

Comparison of WorldSID and Cadaver Responses in Low-Speed and High-Speed Pure Lateral Impacts

Jonathan D. Rupp, Carl S. Miller, and
Lawrence W. Schneider



UNIVERSITY OF MICHIGAN
TRANSPORTATION RESEARCH INSTITUTE

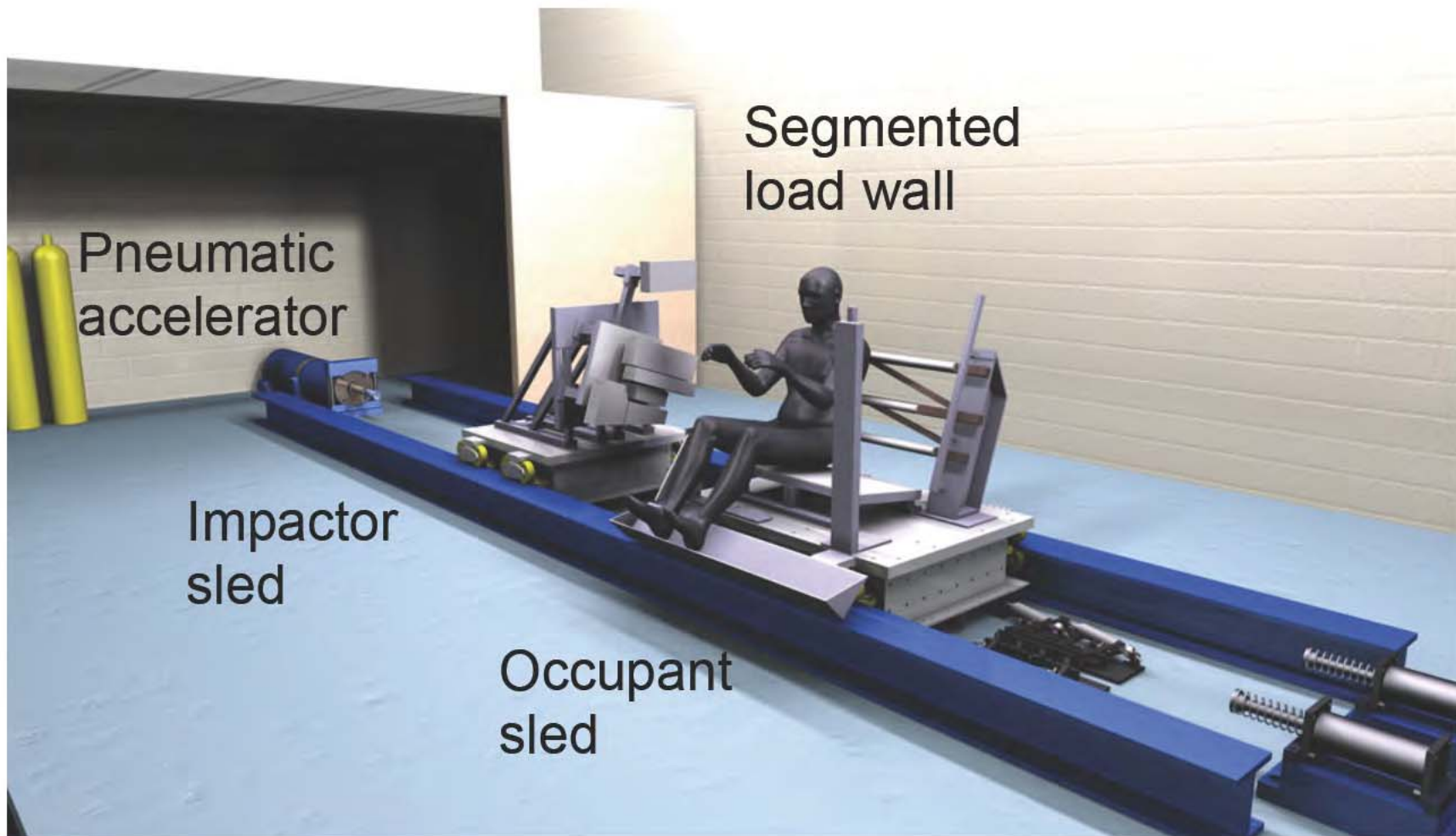
Background

1. WorldSID abdomen response is based primarily on tests where cadavers were dropped on armrest-shaped impactors.
2. No usable data exist on the side impact response of the abdomen from whole body sled tests because previous studies either did not
 - separately measure abdominal force or deflection or
 - scale impactor size with subject size.
3. Little side impact sub-injury response data.
4. Little low-severity impact response data and no low-severity abdomen impact response data

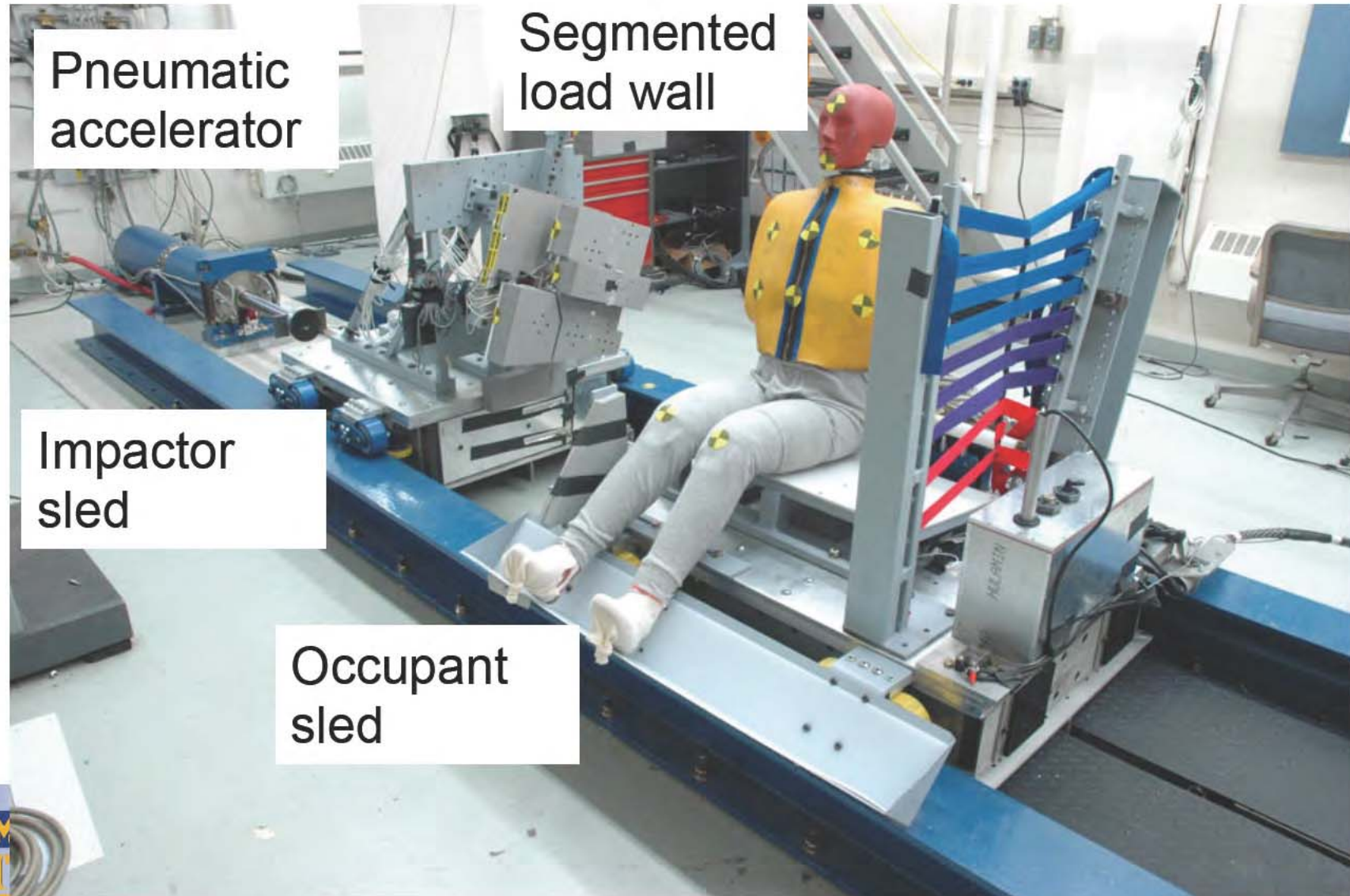
Test Methods

- Impacted cadaver twice using a padded impact wall with a 50-mm abdomen offset.
 - First impact at 3 m/s
 - Second impact at 8 m/s to contralateral side of the body
 - Velocities were selected based on a review SNCAP door velocity histories
- All tests were conducted using the the UMTRI dual-sled side impact sled facility.

Test Methods—UMTRI Side Impact Facility



Test Methods—UMTRI Side Impact Facility

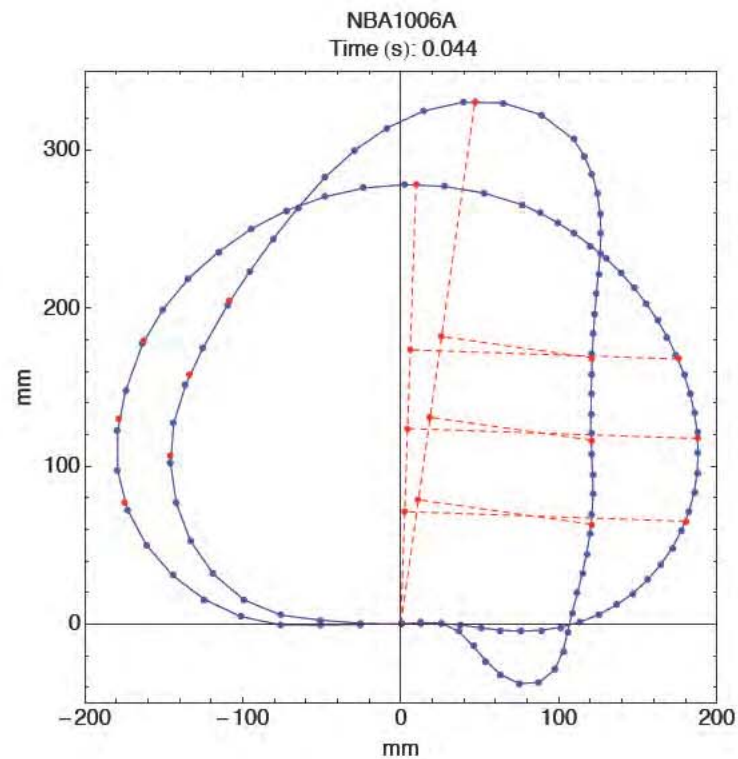


Test Methods, cont.

- Padding force-deflection characteristics set so that mean ATD responses from SNCAP tests were reproduced when impactor and occupant sled masses and velocities were tuned to reproduce door and vehicle velocity histories from SNCAP tests.
- Recorded forces applied to anatomic regions including: thorax, abdomen, iliac crest, greater trochanter, and mid femur. Scaled heights of impactor plates with subject size to ensure that each segment of the impact wall loads the same body region across tests.
- Did not load shoulder to minimize variability between tests.

Test Methods, cont.

- Recorded thorax and abdomen deflection using 59-channel chest bands.



Test Methods, cont.

- Recorded thorax and abdomen deflection using 59-channel chest bands.
- Use a redundant measures of thoracic deflection:
 - Digitized spine and impactor locations from HS video, measure foam deformation using potentiometer that passes through the foam
 - Measured rib and spine accelerations
- Recorded rib fracture timing using strain gages.



Cadaver Test Matrix

Test Series ID	Gender	Age (Yr)	Height (cm)	Weight (kg)	t-score	Impact Velocity		
						3 m/s	8 m/s	10 m/s
NBA0901	M	86	170	77	-1.8	x		x
NBA0902	M	61	185	82	-0.9	x		
NBA0903	M	50	173	64	1.6	x		x
NBA1004	M	66	173	79	-	x	x	
NBA1005	M	51	183	97	1.2	x	x	
NBA1006	M	34	188	102	2.0	x	x	
NBA1007	M	87	175	73	-	x		

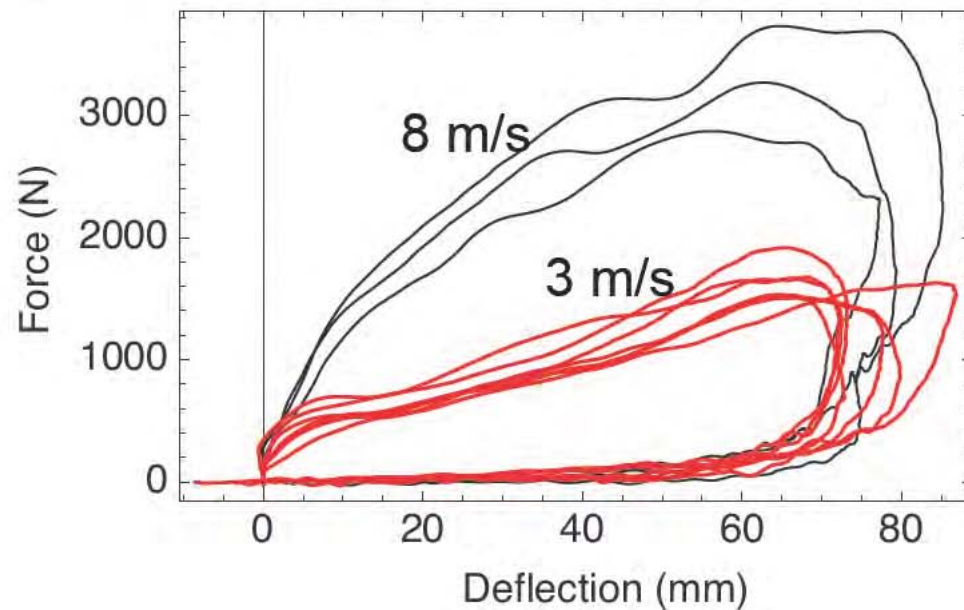
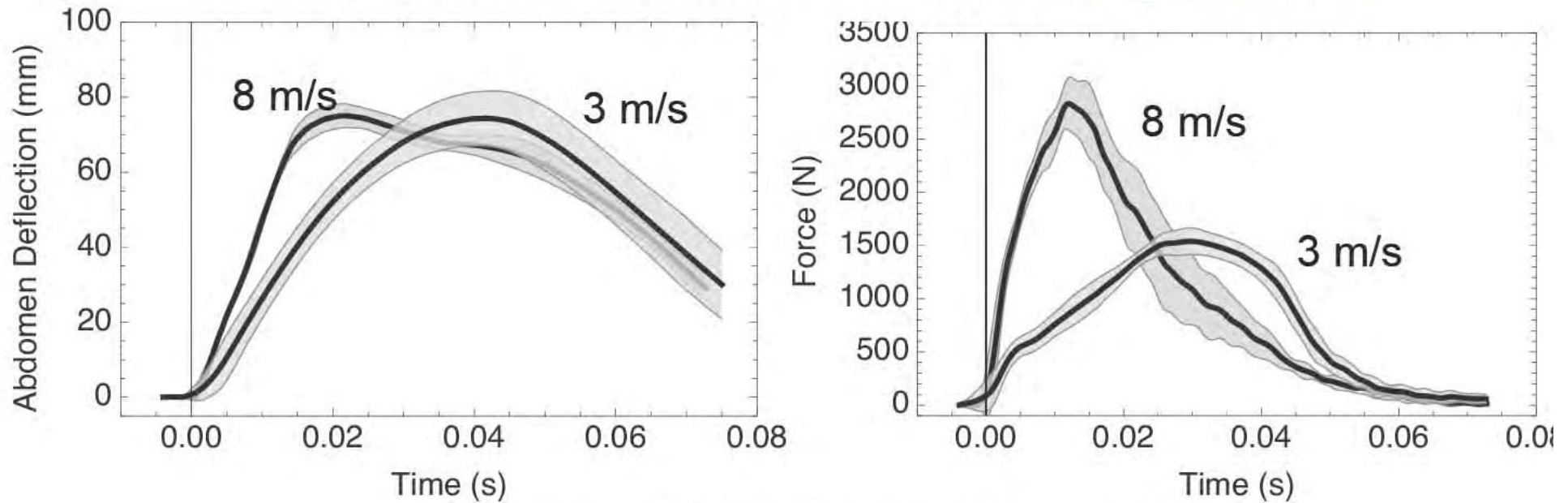
Cadaver Test Results: Injuries

- 3 m/s tests (n=7)
 - 5 subjects had no injury
 - 1 subject has an AIS 2 injury (2 rib fx)
 - 1 subject had an AIS 3 injury (3 rib fx)
- 8 m/s tests (n=3)
 - 2 subjects had no injury
 - 1 subject had an AIS 3 injury (3 rib fx).

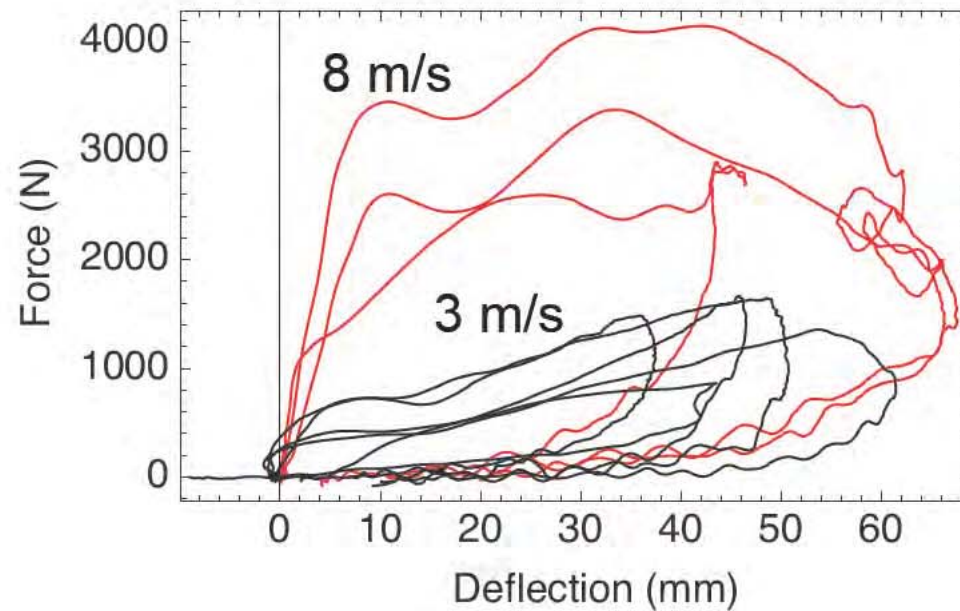
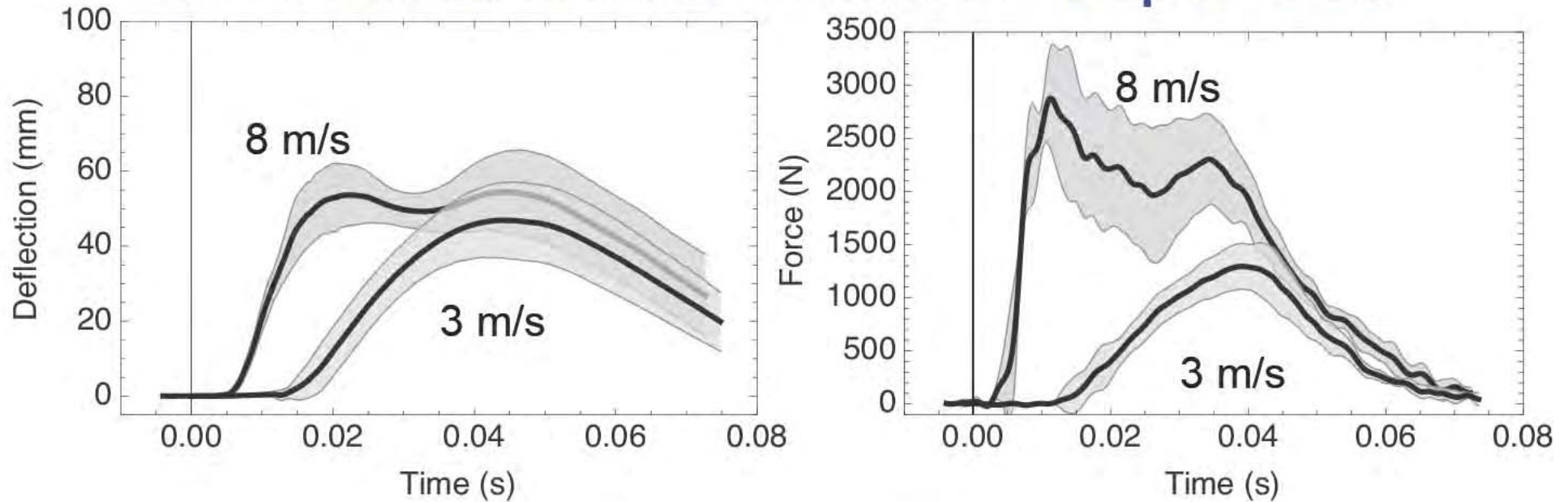
Cadaver Corridor Development

- Normalized using equal-stress equal velocity scaling based on total body mass.
- Calculated ± 1 SD responses using Maltese method.

3 m/s and 8 m/s Abdomen Responses

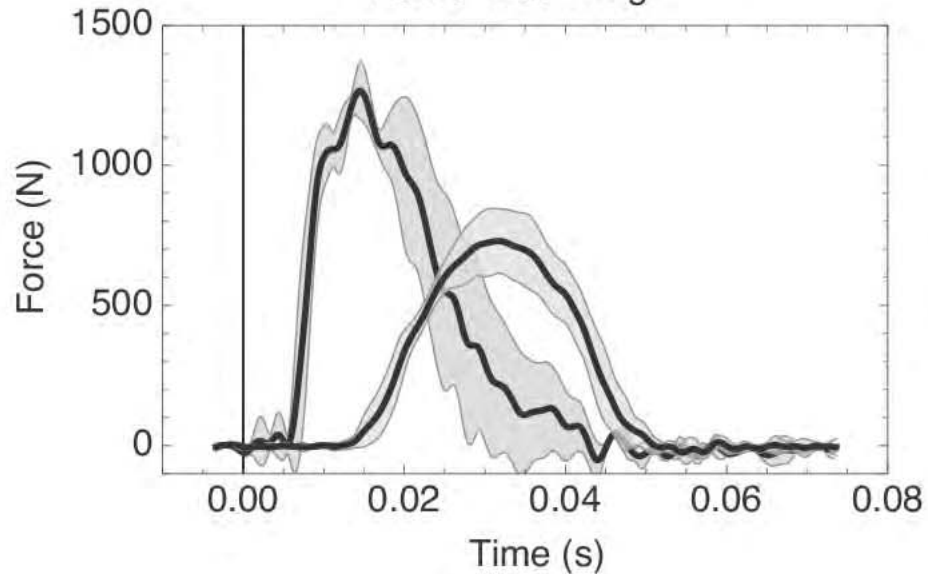


3 m/s and 8 m/s Thorax Responses

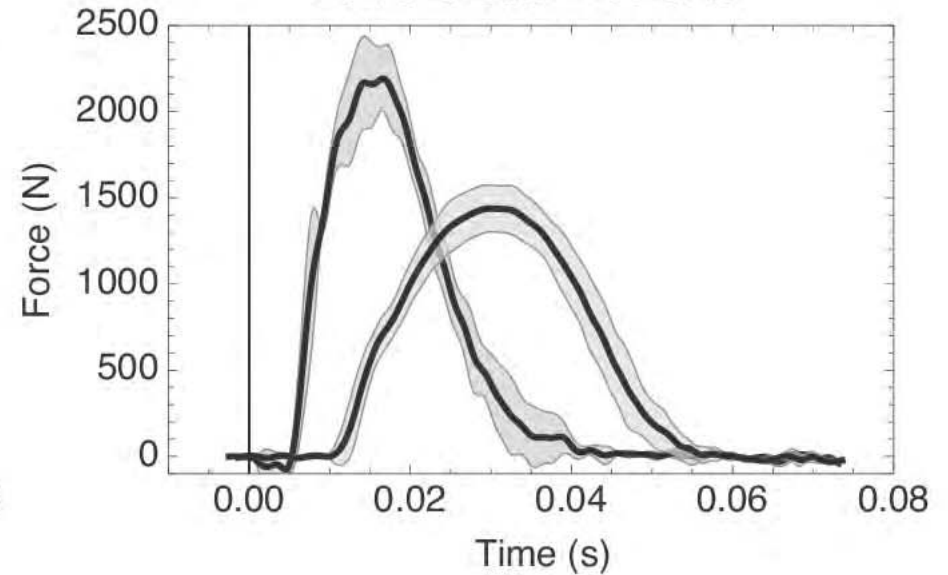


3 m/s and 8 m/s Pelvis Responses

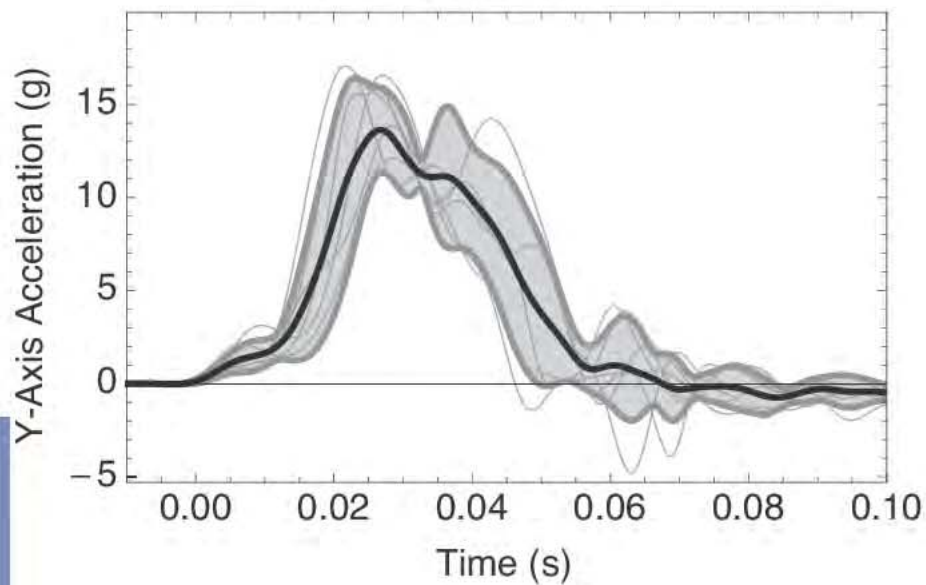
Pelvis-Iliac Wing



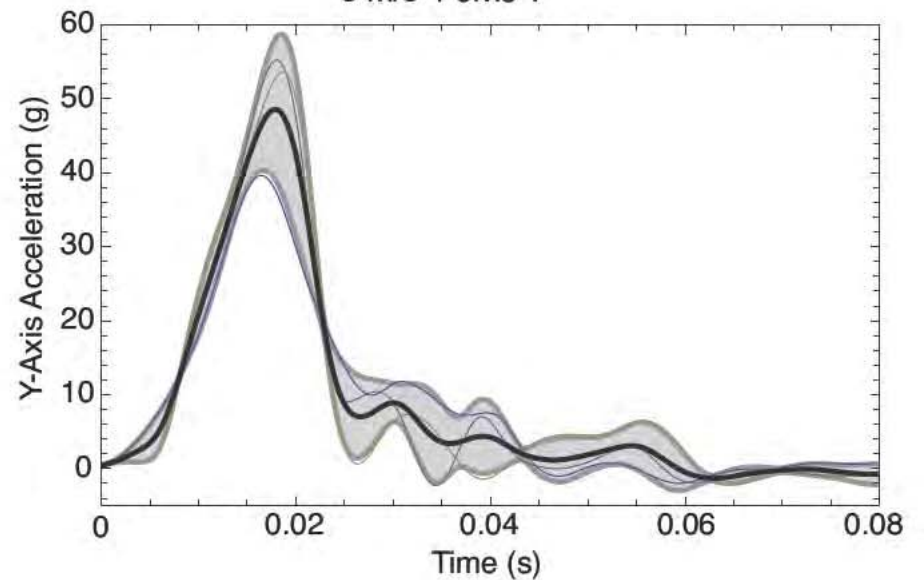
Pelvis-Greater Trochanter



3 m/s Pelvis Y

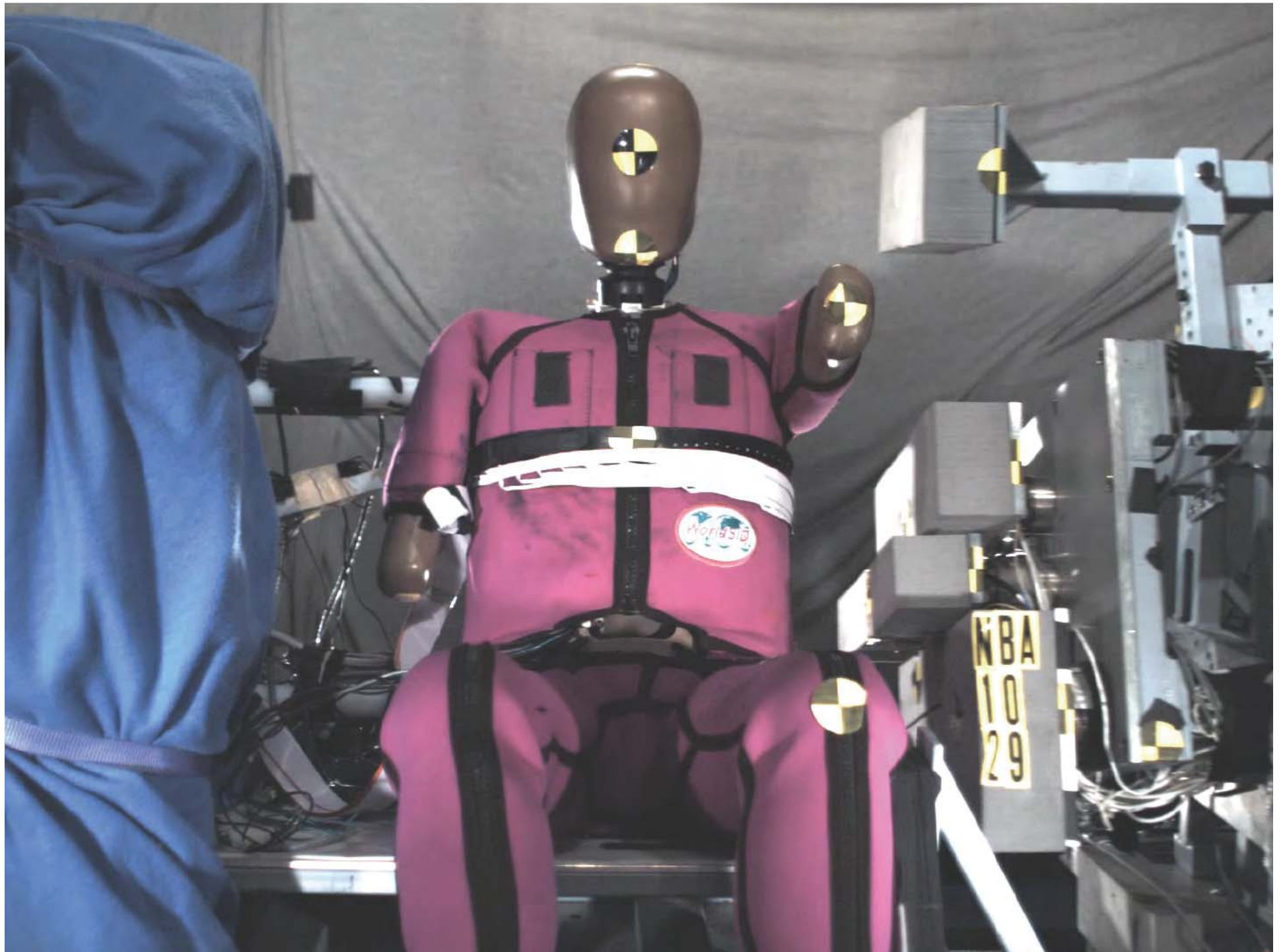


8 m/s Pelvis Y

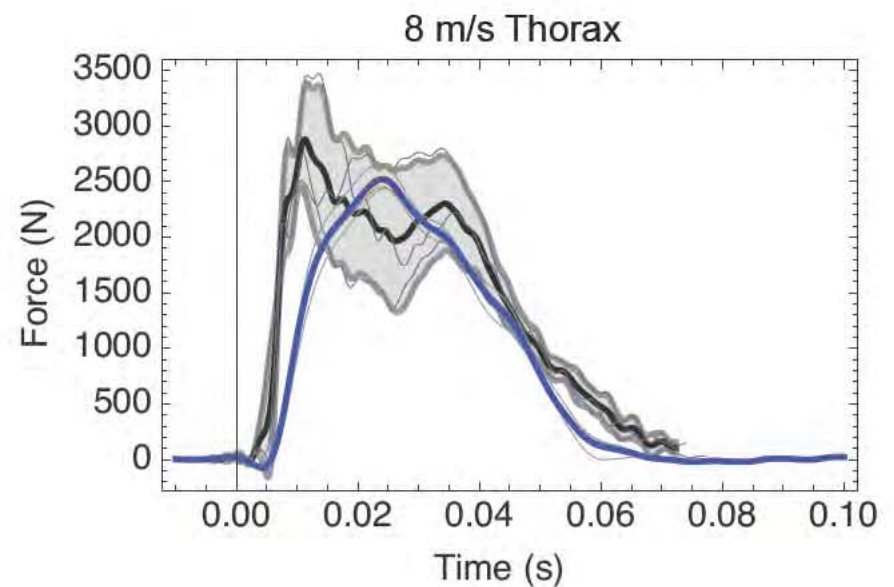
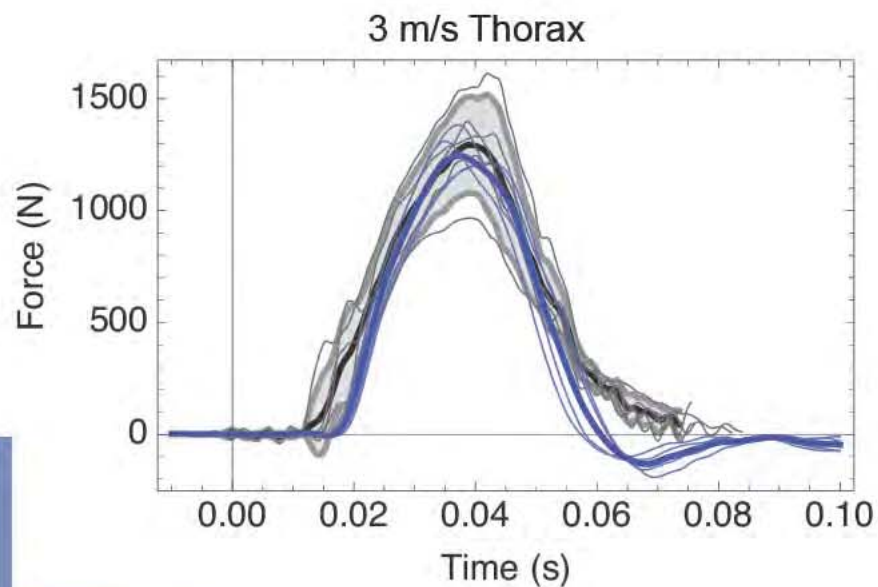
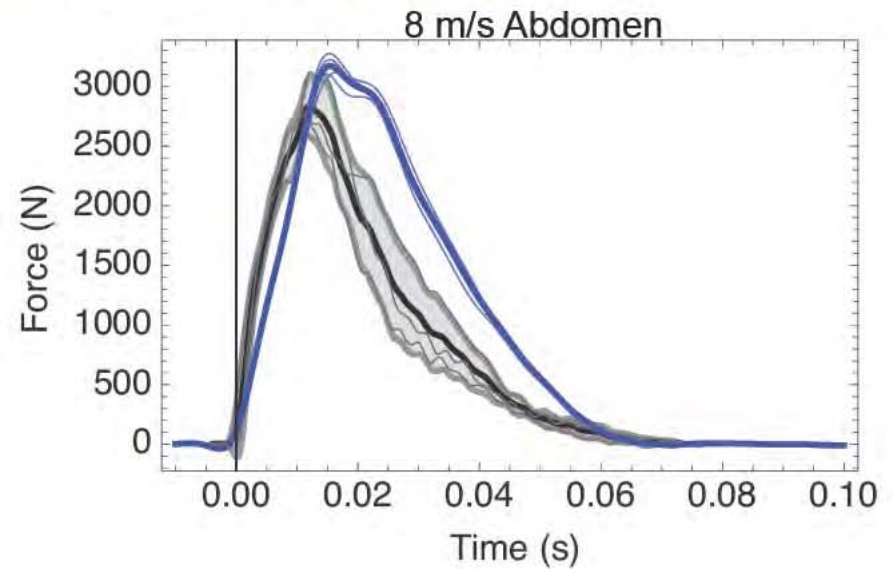
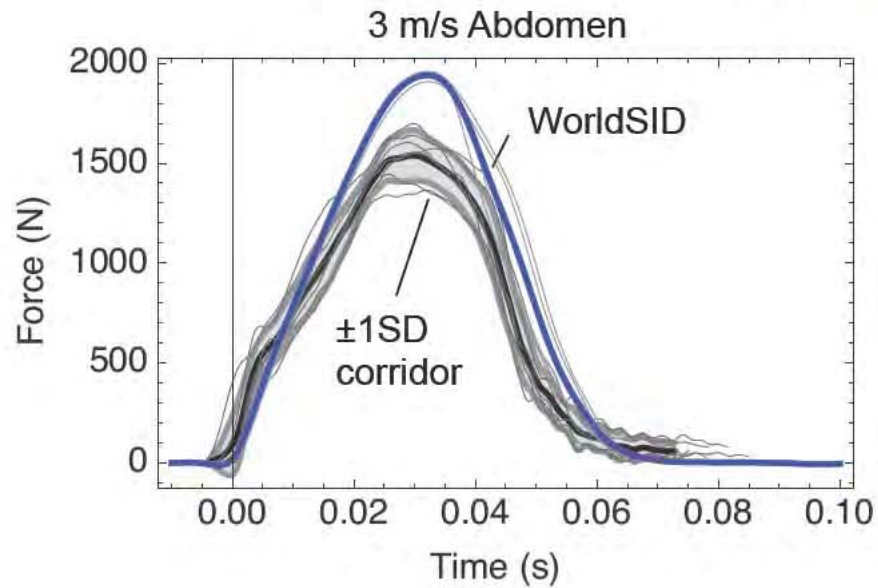


WorldSID test matrix

- 3 m/s, 8 m/s, and 10 m/s impact velocities
- Two impactor wall configurations
 - Padded with 50-mm abdomen offset and
 - Padded with 50-mm pelvis plus abdomen offset
- 4 repeats in each test condition.
- Measure abdomen and chest deflection with chestbands and IR-TRACCs
- Recalibrate at halfway point in test matrix and after all tests are completed.

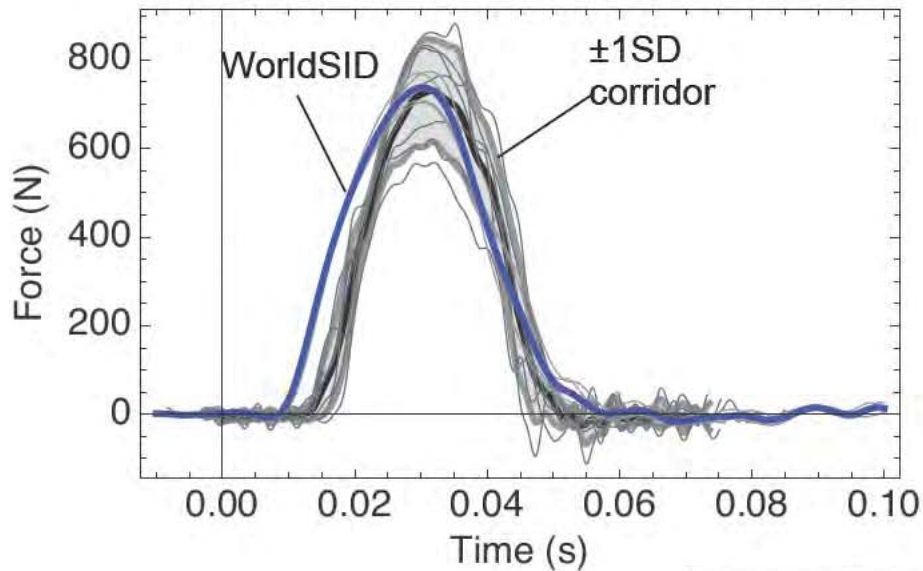


Comparison of WorldSID Force Responses to Force Corridors from 3 m/s and 8 m/s Impacts

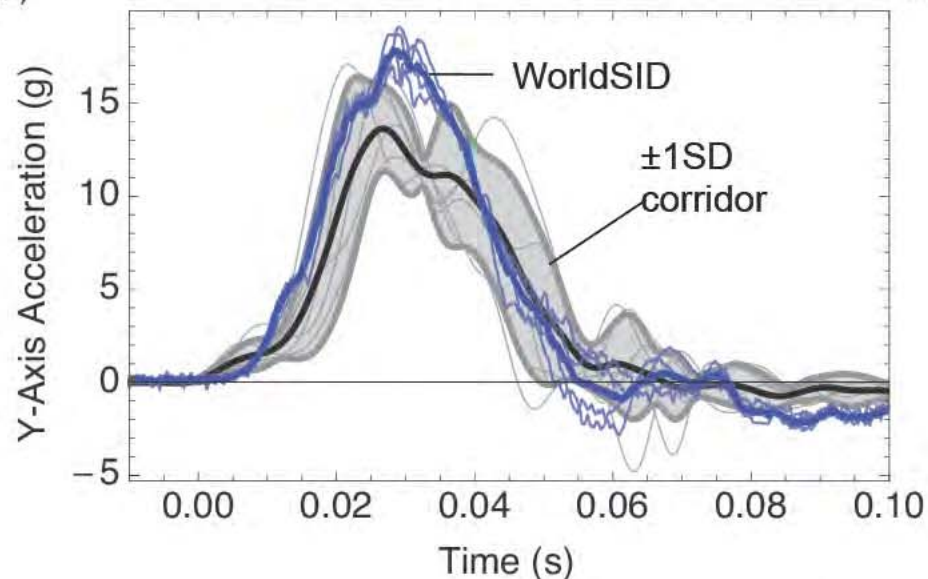
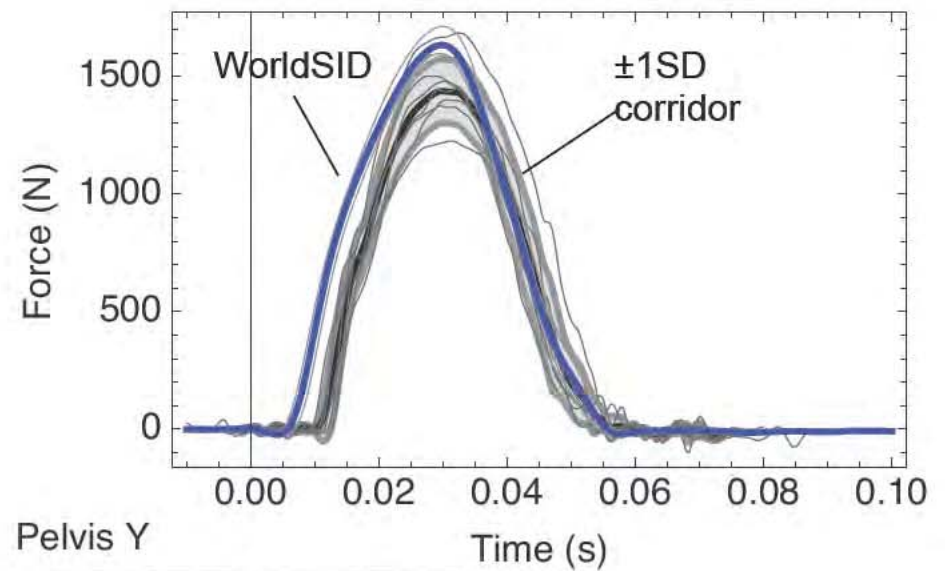


Comparison of WorldSID to 3 m/s Response Corridors for Pelvis Forces and Y-Axis Acceleration

Pelvis-Iliac Wing

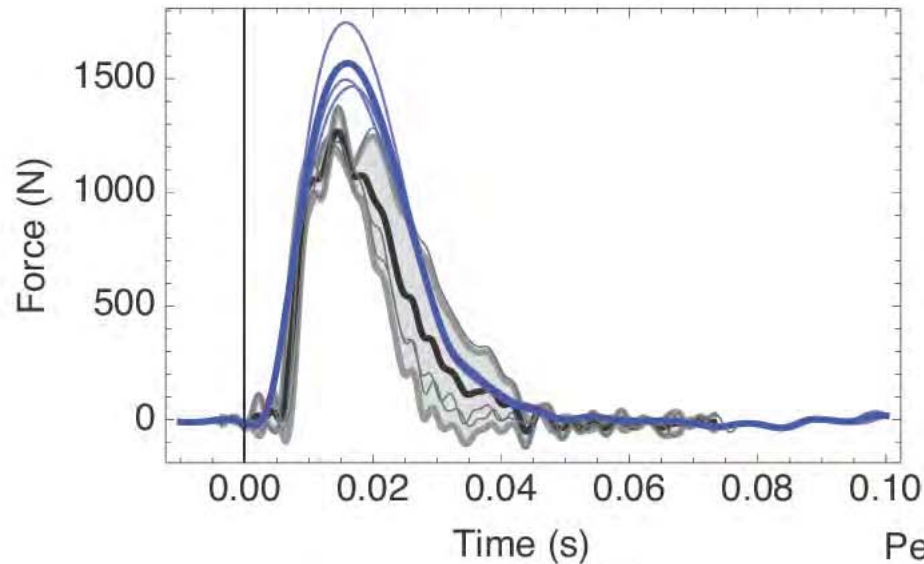


Pelvis-Greater Trochanter

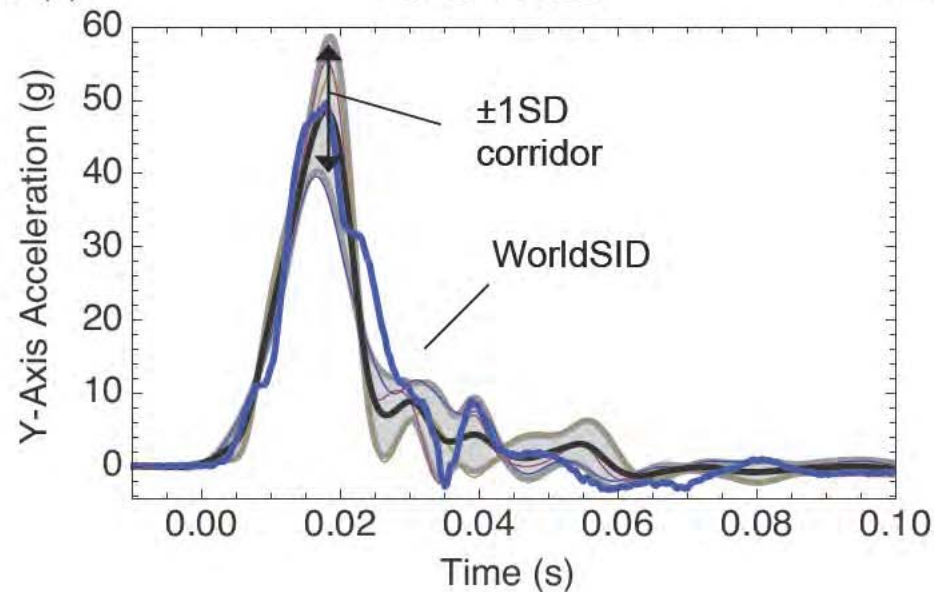
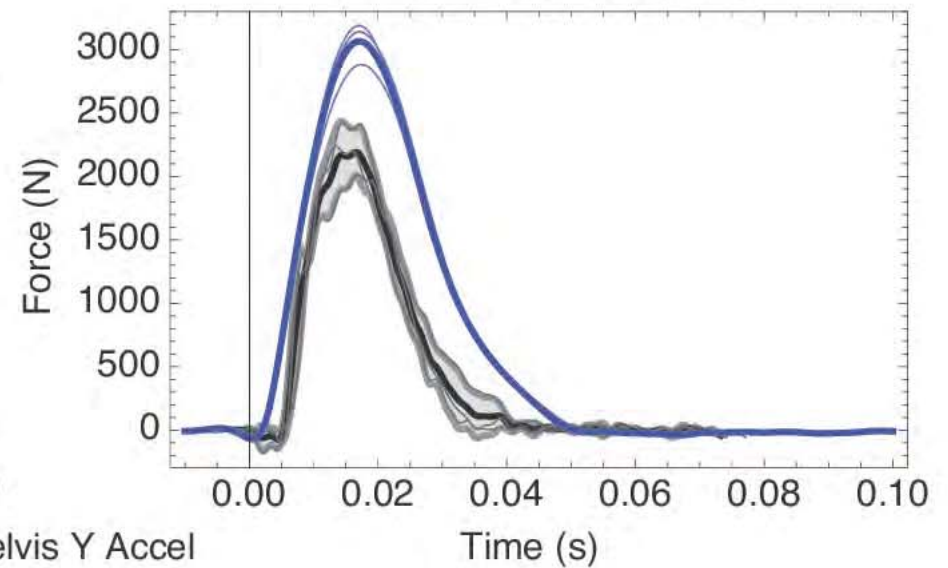


Comparison of WorldSID to 8 m/s Response Corridors for Pelvis Forces and Y-Axis Acceleration

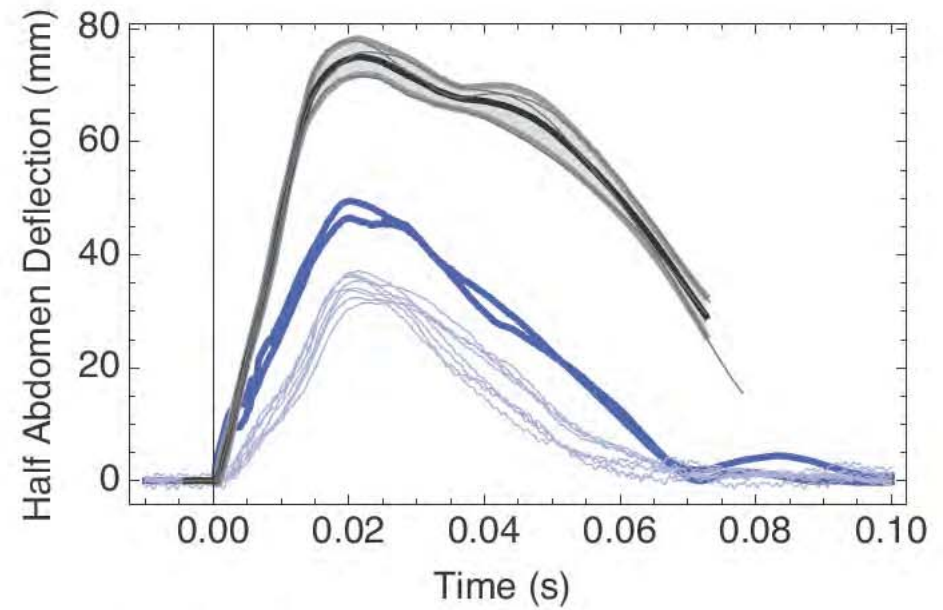
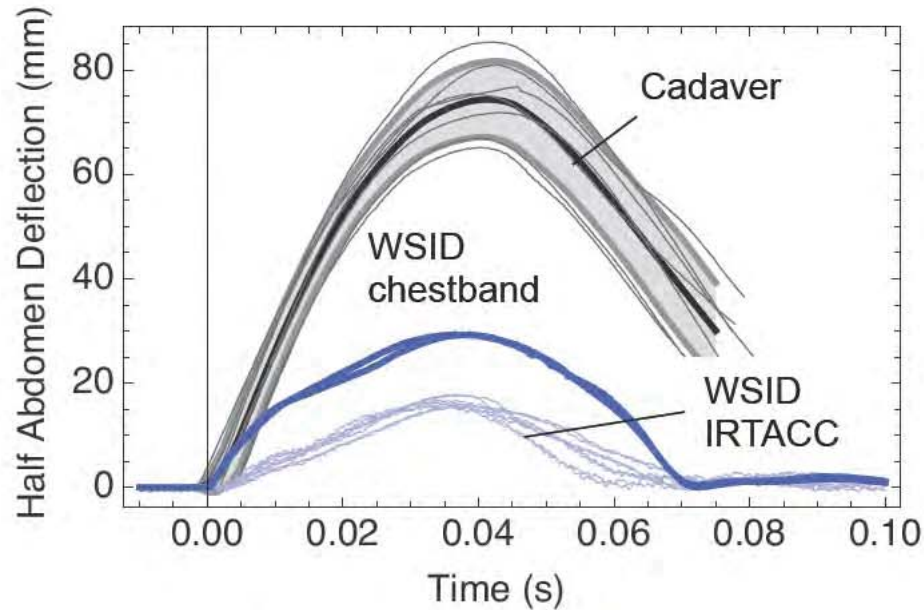
Pelvis-Iliac Wing



Pelvis-Greater Trochanter

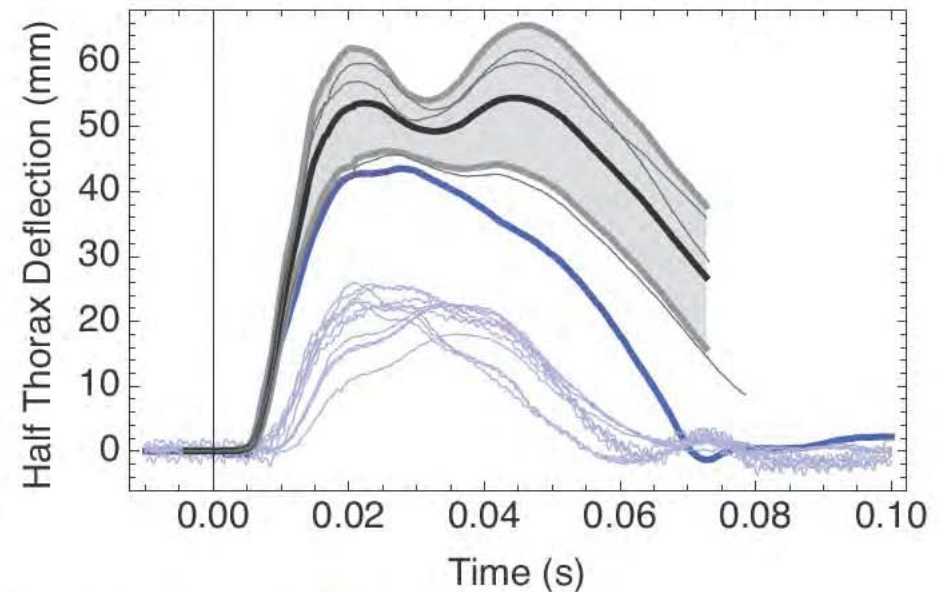
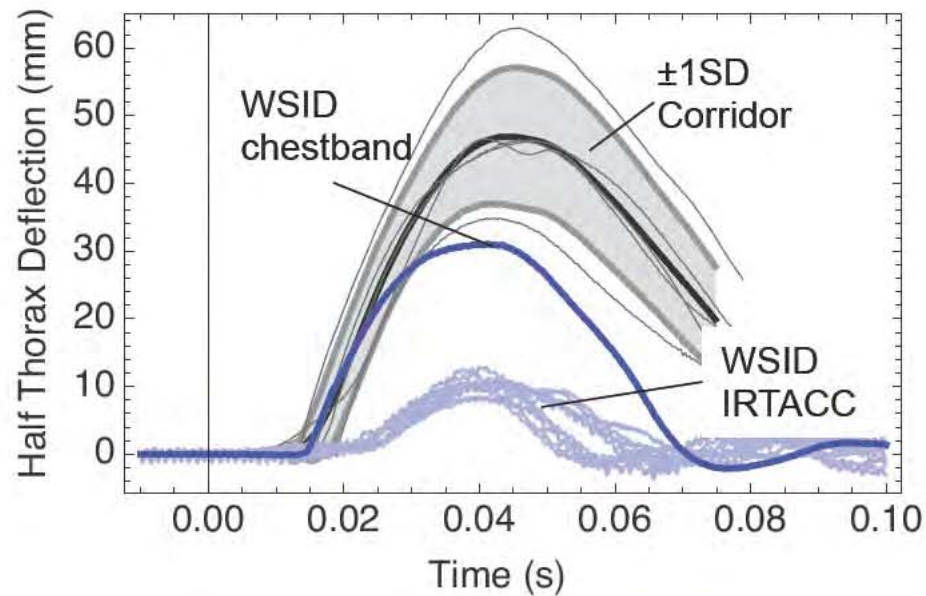


Cadaver Abdomen Deflection vs. WorldSID External and Internal Abdomen Deflection Histories, 3 m/s



- Difference between WorldSID internal and external deflections is approximately the thickness of the chest jacket.

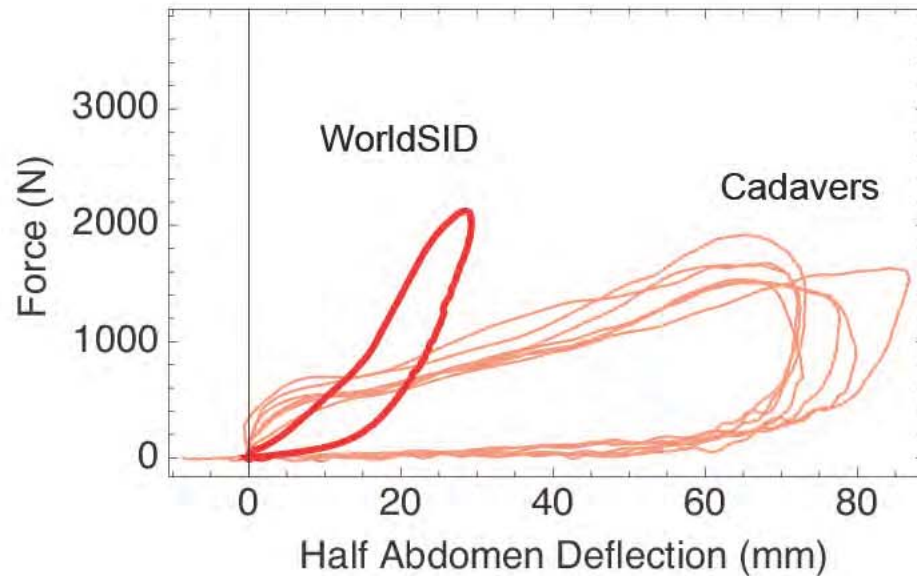
Cadaver Abdomen Deflection vs. WorldSID External and Internal Thorax Deflection Histories, 8 m/s



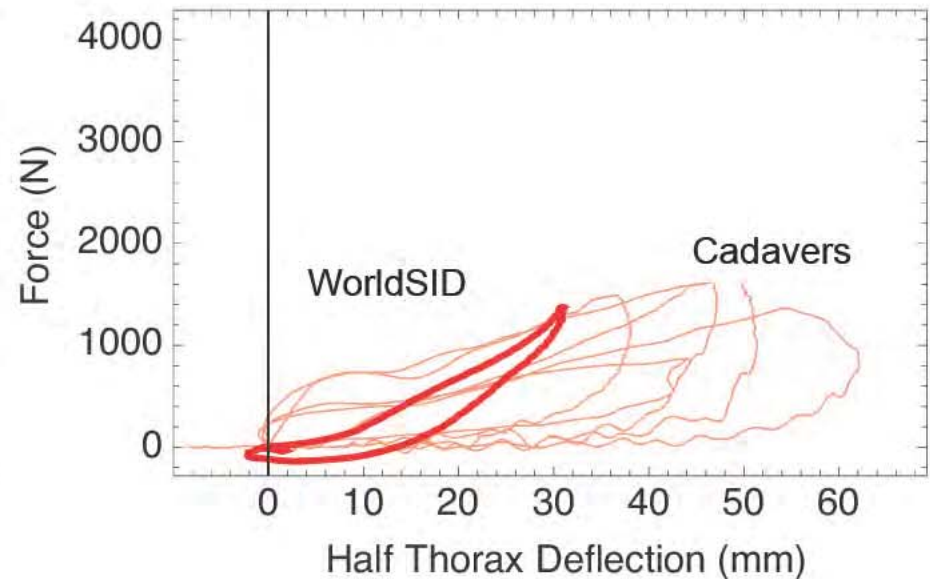
Differences between WorldSID and cadaver external deflections are partially from differences in pelvis to-spine coupling that result in the World SID tilting towards the impactor and thus reducing deflection of the ribs that are underneath the chestband location.

Cadaver vs. WorldSID Abdomen and Thorax Force-Deflection Responses

3 m/s Abdomen



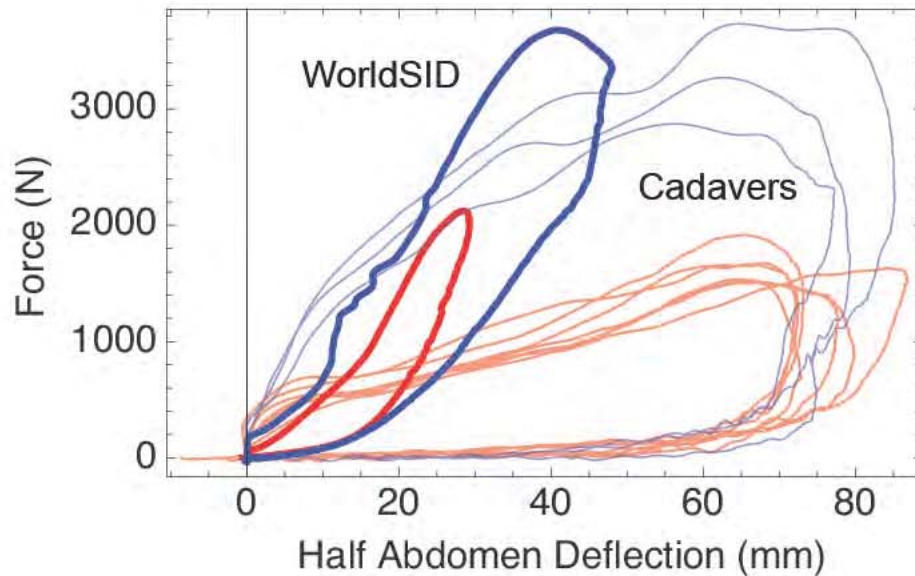
3 m/s Thorax



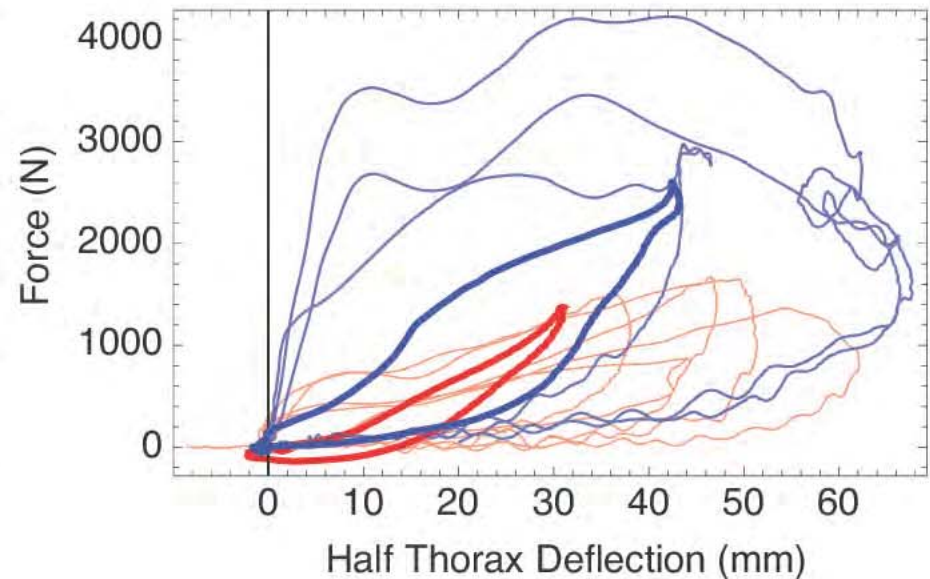
All deflections are based on chestband data

Cadaver vs. WorldSID Abdomen and Thorax Force-Deflection Responses

3 and 8 m/s Abdomen



3 and 8 m/s Thorax



All deflections are based on chestband data

Conclusions

- WorldSID abdomen does not deform as much as the cadaver abdomen under similar loading conditions and is somewhat less rate sensitive.
 - Implies that $V \cdot C$ calculations based on abdomen rib deflection are questionable.
- WorldSID pelvis forces were higher than the cadaver response corridors at 8 m/s, but WorldSID pelvis Y-axis was within the response corridors, suggesting that the WorldSID pelvis may need to be less stiff and have less tightly coupled mass.
- Differences in thorax responses between WSID and cadavers may be due to difference in torso kinematics.

Thanks for your attention.



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