



A Preliminary Biofidelity Assessment of THOR and BioRID in a Moderate-Speed Rear Impact Sled Test

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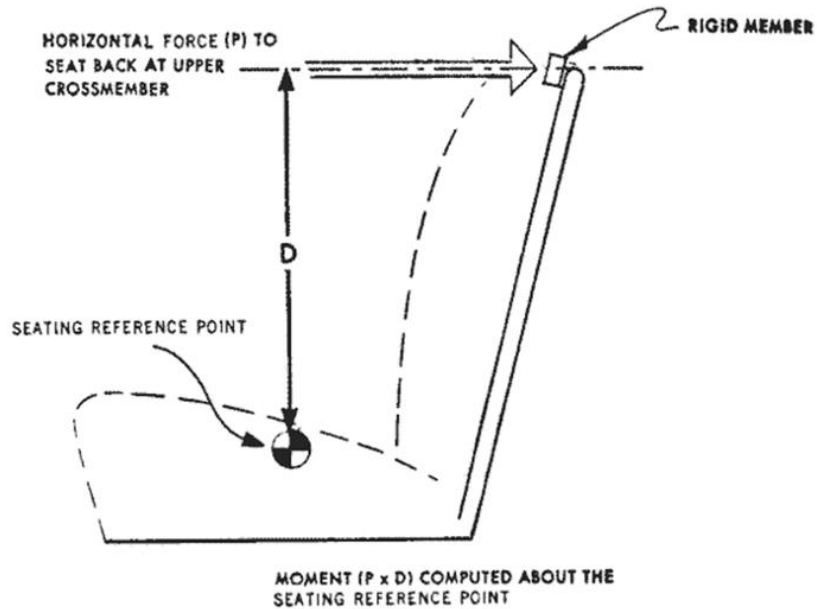
*SAE Government Industry Meeting
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Some content in this presentation depicts post-mortem human subjects (PMHS), or cadavers, that some may find disturbing. NHTSA and its university research partners follow an Institutional Review Board process to ensure protection of the rights and welfare of human subjects of research.

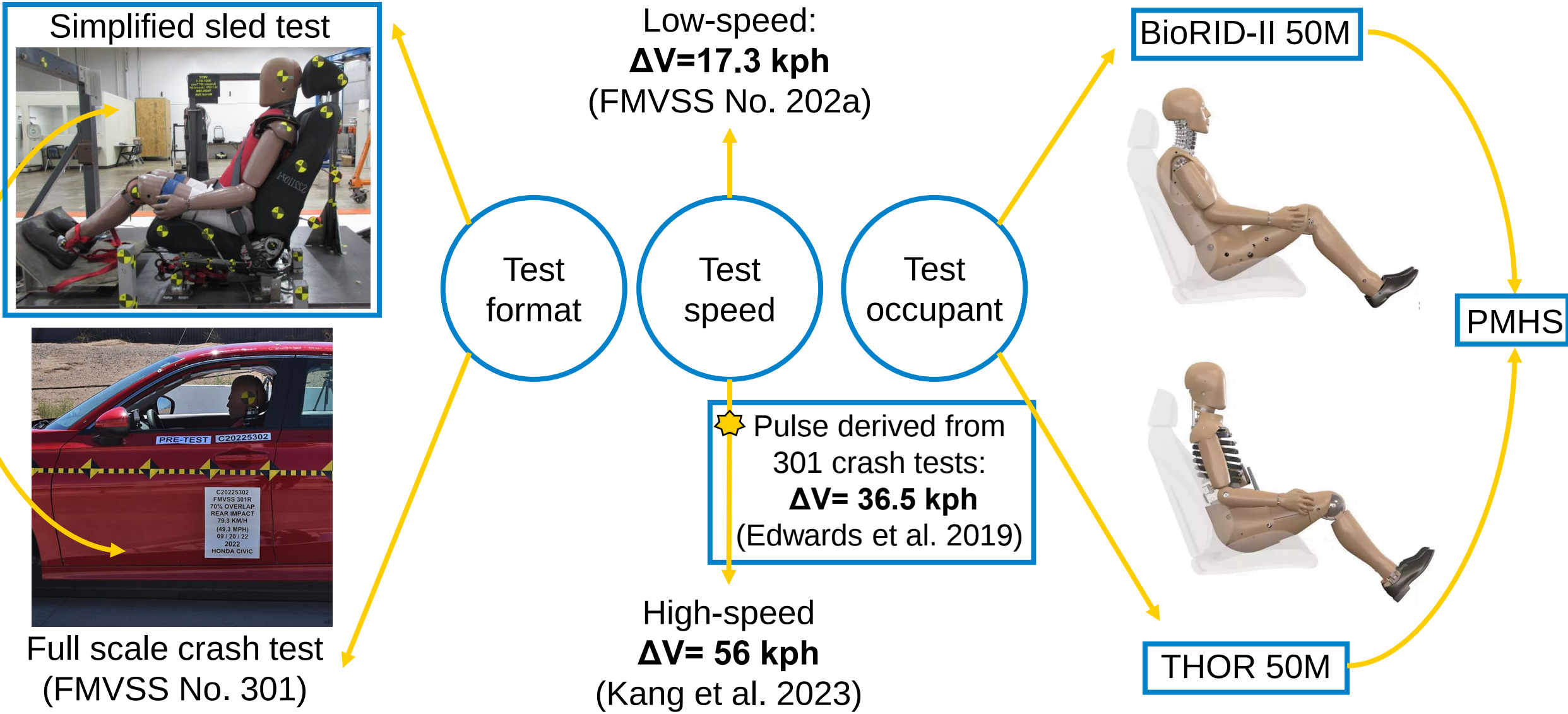
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Motivation

- Current FMVSS No. 207 Requirement
 - Seat back must withstand a rearward moment of 373 Nm



Exploring a Dynamic Test Option for FMVSS No. 207





Objective

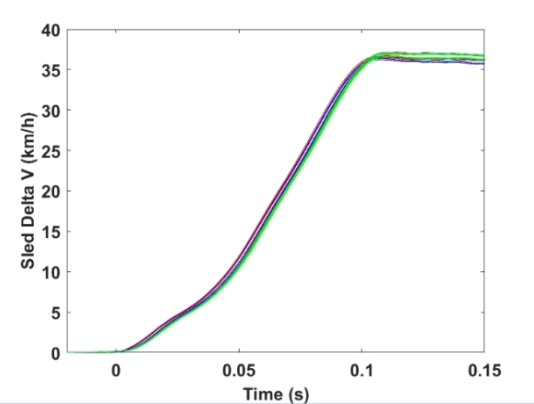
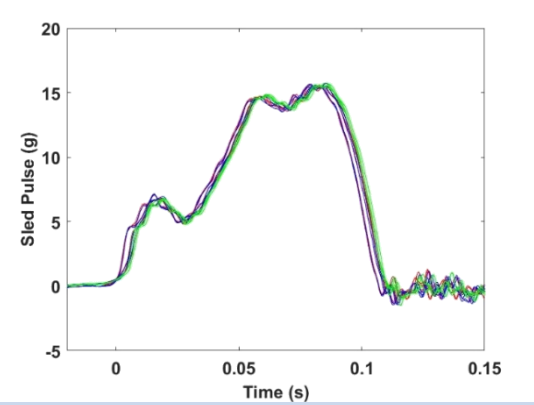
Conduct pilot testing with the THOR-50M and BioRID-II ATDs and PMHS on a rear impact buck using multiple vehicle platforms

- Analyze ATD kinematics compared to PMHS response

Methodology

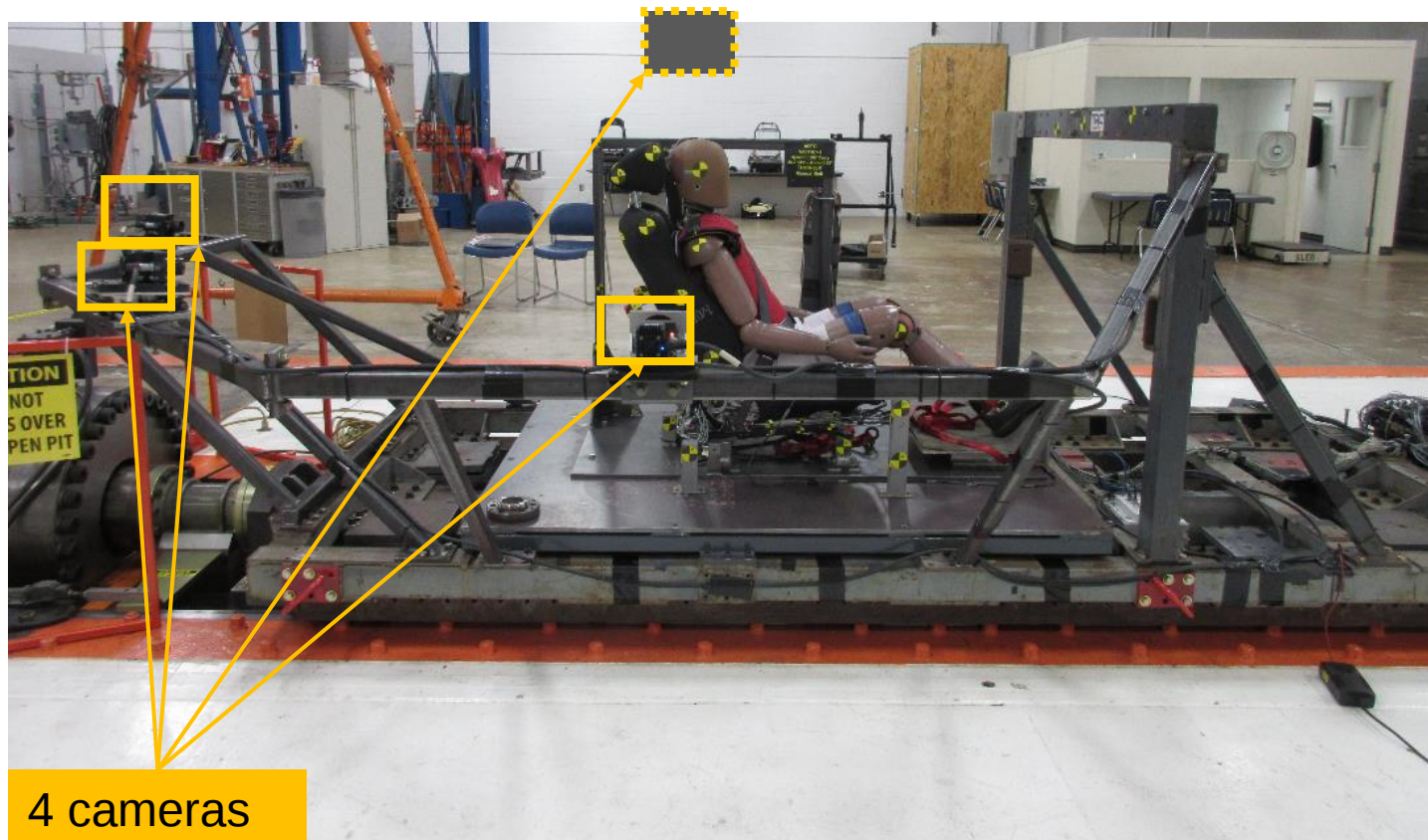


Test Matrix

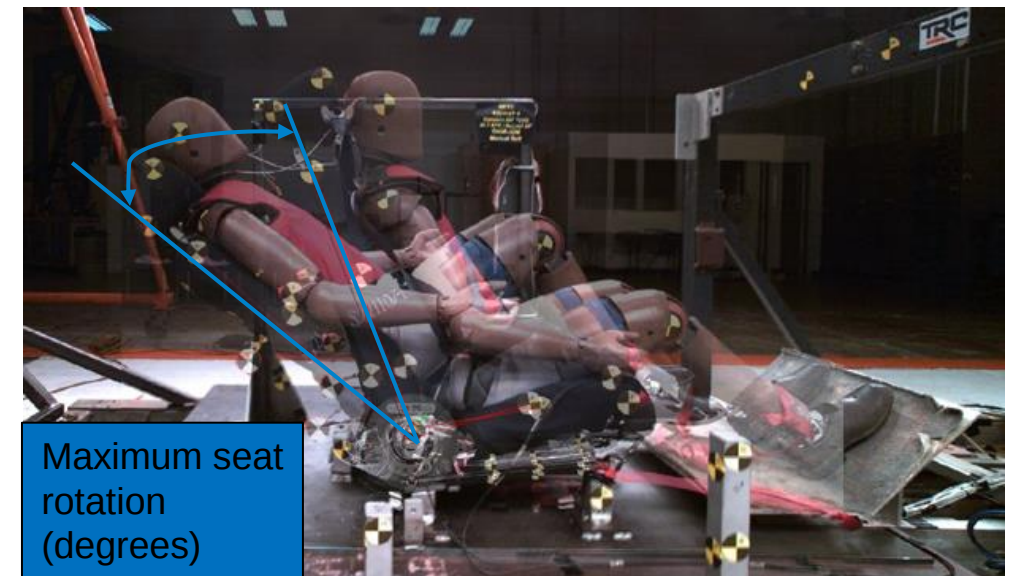
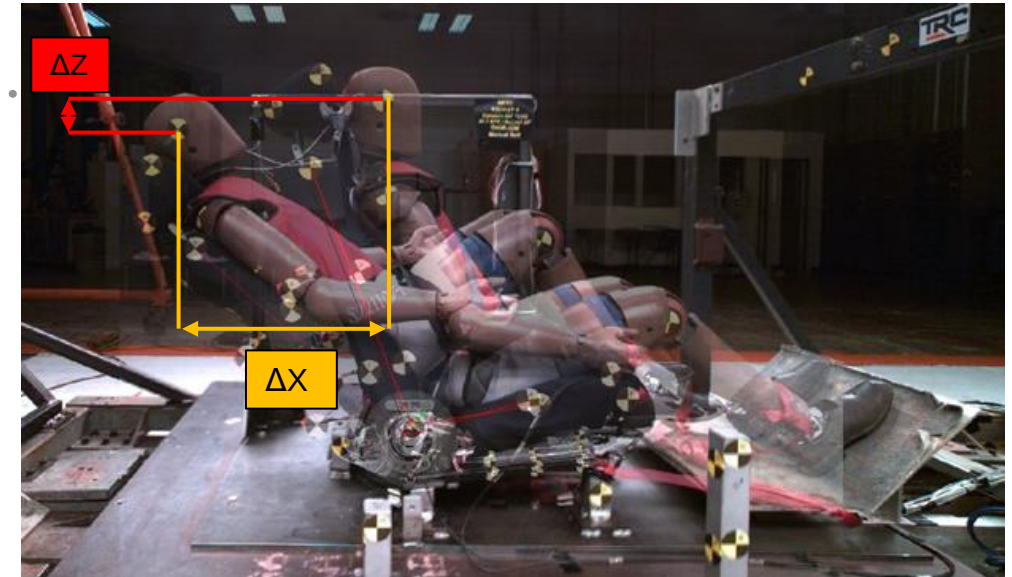
Seat	Subject	Pretensioner?	Sled Pulse
Ford Fusion Expected high seatback rotation	THOR-50M	Yes	  36.5 kph (15 g)
		No	
	BioRID-II	Yes	
		No	
	PMHS	No	
		No	
Honda Accord Expected medium seatback rotation	THOR-50M	Yes	
		No	
	BioRID-II	Yes	
		No	
	PMHS	No	
		No	
Volkswagen Tiguan Expected low seatback rotation	THOR-50M	Yes	
		No	
	BioRID-II	No (2023)	
		No	
	PMHS	No	
		No	

Methods

Sled Testing

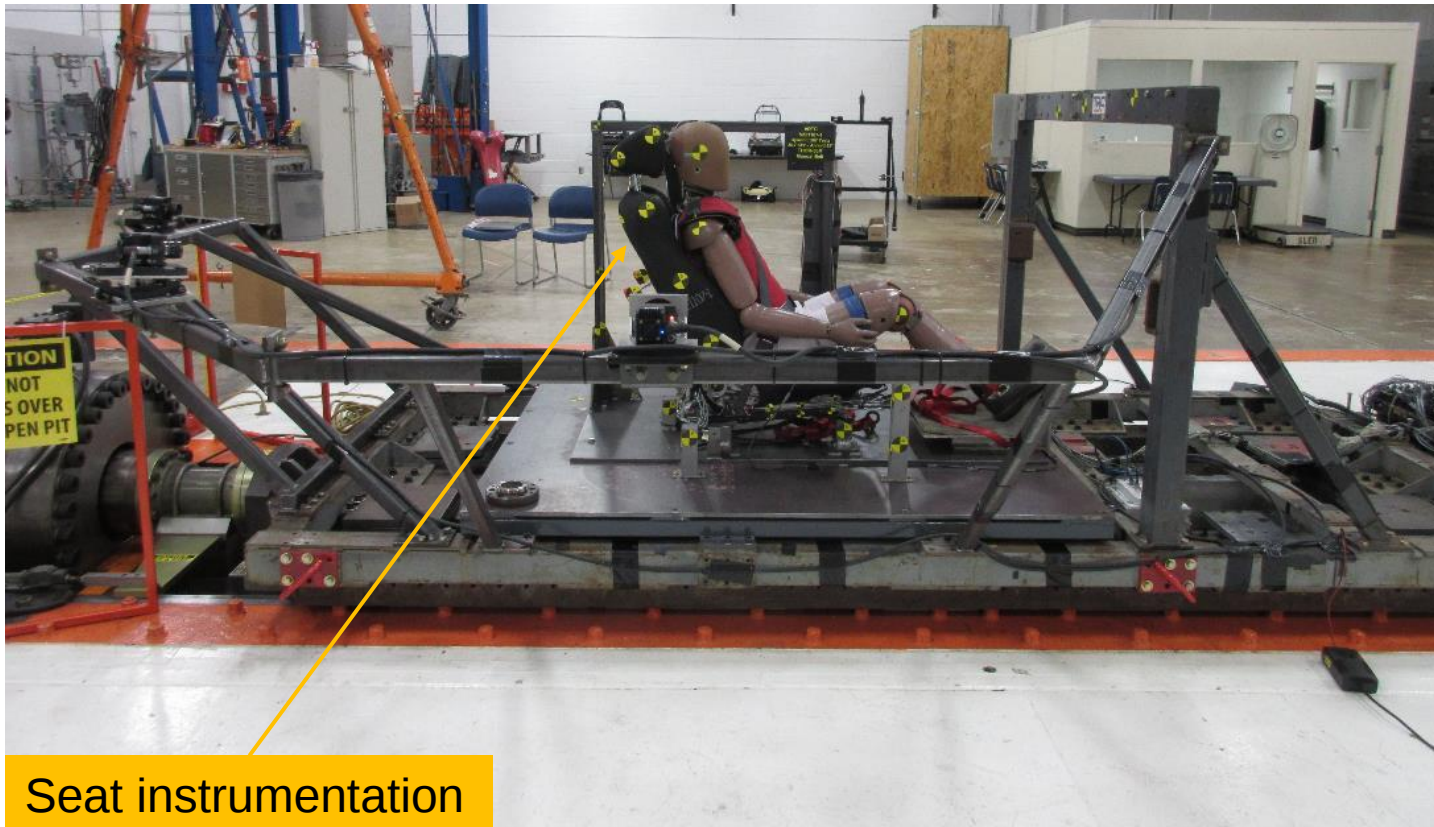


TEMA Evaluation

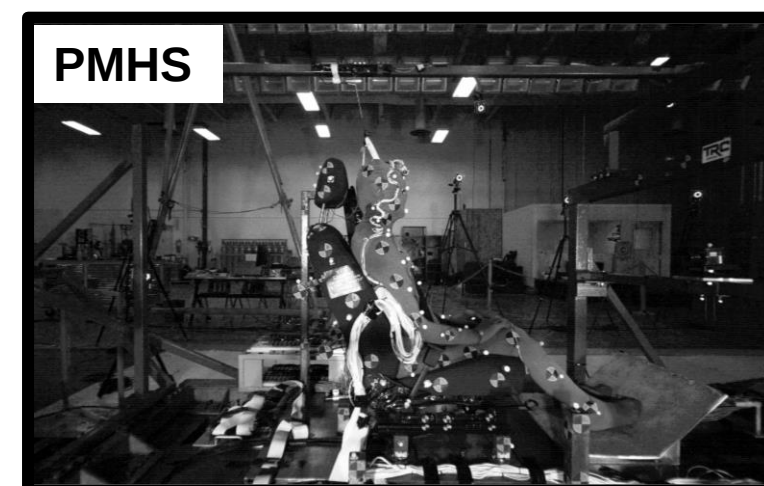
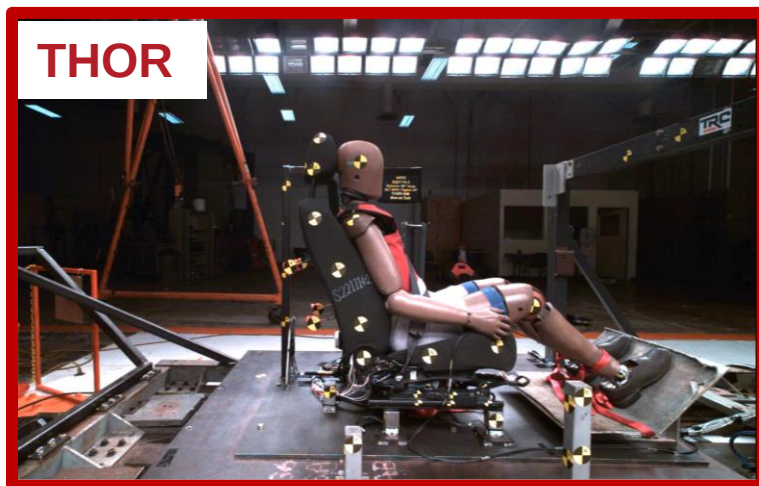


Methods

Sled Testing



Subject Information



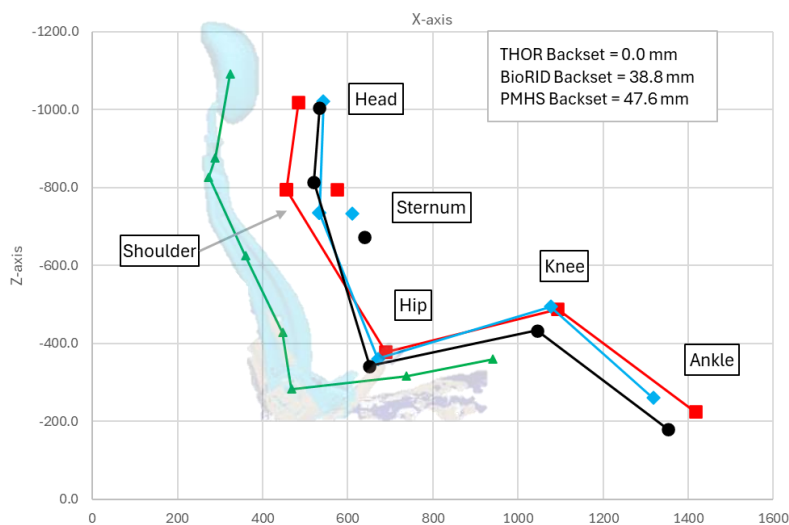
Subject	Sex	Age (years)	Weight (kg)	Seated Height (cm)
THOR-50M	M	--	76.6	83.1
BioRID-II	M	--	77.6	81.9
PMHS 1	M	69	64.6	81.6
PMHS 2	M	85	73.5	72.8
PMHS 3	M	77	70.8	81.0
<i>50th Percentile</i>	<i>M</i>	--	<i>78.2</i>	<i>88.4</i>

Results and Discussion

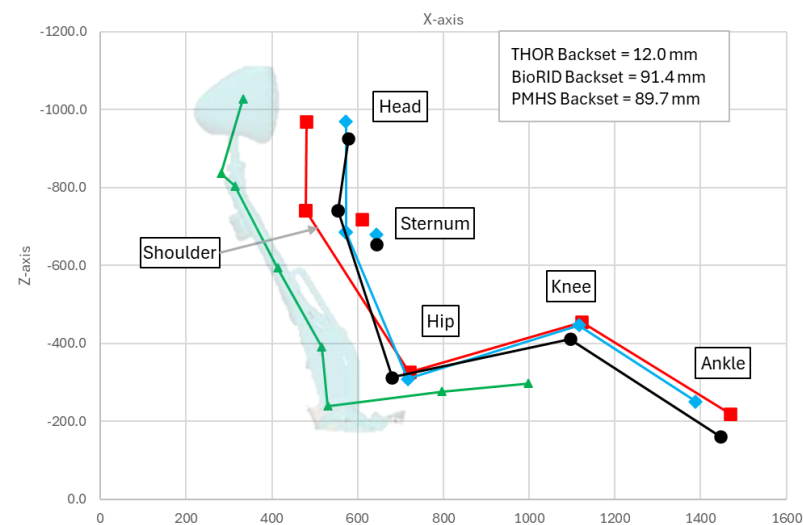


Seating Comparison

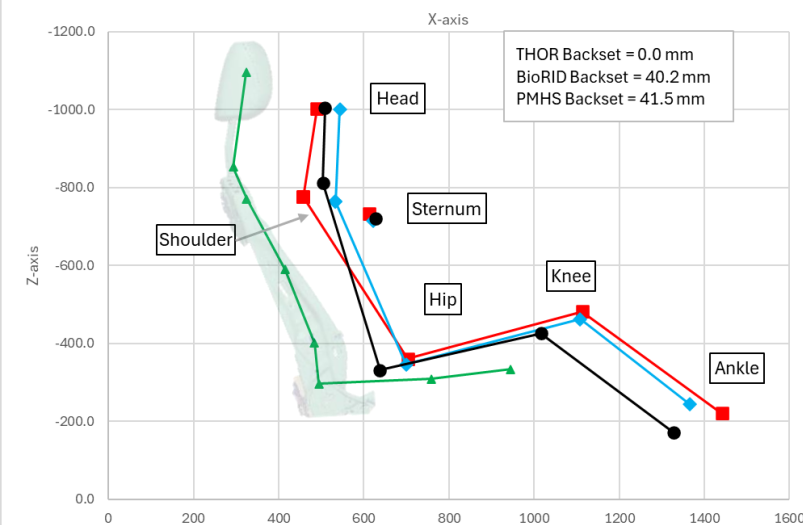
Ford Fusion Seating Positions



Honda Accord Seating Positions



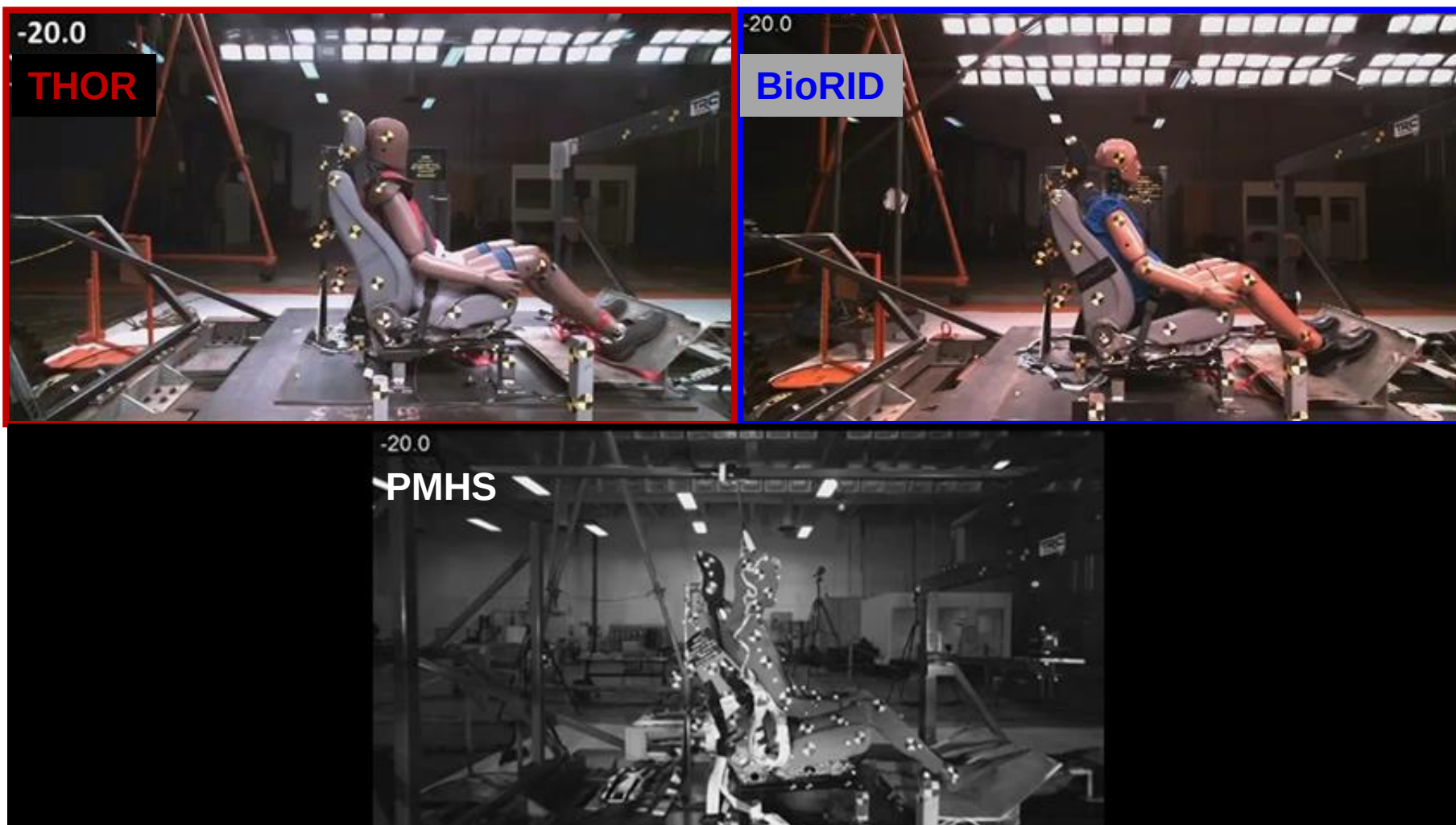
VW Tiguan Seating Positions



■ THOR ● PMHS2
◆ BioRID ▲ Seat

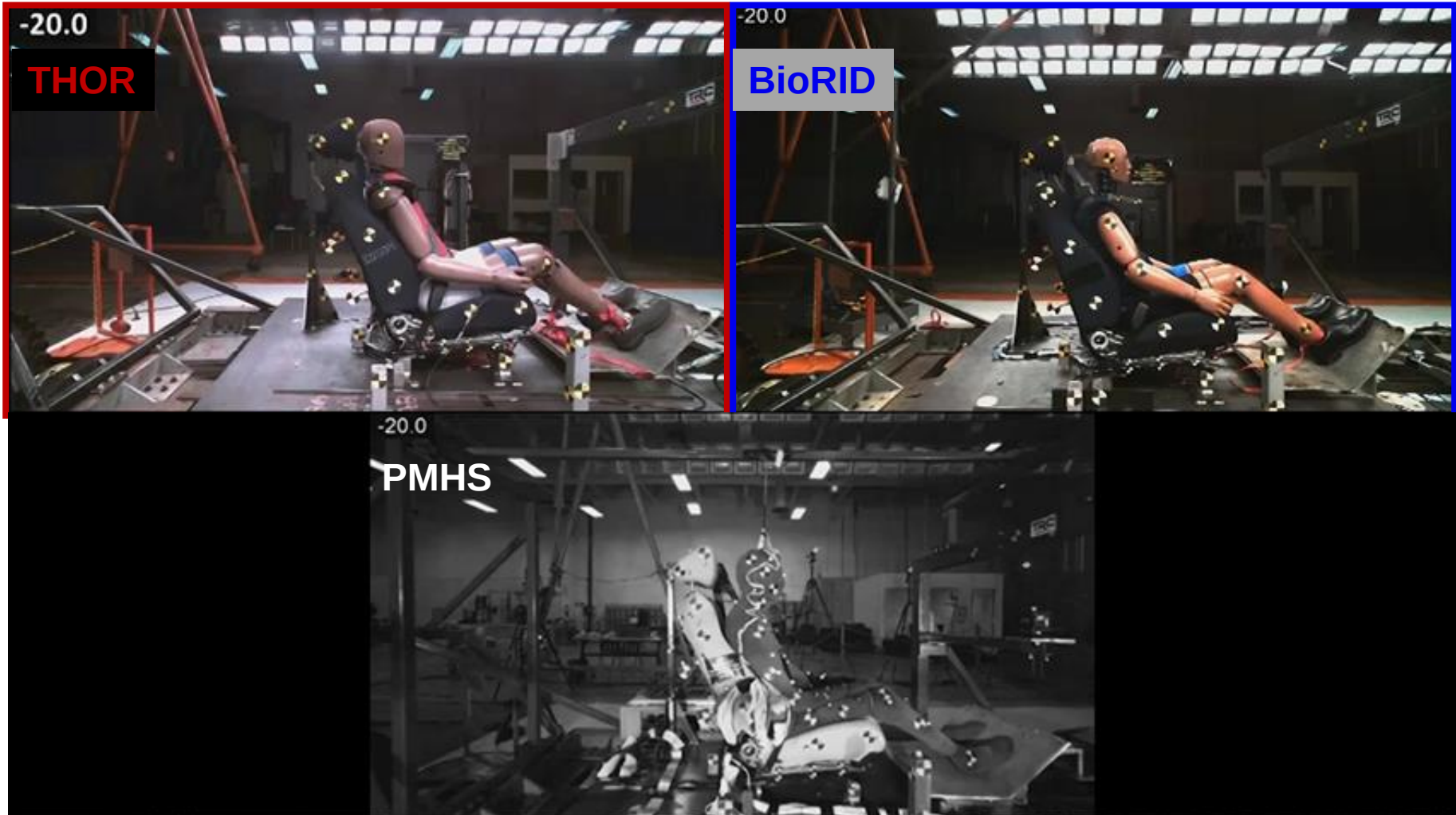
Ford Fusion

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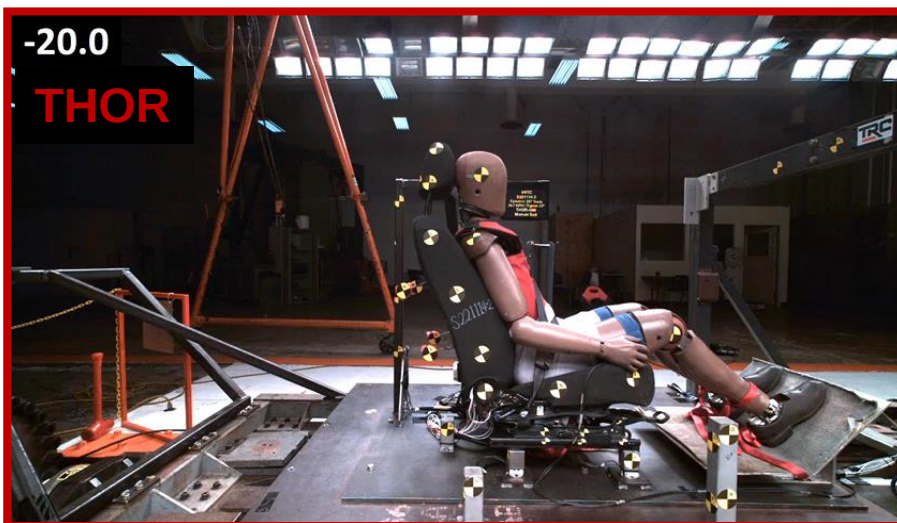
Honda Accord

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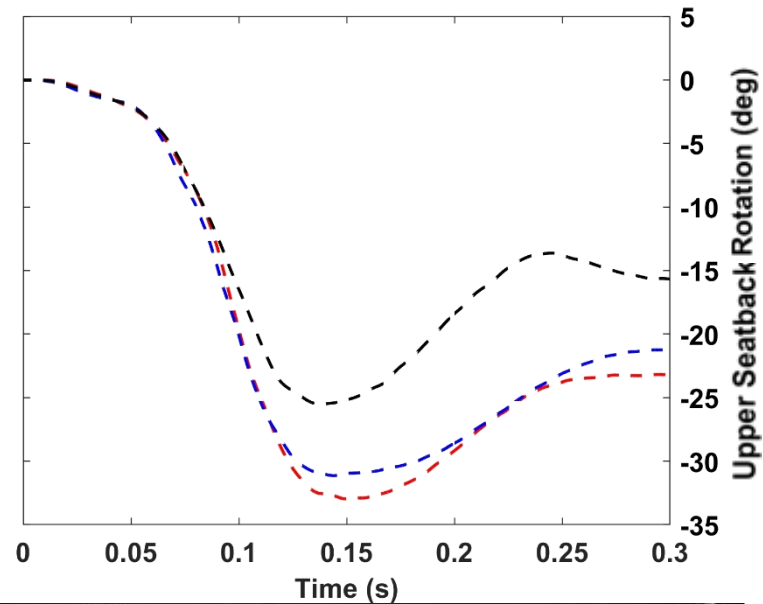
Volkswagen Tiguan

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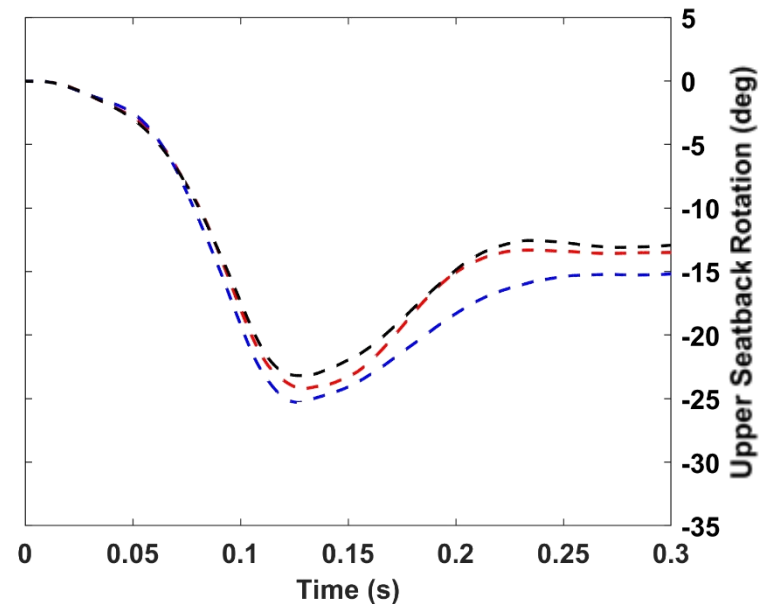


Seatback Rotation

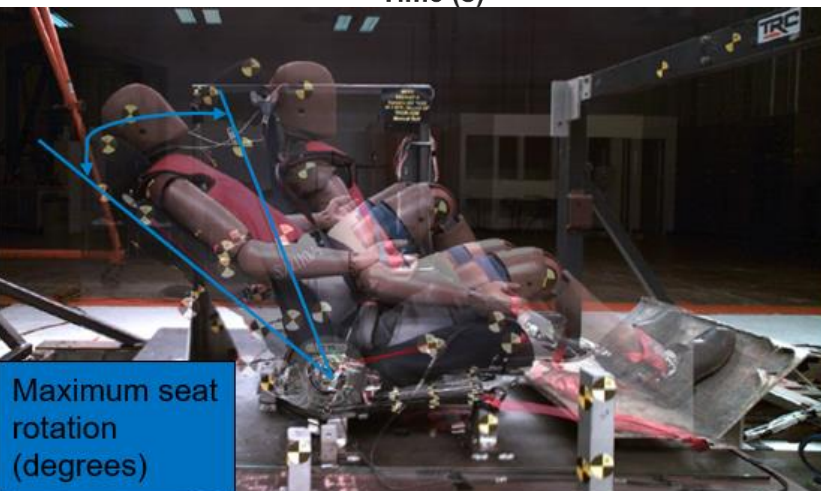
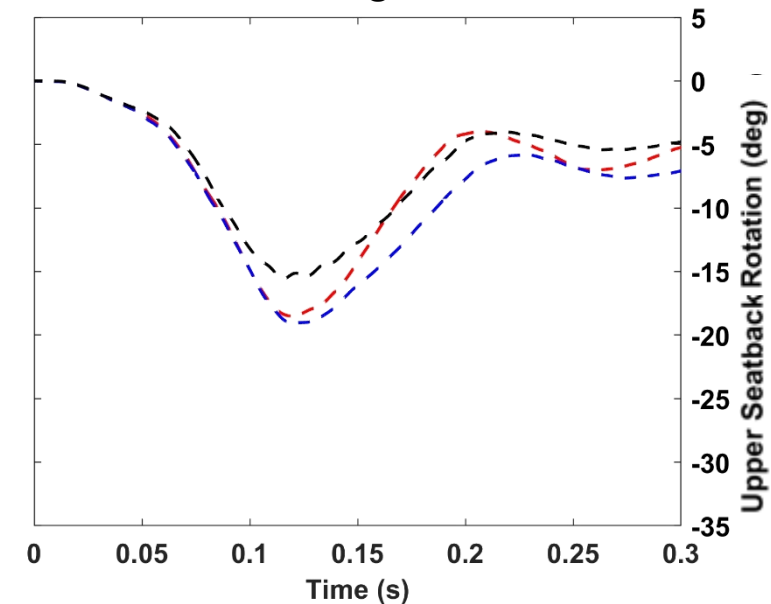
Ford Fusion



Honda Accord



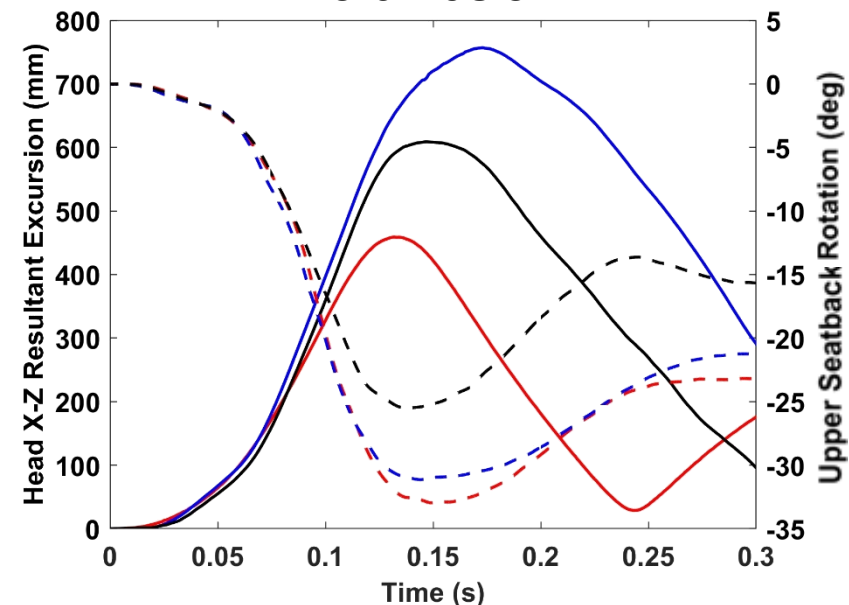
VW Tiguan



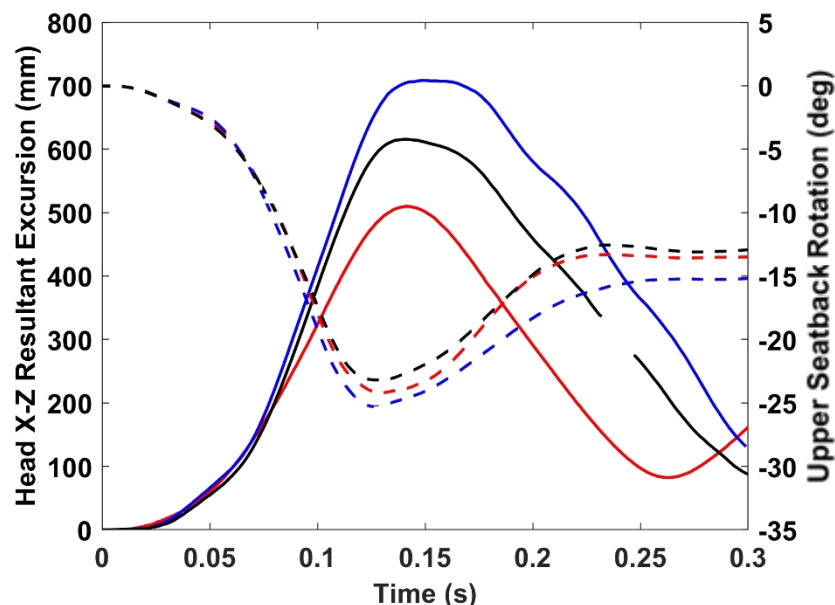
- Seatback rotation- THOR
- Seatback rotation- BioRID
- Seatback rotation- PMHS

Seatback Rotation and Head Excursion

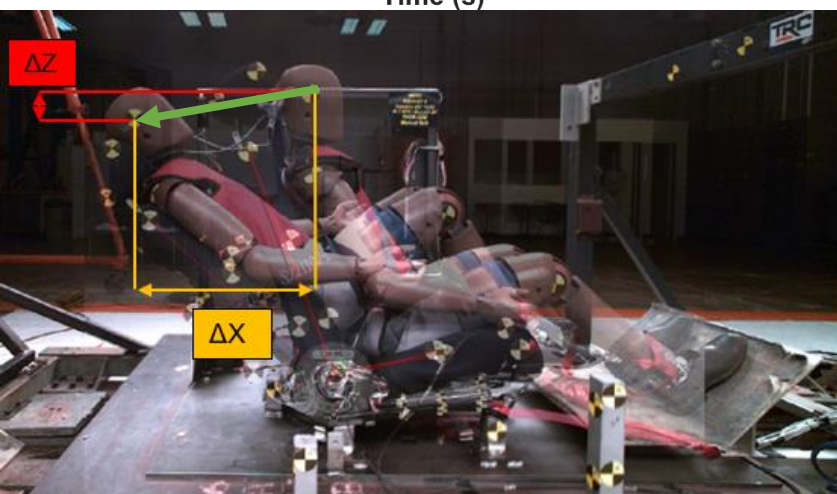
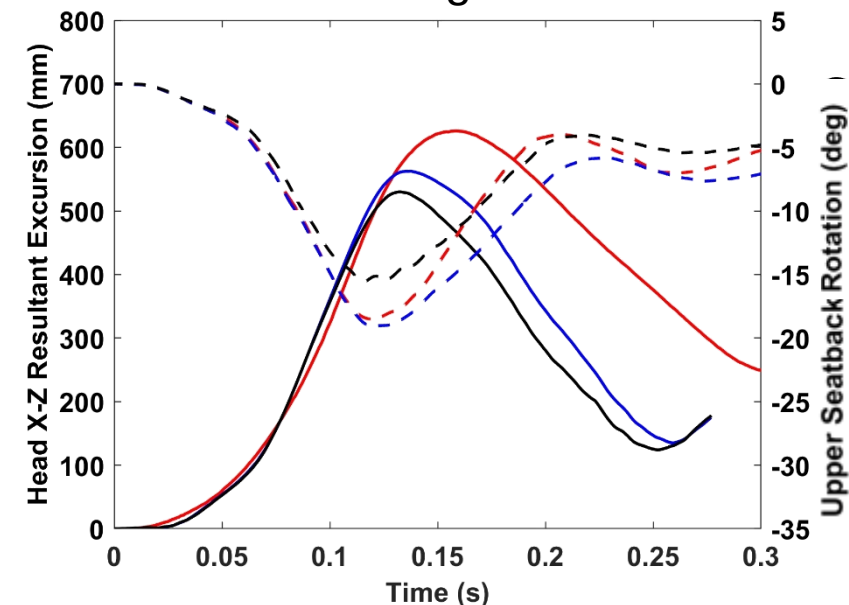
Ford Fusion



Honda Accord



VW Tiguan



- Head excursion- THOR
- Head excursion- BioRID
- Head excursion- PMHS
- - - Seatback rotation- THOR
- - - Seatback rotation- BioRID
- - - Seatback rotation- PMHS

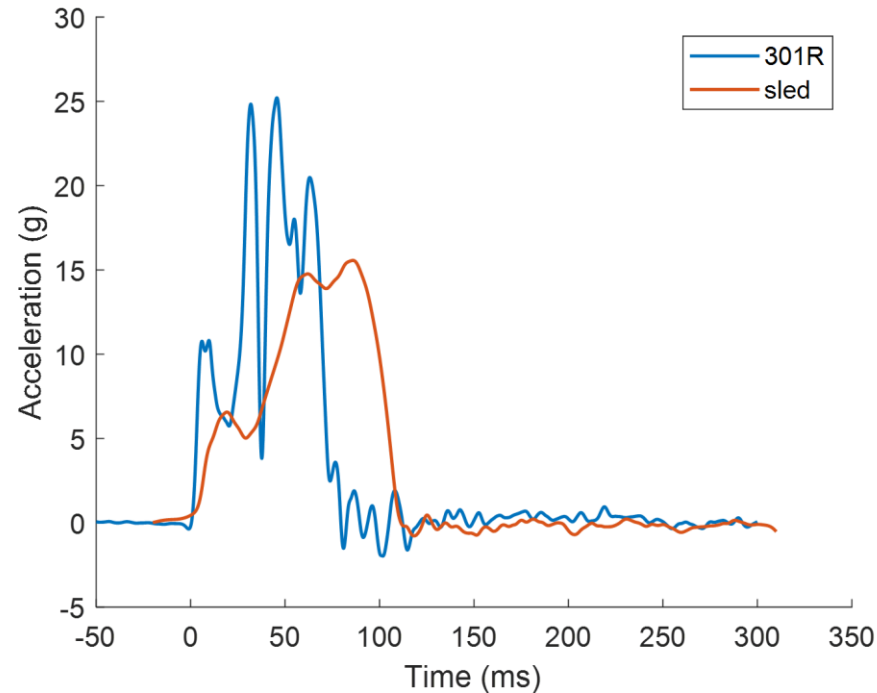
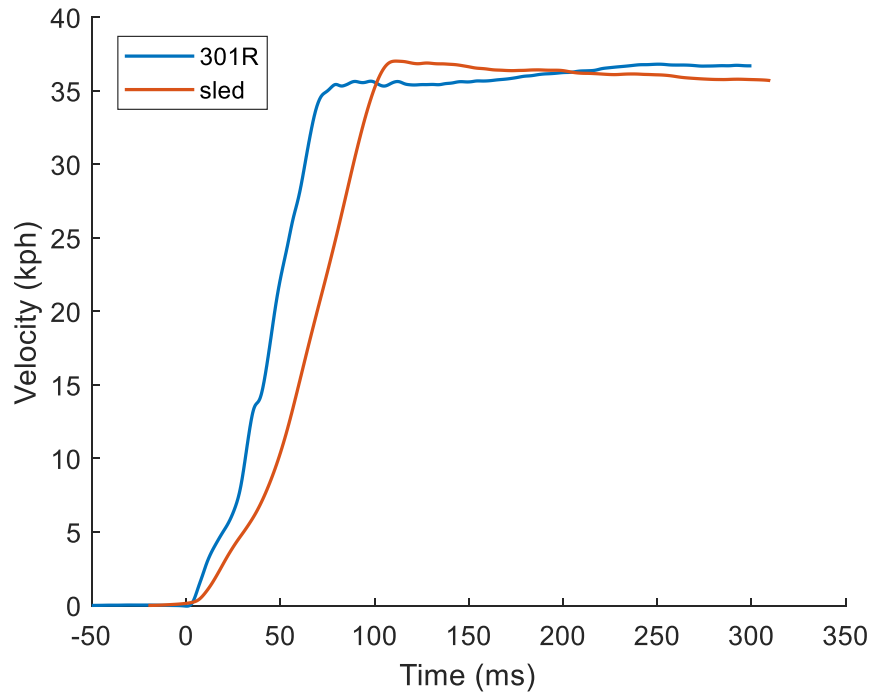
ATD Comparison to PMHS Response

Comparison of peak values		Ford Fusion		Honda Accord		Volkswagen Tiguan	
		THOR	BioRID	THOR	BioRID	THOR	BioRID
Kinematics	Head X accel		✓		✓		✓
	Head Y ARS						
	Head Z accel				---		✓
	Pelvis X accel		✓	✓			
	Pelvis Y ARS	---	---	---	---	---	---
	Pelvis Z accel		✓	---	---		
	Head excursion						✓
Seat	Seatback rotation			✓	✓		
	Seat twist	---	---			---	---

✓: within 10% difference from PMHS peak value
 --- : over 50% difference from PMHS peak value

Considerations

- Small sample size
- PMHS sustained no injury
 - No conclusions on ATD injury prediction ability
 - Sled pulse vs. full vehicle crash



Sled Test

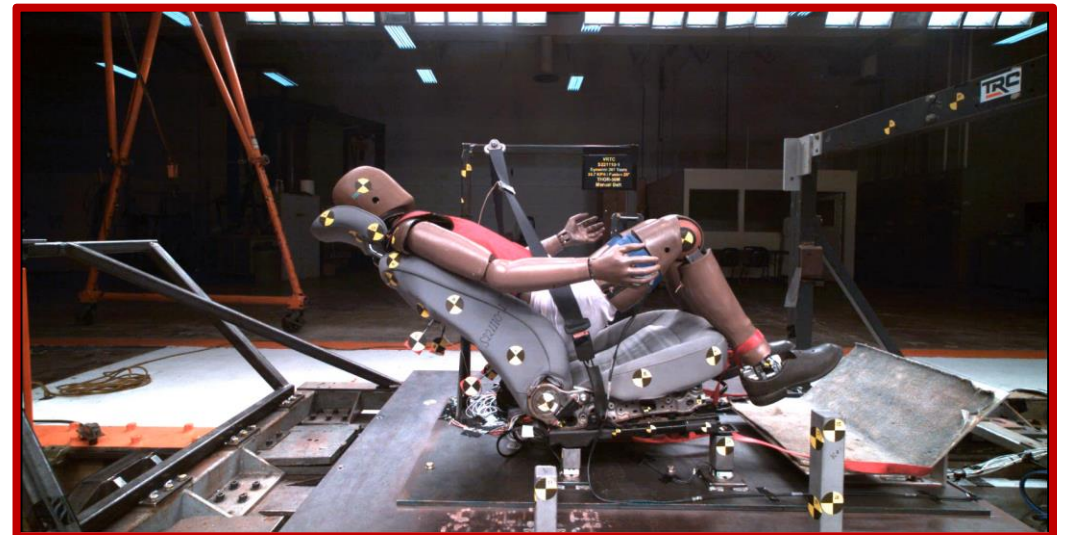
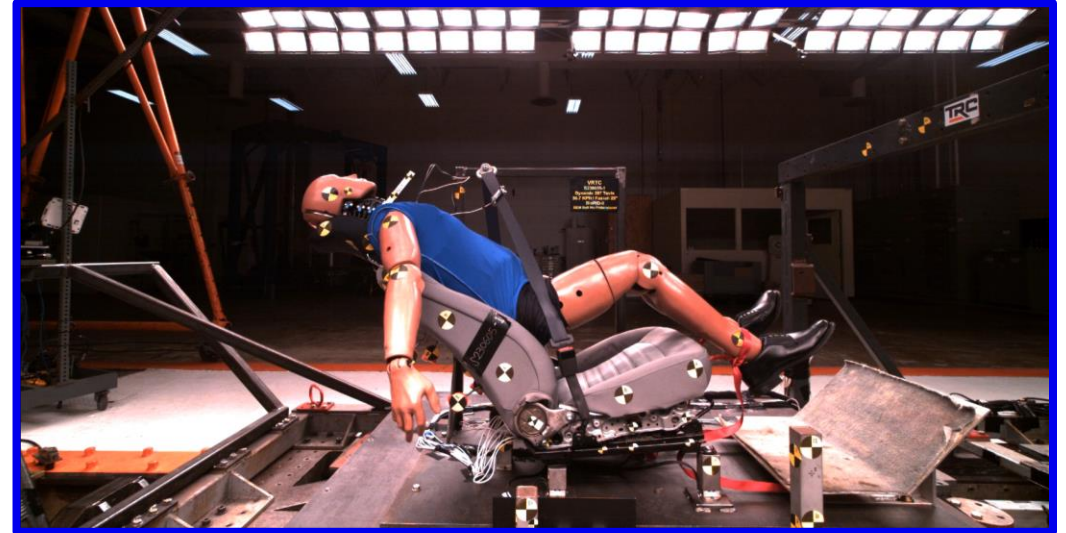
- Average of 8 mid-sized vehicles tested in FMVSS No. 301 condition
- Used for rear impact assessment by IIHS
 - *Edwards et al. 2019*

301 Test– VW Tiguan

- Full scale vehicle test

Current Work

- Next steps:
 - Explore boundary conditions to understand if injuries can be recreated in PMHS and replicated in the ATDs
 - Informed by real-world data
 - Run repeat testing using the same vehicle seat with multiple occupants
 - Create a PMHS corridor (n=3) to capture variation
 - Further assess repeatability of methodology and occupant/seat response
 - Further evaluation of different ATDs in different seats



References

- "Standard No. 207; Seating systems." Code of Federal Regulations, title 49 (2010):721-725. <https://www.govinfo.gov/app/details/CFR-2010-title49-vol6/CFR-2010-title49-vol6-sec571-207>.
- Edwards M, Brumbelow M, Trempel R, Gorjanc T. 2019. Seat Design Characteristics Affecting Occupant Safety in Low- and High-Severity Rear-Impact Collisions. Proceedings of IRCOBI Conference. Florence, Italy.
- Kang Y, Stammen J, Agnew A, Baker G, Pradhan V, Bendig A, Hagedorn A, Moorhouse K Bolte J. 2023. Thoracic responses and injuries to male postmortem human subjects (PMHS) in rear-facing seat configurations in high-speed frontal impacts, Traffic Injury Prevention, 24:sup1, S47-S54, doi: 10.1080/15389588.2023.2167490.



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