

# **NHTSA's Initial Evaluation of Child Side Impact Test Procedures**

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**Under contract to NHTSA's Vehicle Research & Test  
Center (VRTC)**

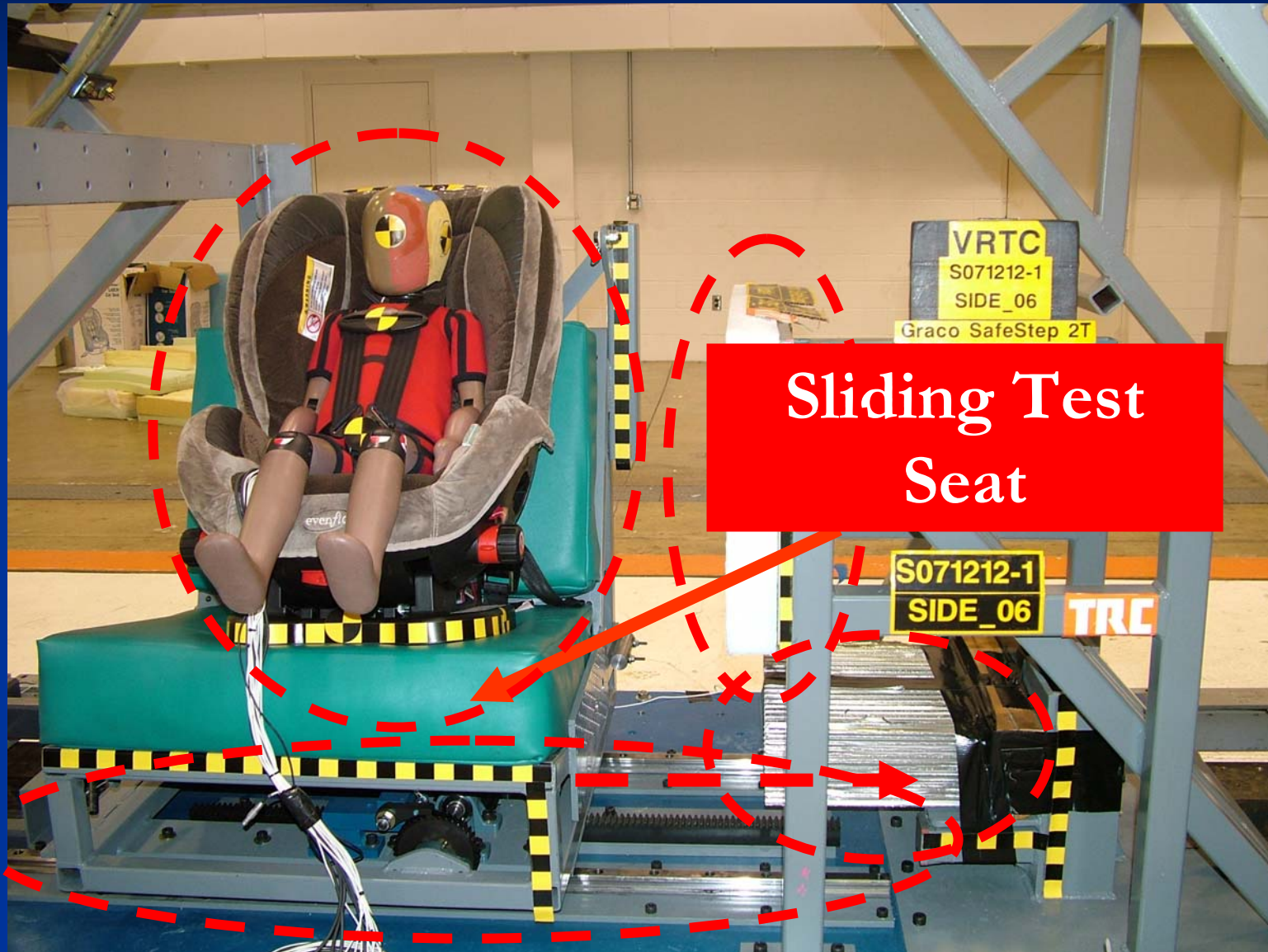
# Outline

- Background
- Purpose
- Test Conditions
- Test Series
- Future Work

# Background

- Takata and a number of other research groups were involved with initial look at child side impact sled testing
- Sled buck and test procedure developed
- Basic design of buck
  - seat slides along low friction rail
  - contact and crush with honeycomb creates seat deceleration

# Takata Buck Design



Sliding Test  
Seat

VRTC  
S071212-1  
SIDE\_06  
Graco SafeStep 2T

S071212-1  
SIDE\_06 TRC

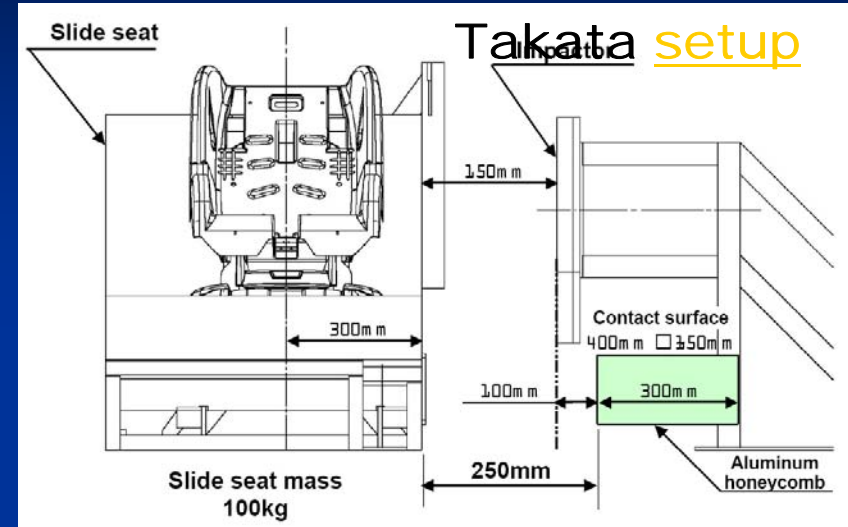
# Purpose

- NHTSA evaluating Takata buck and procedures at VRTC
- **PURPOSE:** viability of using Takata test buck and procedure for child side impact tests
  - Repeatability of test input pulse
  - Dummy response

# Test Conditions

# Side Impact Sled Variables

- Sliding seat acceleration
  - Honeycomb stiffness
- “Door” velocity
  - (sled pulse)
- “Door” padding stiffness
- Seat cushion foam
- Impact angle
- Locked vs. sliding seat



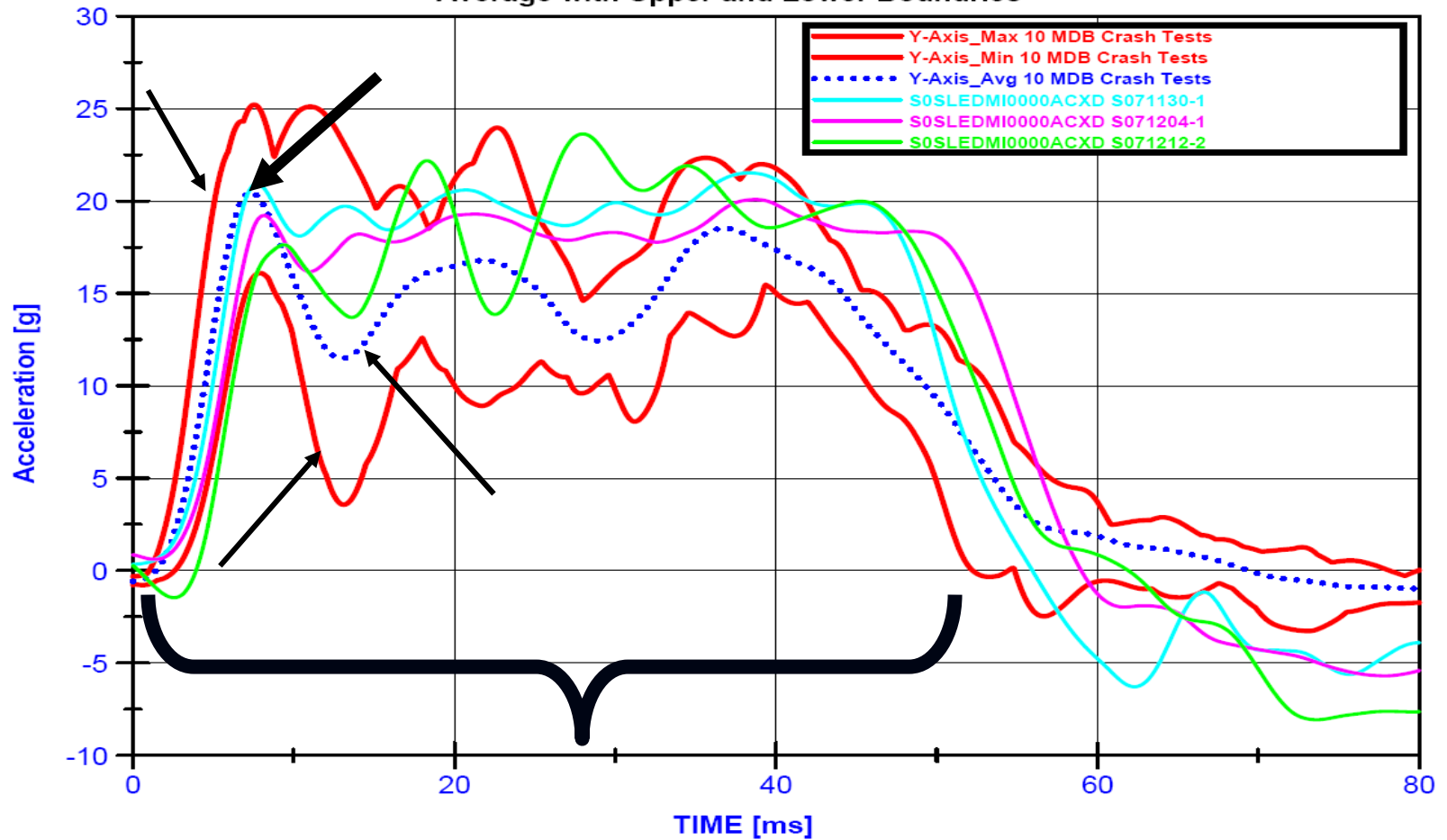
# Sled Test Pulse Parameters

- Sliding seat acceleration  $\sim 20$  g's
  - based on right rear sill accelerometers from 10 FMVSS No. 214 tests of small vehicles
- Sled (Door) velocity  $\sim 20$  mph
  - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- **Actual sled pulse:**
  - **$\frac{1}{2}$  sine wave with peak of 28 g's and velocity of  $\sim 20$  mph with a duration of  $\sim 50$  ms**
  - **Sled pulse –  $\frac{1}{2}$  sine**
    - **shape not critical; reach velocity in 250 mm**

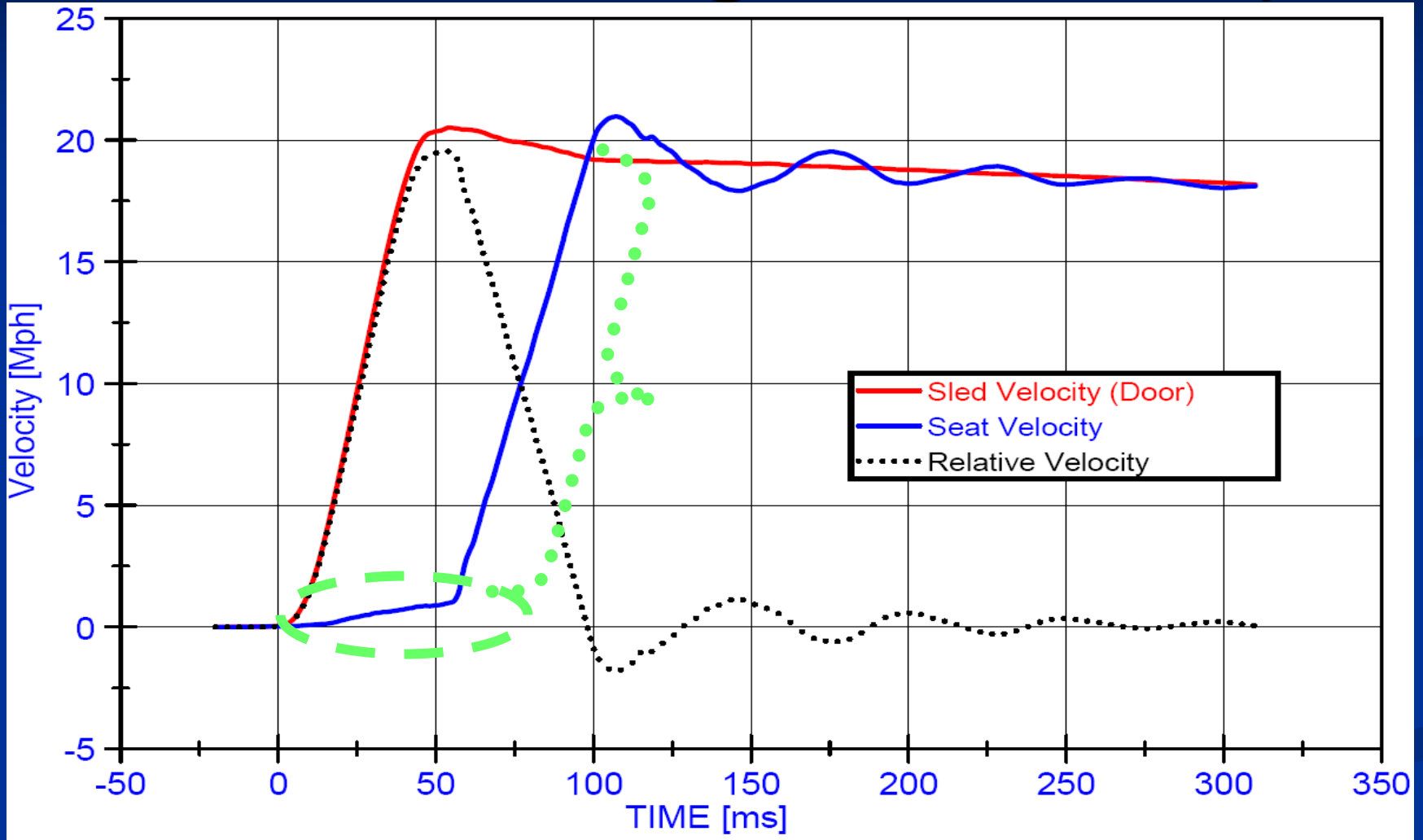


# Sliding Seat Acceleration Pulse

10 MDB Tests Combined  
Right Rear Sill Y-axis Acceleration  
Average with Upper and Lower Boundaries



# Sled and Sliding Seat Velocity



# Seats with “straight” wings

# CRS Tested

U.S. Models	Graco SafeSeat Step 2 Toddler		
	Evenflo Triumph Advance DLX		
	Safety 1st All-in-One Convertible		
European Models	Maxi-Cosi Priori (SIP)		
	Graco Logico M (SIP) (does not meet FMVSS 213)		Doesn't have LATCH

# Seats with “fan” wings

# CRS Tested

U.S. Models	Graco SafeSeat Step 2 Toddler		
	Evenflo Triumph Advance DLX		
	Safety 1st All-in-One Convertible		
European Models	Maxi-Cosi Priori (SIP)		
	Graco Logico M (SIP) (does not meet FMVSS 213)		Doesn't have LATCH

Seats with no pronounced wings

# CRS Tested

U.S. Models	Graco SafeSeat Step 2 Toddler		
	Evenflo Triumph Advance DLX		
	Safety 1st All-in-One Convertible		
European Models	Maxi-Cosi Priori (SIP)		
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# CRS SI Sled Test Series

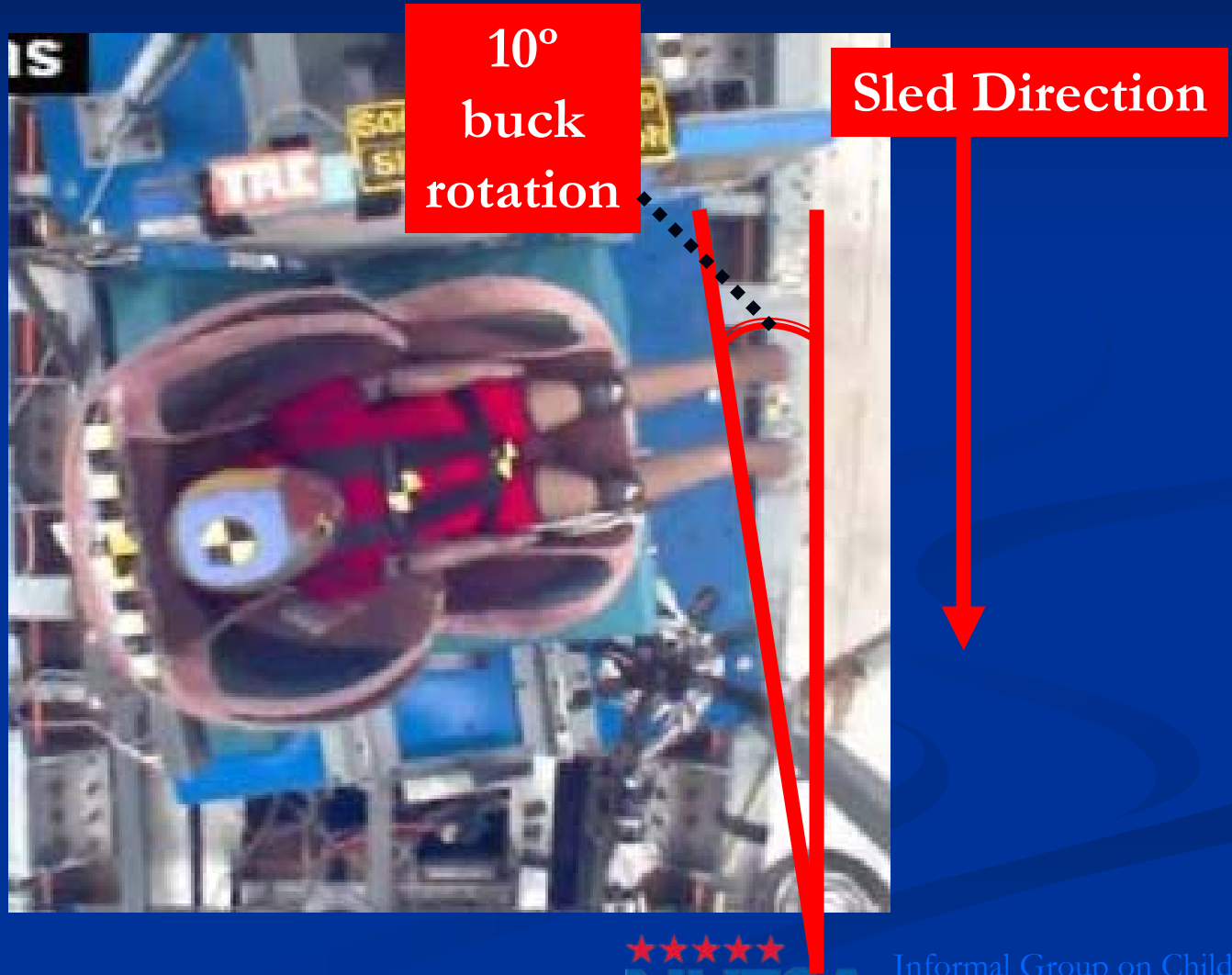
## ■ Series #1:

- Sliding seat
- Q3s dummy
- 0° and 10° impact angles

## ■ Series #2:

- Locked seat
- Q3s dummy
- 0° and 10° impact angles

# 10 degree setup



# Series # 1: Sliding Seat, 0° vs. 10° Impact Angle

- at least 2 repeats for each child seat
- Q3s dummy
- Takata sliding seat fixture
- 0° and 10° impact angles
  - 10° based on FMVSS 214 crash data
  - Performed repeat tests with 5 CRS models at 0°
- Door padding - 2" foam thickness



# Safety 1<sup>st</sup> All-in-One, 0° vs. 10° Impact



0° impact



10° impact

# Safety 1<sup>st</sup> All-in-One, 0° vs. 10° Impact

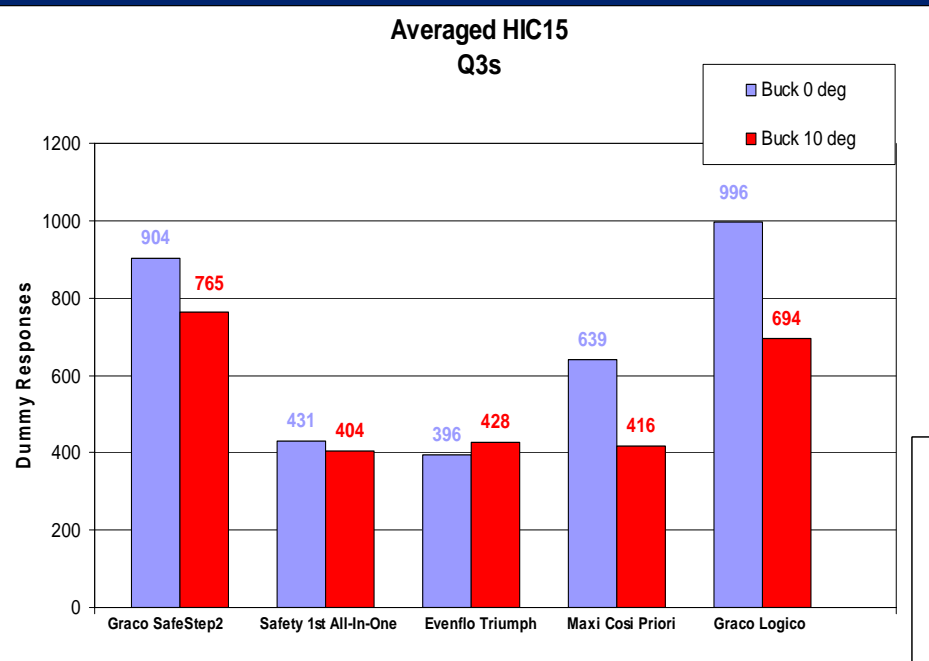


0° impact



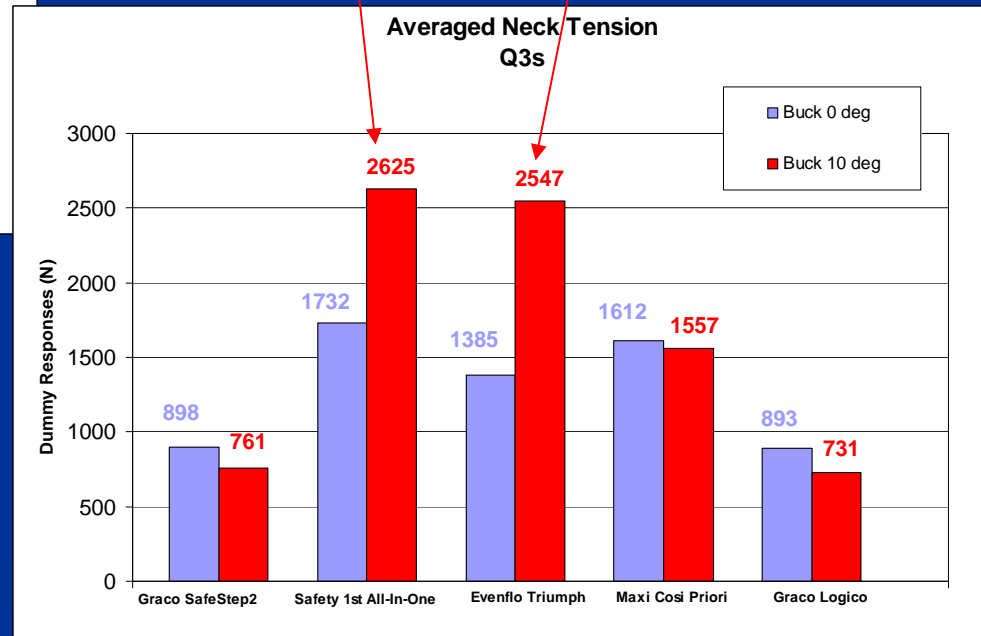
10° impact

# 0° vs 10° Impact Angle



HIC response similar trend for all CRS (generally higher at 0° than at 10°)

High neck tensions in All-in-One and Triumph at 10° appear due to CRS wing designs



# Series # 1: 0° Angle, Sliding Seat

Number	Car Seat	HIC15	Neck Tension (+FZ)	Shoulder Y defl (mm)	Chest Defl (mm)	Spine Y (G)	Pelvis Y (G)	Pubic ForceY (N)
Side_002	Graco SafeStep2	957	949	-21.2	-27.3	88.2	119.7	295.8
Side_003	Graco SafeStep2	948	957	-22.4	-23.9	91.1	124.1	325.2
Side_004	Graco SafeStep2	915	856	-21.8	-23.9	94.1	107.3	379.1
Side_005	Graco SafeStep2	818	840	-20.2	-24.3	99.7	106.9	273.4
Side_006	Evenflo Triumph Deluxe	416	1382	-21.6	-24.8	120.9	142.0	430.2
Side_007	Evenflo Triumph Deluxe	375	1387	-22.2	-26.3	119.3	152.6	451.5
Side_008	Maxi-Cosi Priori	649	1685	-23.3	-26.3	73.3	98.1	342.5
Side_009	Maxi-Cosi Priori	629	1539	-20.5	-22.0	85.0	99.5	360.7
Side_010	Safety 1st All-in-One	400	1686	-22.6	-27.8	120.5	119.2	490.3
Side_011	Safety 1st All-in-One	451	1767	-24.3	-21.1	138.0	112.6	432.4
Side_012	Graco SafeStep2 (Takata foam)	988	860	-22.8	-23.7	127.7	106.2	287.1
Side_013	Graco SafeStep2 (Takata foam)	798	925	-19.7	-24.7	129.2	102.6	338.1
Side_014	Safety 1st All-in-One (Takata Foam)	431	1730	-22.7	-23.8	169.6	122.0	527.2
Side_015	Safety 1st All-in-One (Takata Foam)	443	1746	-22.5	-22.0	163.9	114.7	595.0
Side_022	Graco Logico M (Takata Foam)	959	893	-24.1	-31.1	96.0	112.5	216.7
Side_023	Graco Logico M (Takata Foam)	1033	894	-23.1	-25.8	111.8	101.7	306.1

Side\_011 & Side\_012: Q3s jacket was removed

# Series # 1: 10° Angle, Sliding Seat

Number	Car Seat	HIC15	Neck Tension (+FZ)	Shoulder Y defl (mm)	Chest Defl (mm)	Spine Y (G)	Pelvis Y (G)	Pubic Force Y (N)
Side_016	Graco Logico M (European)	694	731	-21.9	-28.6	126.7	78.5	183.3
Side_017	Graco SafeStep2	773	837	-21.6	-29.5	87.3	91.3	303.1
Side_021	Graco SafeStep 2	756	685	-23.8	-30.4	77.9	89.7	299.6
Side_018	Evenflo Triumph Deluxe	428	2547	-21.5	-26.2	94.4	107.2	464.4
Side_019	Safety 1st All-in-One	404	2625	-20.3	-25.6	136.0	104.8	336.8
Side_020	Maxi Cosi Priori (European)	416	1557	-22.2	-27.4	75.7	89.9	295.8

# Sliding Seat, 0° vs 10° Impact Angle

## Summary

- Takata sled exhibited good repeatability
- Able to distinguish between carseat models using dummy responses
  - CRS wing design differences
- Observed differences between 0° and 10° impact angles for 2 CRS models tested
  - Significantly higher neck tensions during 10° test for CRS with minimal wing or wider angled wing designs

# CRS SI Sled Test Series

## ■ Series #1:

- Sliding seat
- Q3s dummy
- 0° and 10° impact angles

## ■ Series #2:

- Locked seat
- Q3s dummy
- 0° and 10° impact angles

# Method to Lock Seat



Rigid bar with removable shims





# Sliding vs. Locked Seat



Evenflo Triumph



Graco SafeSeat



Maxi Cosi Priori



Safety 1st All-in-One

# Sliding vs. Locked Seat 10° impact



Sliding seat

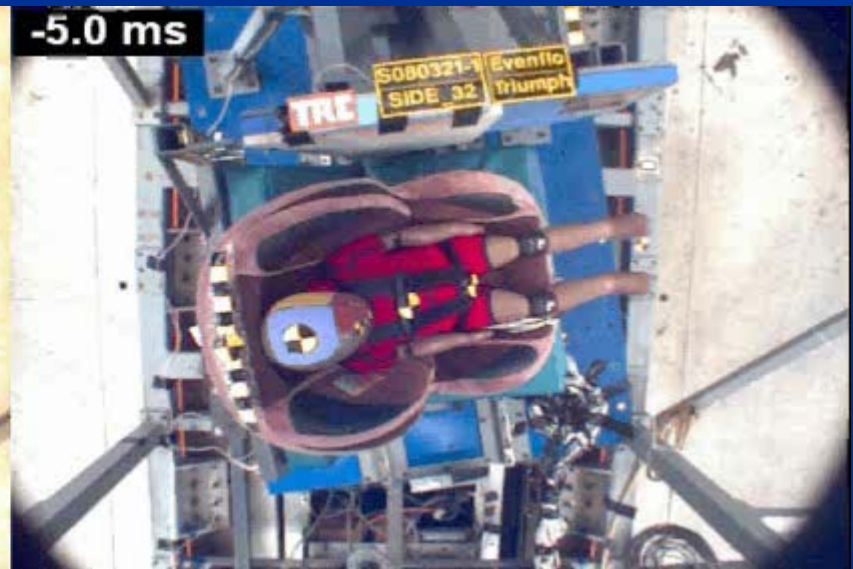


Locked seat

# Sliding vs. Locked Seat 10° impact

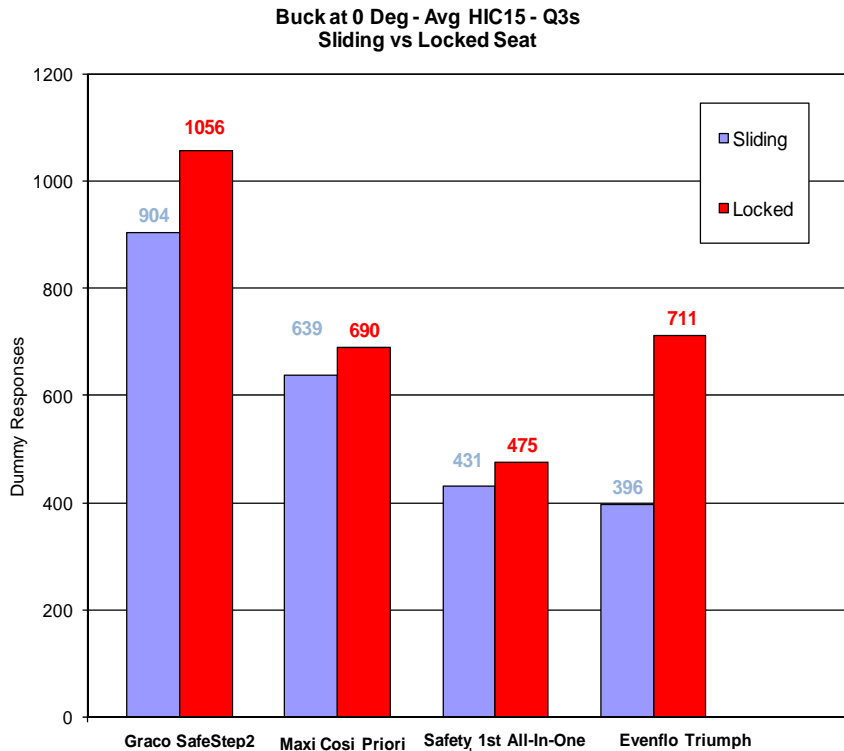


Sliding seat



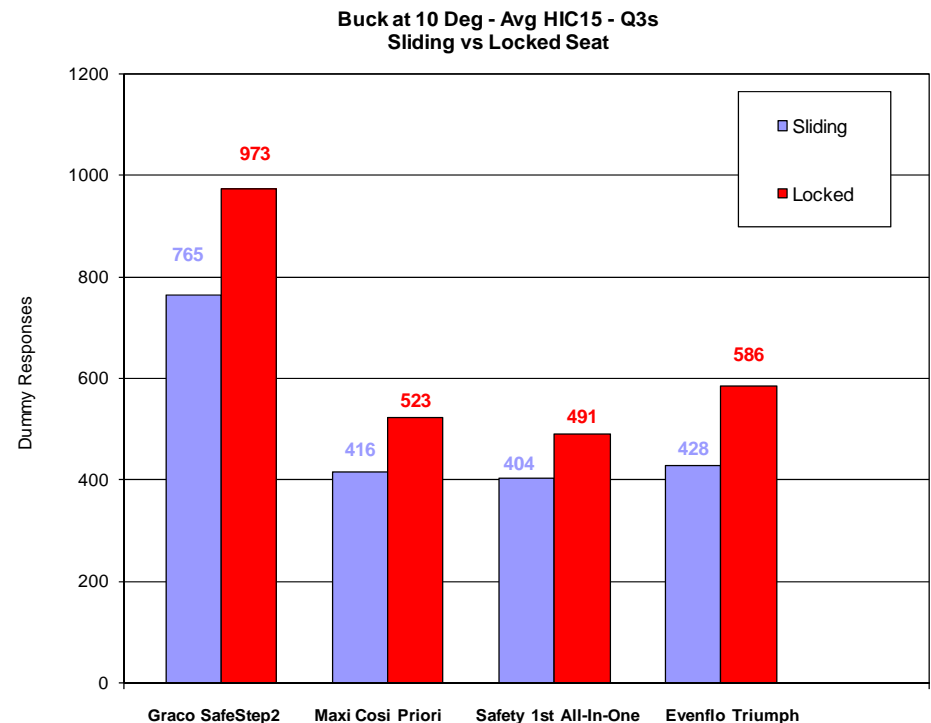
Locked seat

# Sliding vs Locked Seat, 0° and 10° Angles



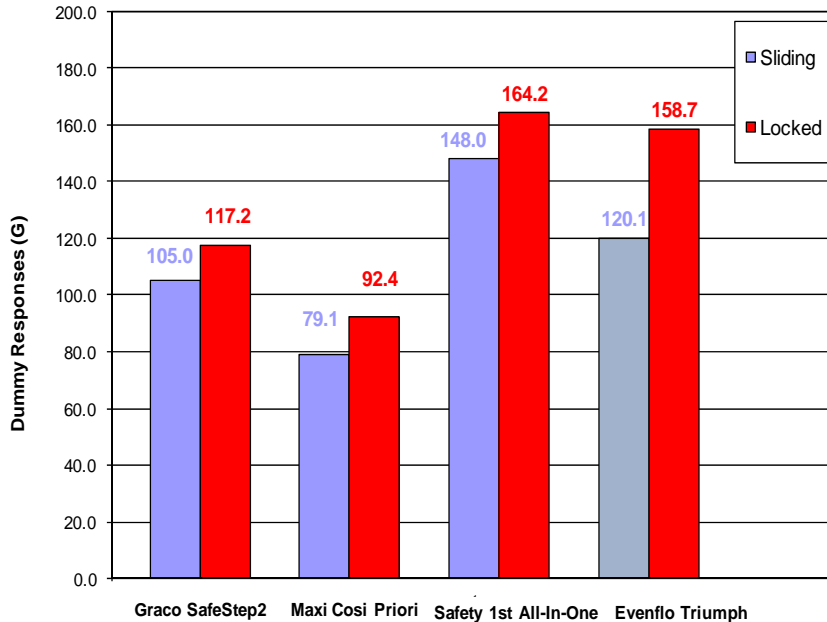
HIC responses follow similar trends for both 0° and 10° test conditions

HIC responses follow similar trends for both sliding and locked seat conditions



# Sliding vs Locked Seat, 0° and 10° Angles

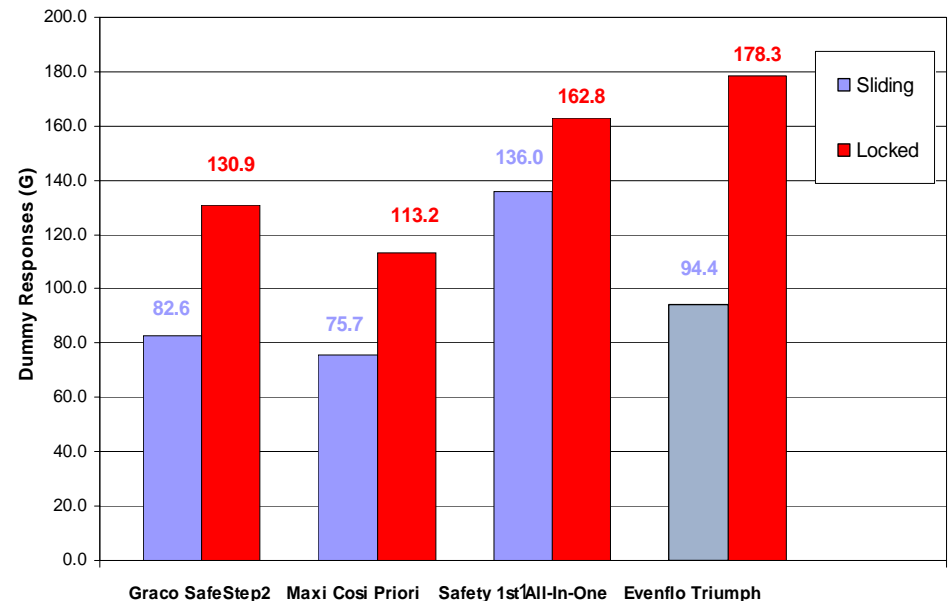
Buck at 0 Deg - Avg Spine Y Acc. - Q3s  
Sliding vs Locked Seat



For 0° test condition, dummy responses show similar trends

For 10° test condition, the effect of child restraint design appears to be more pronounced

Buck at 10 Deg - Avg Spine Y Acc. - Q3s  
Sliding vs Locked Seat



# Series # 2: 0° and 10° Angle, Locked Seat

Number	Car Seat	HIC15	Neck Tension (+FZ)	Shoulder Y defl (mm)	Chest Defl (mm)	Spine Y (G)	Pelvis Y (G)	Pubic ForceY (N)
Side_32	Evenflo Triumph (Takata foam) Buck angled 10 deg Veh. seat locked	586	1872.35	-21.32	-29.55	178.3	131.69	736.6
Side_033	Graco SafeStep2 (Takata foam) Buck angled 10 deg Veh. seat locked	918	1459.59	-18.66	-25.56	121.67	119.48	716.82
Side_034	Graco SafeStep2 (Takata foam) Buck angled 10 deg Veh. seat locked	1027	1572.04	-18.02	-23.58	140.12	114.31	555.02
Side_035	Maxi Cosi Priori (Takata foam) Buck angled 10 deg Veh. seat locked	523	2459.52	-19.11	-19.94	113.18	108.71	742.48
Side_036	Safety 1st All-in-One (Takata foam) Buck angled 10 deg Veh. seat locked	491	2306.25	-18.86	-24.77	162.82	121.52	590.73
Side_037	Safety 1st All-in-One (Takata foam) Buck angled 0 deg Veh. seat locked	475	2427.59	-19.59	-12.60	164.23	119.76	416.47
Side_038	Graco SafeStep2 (Takata foam) Buck angled 0 deg Veh. seat locked	1056	1424.27	-19.95	-26.34	117.24	113.63	370.87
Side_039	MaxiCosi Priori (Takata foam) Buck angled 0 deg Veh. seat locked	690	2129.00	-21.37	-23.48	92.44	117.85	630.41
Side_040	Evenflo Triumph (Takata foam) Buck angled 0 deg Veh. seat locked	737	1547.82	-22.02	-27.65	150.92	139.49	649.89

# Sliding vs. Locked Seat Summary

## ■ Sliding Seat Configuration

- better real-world simulation
- sliding seat configuration repeatable

## ■ Locked Seat Configuration

- simpler to fabricate
- have not conducted repeatability tests
- generally resulted in higher injury values
  - reducing velocity could compensate for difference in values

## ■ Unknown if both sled configurations will produce same outcome

- Mixed outcomes of observed trends

# NHTSA's Future CRS Side Impact Research

- Recent tests:
  - a few 15° and 20° tests
  - 1 FMVSS 214 crash test
- Continue test procedure development and evaluation
  - Additional side impact crash tests
  - Wall padding stiffness
  - Buck angle
  - Seat cushion stiffness
  - Other CRS types and child size dummies



# Test data and AVI footage available at

[http://www-nrd.nhtsa.dot.gov/database/  
nrd-11/veh\\_db.html](http://www-nrd.nhtsa.dot.gov/database/nrd-11/veh_db.html)

Test Numbers 6392 through 6436

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# Thank You

