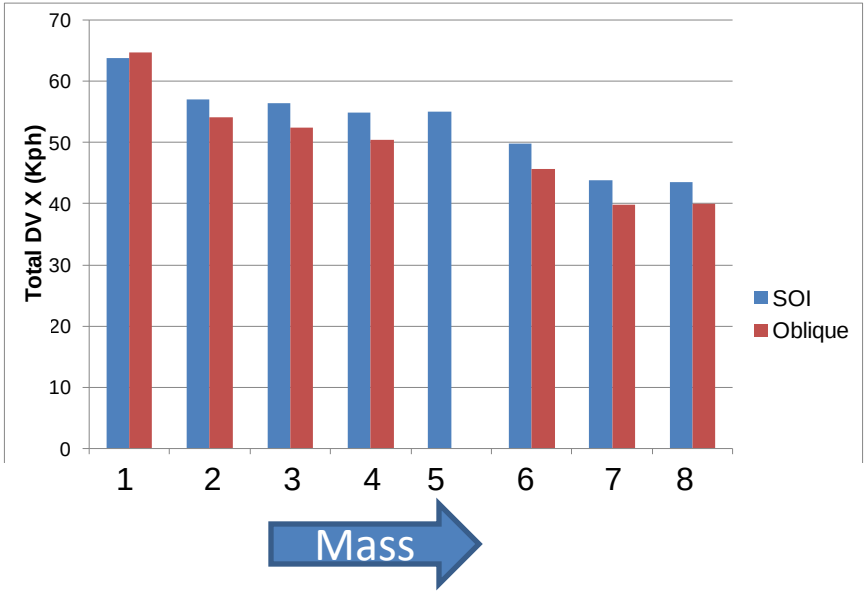
	Oblique	Rationale
Barrier Closing Speed	56 mph	Achieve 35mph Delta-V in average-mass passenger car
Overlap	35%	Represent vehicle-to-vehicle test with 50% overlap (engagement of one longitudinal rail)
Angle Relative to Track	15 degrees	PDOF of 10-20 degrees most prominent in field after full frontal

Oblique: Vehicle Top View

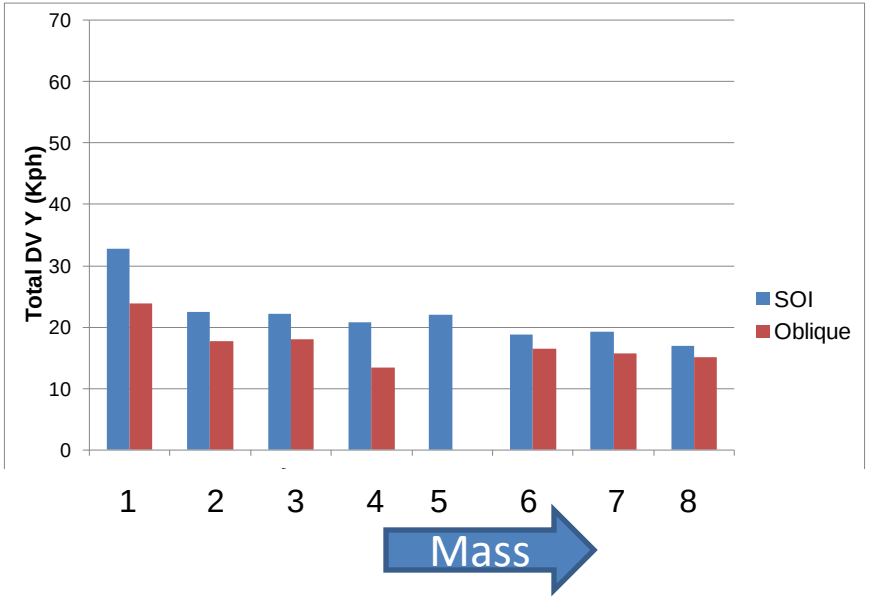
Total DV

- Delta-V decreases with increasing vehicle weight
- X-axis (longitudinal) Delta-V slightly higher for SOI
- Y-axis (lateral) Delta-V slightly higher for SOI

Longitudinal



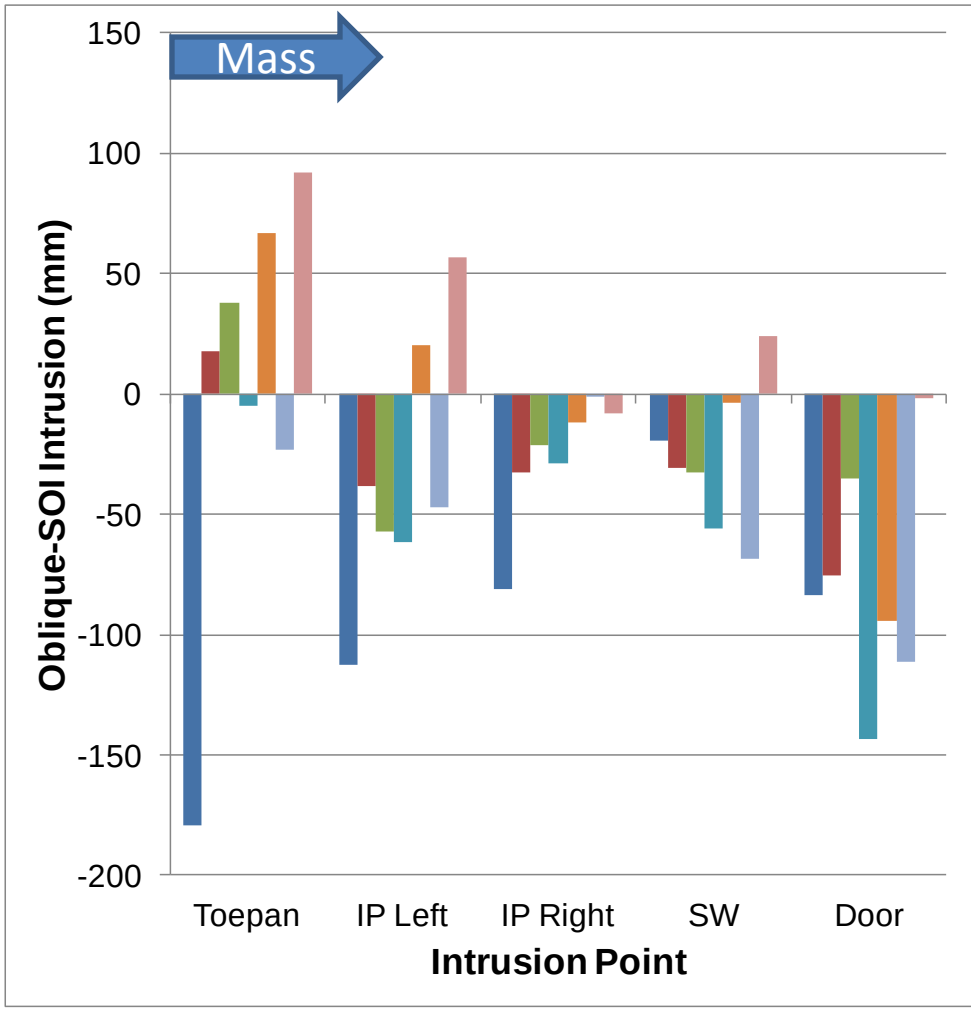
Lateral



Comparison: Difference in Intrusions

Oblique > SOI

SOI > Oblique



SOI vs. Oblique Summary

- Vehicle response
  - Delta-V: SOI slightly higher
  - Intrusion: SOI consistently higher (except toepan)

Thank You

- More details in the paper “Moving Deformable Barrier Test Procedure for Evaluating Small Overlap/Oblique Crashes” to be published at the 2012 SAE World Congress