

Status of ES-2 Research at NHTSA

***Presentation at the
U.N./ECE/GRSP Meeting***

***Geneva, Switzerland
December 10, 2002***

What Is Our Motivation?

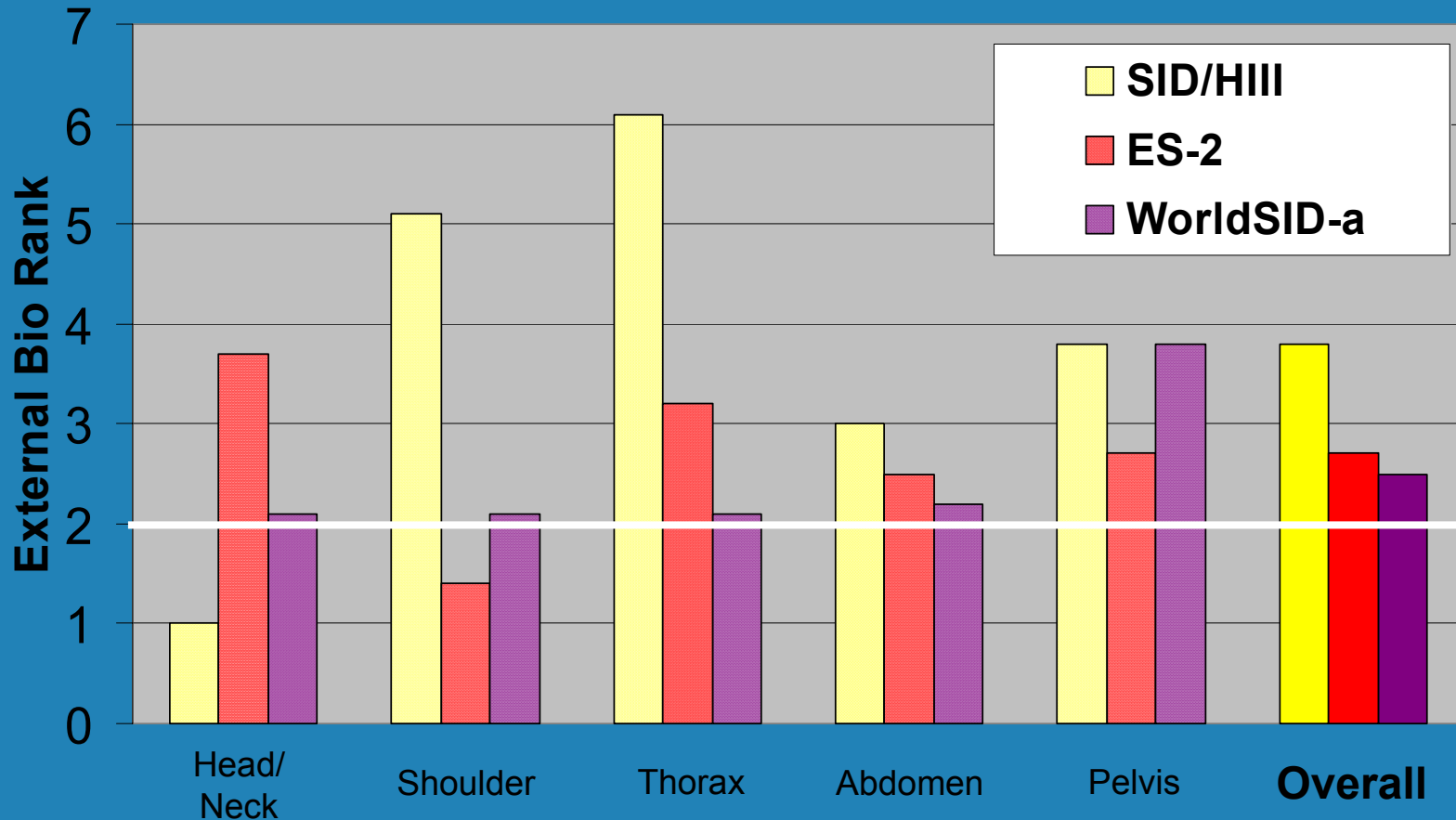
- **Injury criteria: improve injury measurement capabilities in FMVSS 214 (thorax, abdomen, & pelvis)**
- **Harmonization: if viable, incorporate ES-2 in FMVSS 214 as an interim harmonized side impact dummy**

ES-2 Testing Update

- **Crash tests* (34 completed)**
 - 201P (9) and forward oblique pole side impact (11)
 - US side impact NCAP (7)
 - High Severity Tests (7) - IIHS MDB and F150 striking vehicle
- **Mechanical performance component tests**
 - Pendulum and rib drop tests
 - Seat back pressure maps
- **Biofidelity tests (total of 19 sled & 10 impactor)**
 - Head/neck/shoulder sled tests
 - Shoulder/thorax/pelvis impactor tests
 - Additional abdominal offset sled tests
- **Repeatability/Durability tests (12 sled)**
 - High speed padded wall
 - Low speed rigid flat wall
 - Low speed abdominal offset rigid wall
 - Low speed thoracic offset rigid wall

* Since ESV 6/01

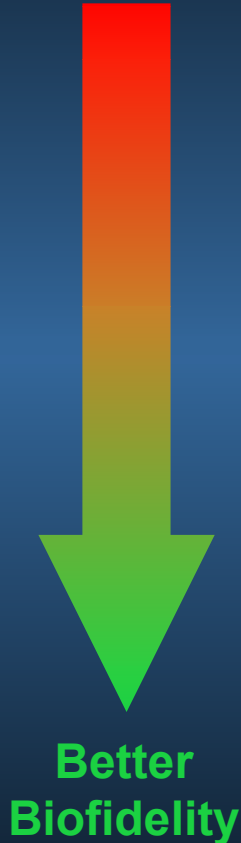
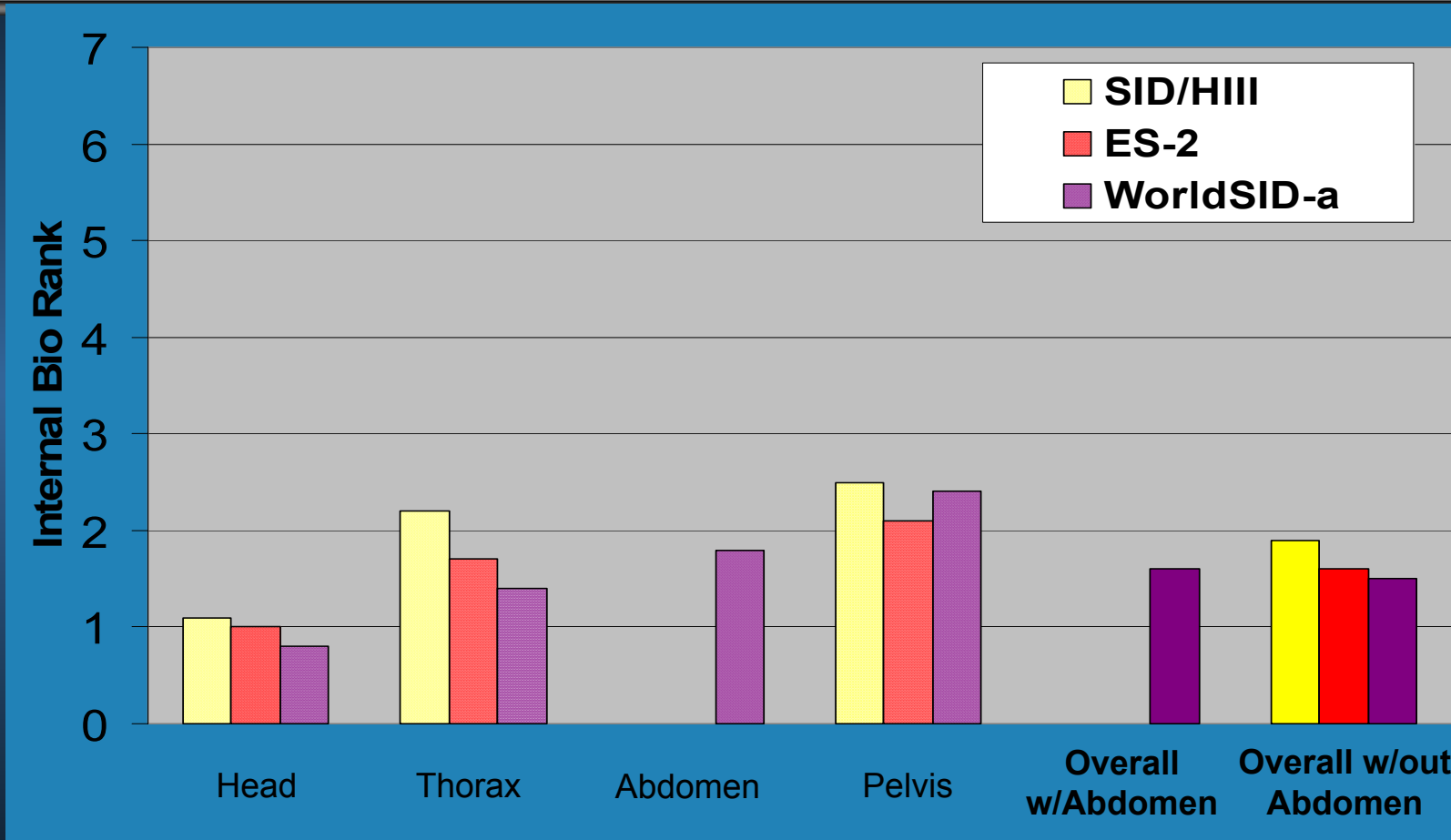
Preliminary External Dummy Biofidelity Ranks*



Better Biofidelity

*Rhule et al 46th STAPP, 2002

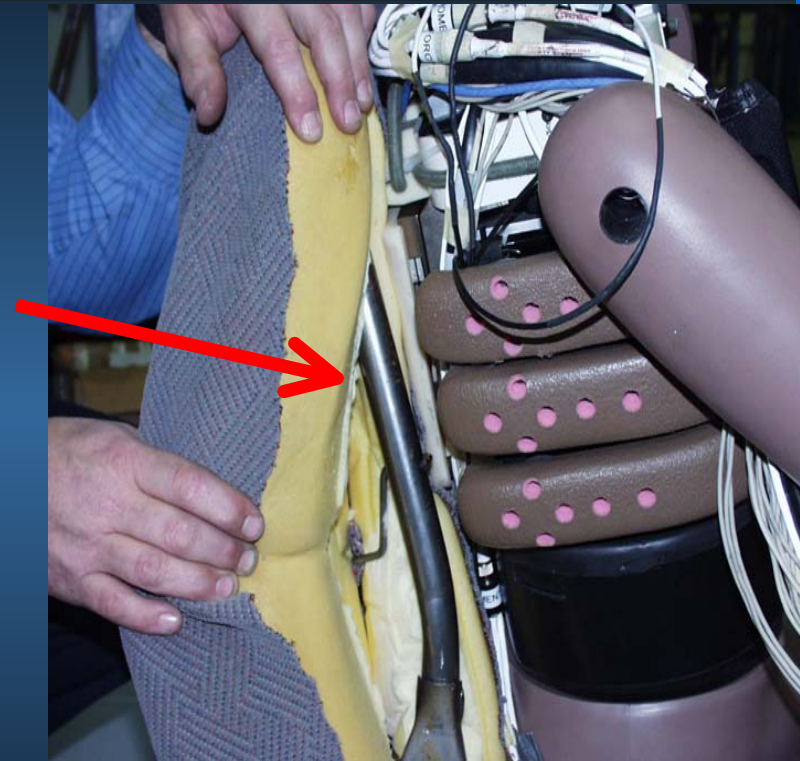
Preliminary Internal Dummy Biofidelity Ranks



***Rhule et al 46th STAPP, 2002**

Earlier ES-2 Testing Findings

- Rib binding is gone
- Dummy is durable
- Back plate/seat interaction is an issue (seat frame can catch back plate and off-load the thorax)
 - Possible solutions
 - Placing a limit on back plate loads
 - Retrofit internal dummy fix
 - Use of protective shield as part of seating procedure
- ES-2 demonstrated ability to detect usefulness of head protection
- ES-2 exceeded thoracic and abdominal injury threshold in some vehicles (SID did not)



ES-2 Torso Back Plate Loads

	Driver		Rear Occupant							
	Fy(N)	Time(ms)	Fx(N)	My(N-m)	Mz(N-m)	Fy(N)	Time(ms)	Fx(N)	My(N-m)	Mz(N-m)
2002 Side NCAP Fleet Performance ES-2 Tests										
Focus	1214	39	434	20	17	-492	44	803	-39	-30
Corolla	-321	33	578	42	26	CRS child dummies in rear				
Impala (combo)	4710	33	3354	78	149	-622	77	955	-41	-24
LeSabre	825.16	34			-102	609	46	883	-9	-16
Escape	-415	53	649	-19	28	-365	56	-117	7	-5
Odyssey (thorax)	704	40	-905	-40	33	CRS child dummies in rear				
Tundra	80	28		-130	83					
FMVSS 214 MDB Upgrade/High Severity Tests										
Prizm/IIHS MDB	8103	24	6684	393	246	-565	90	1931	39	-57
Prizm/F150	11533	33	2965	-67	155	-520	98	1088	-25	-29
Deville/IIHS MDB	-332	43	482	-25	20	-484	60	1143	-12	-11
Deville/F150	-198	43	234	-13	18	-363	61	364	-12	-9
NCAP Deville/IIHS MDB	-512	36	1390	-28	-41	-821	51	1323	-14	-18
NCAP Deville/F150	-215	61	680	-16	32	-520	53	611	-9	-19
Maxima/IIHS MDB	-408	37	741	-23	26.7	-161	79	554	-18	18

Back Plate Loads

ES-2 Torso Back Plate Loads in Pole Tests

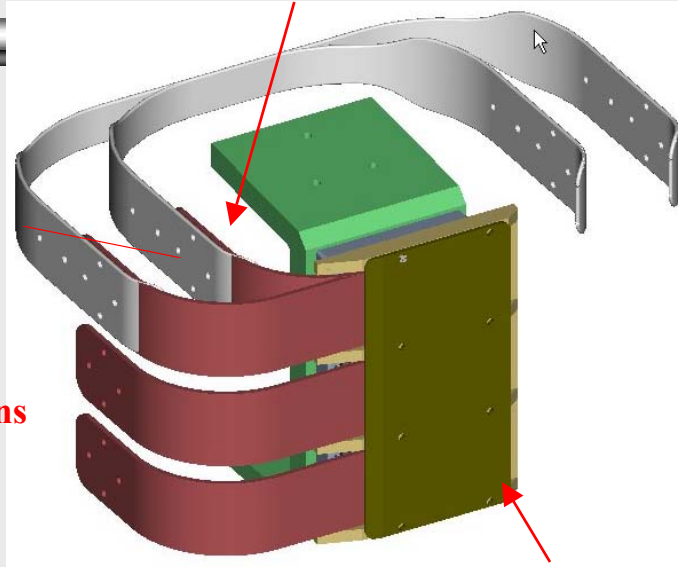
	Driver				
	Fy(N)	Time(ms)	Fx(N)	My(N-m)	Mz(N-m)
Saturn	1774	52	723	21	31
Saturn (curtain)	2047	49	502	-9	17
Maxima	-294	42	243	-14	17
Maxima (combo)	279	49	110	17	19
Cougar (combo)	665	51	127	-37	59
Saab (combo)	-225	63	534	13	22
Volvo (thorax/curtain)	324	43	691	-14	28
Windstar (combo)	194	58	-1098	35	24
Explorer (curtain)	-542	55	308	-5	11



People Saving People
<http://www.nhtsa.dot.gov>

FTSS ES-2 Rib Extensions Upgrade

Rib Extension at 58mm deflection



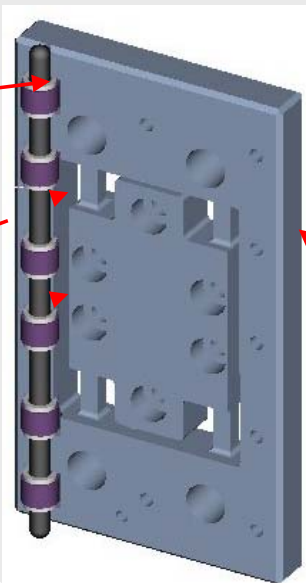
Steel Rib Extensions

The new back plate is made of aluminum for providing enough strength to retain the bearing shaft

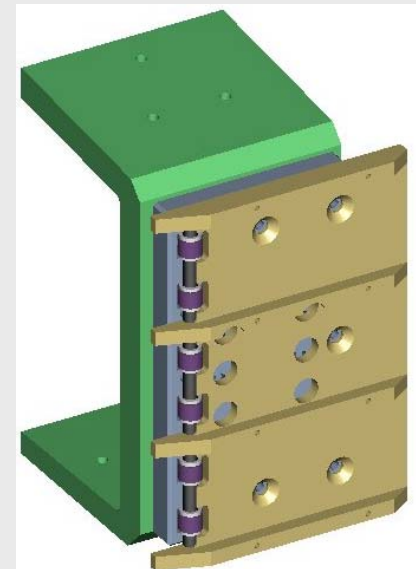
Teflon Cover.

Needle bearing. Two bearings per rib, a total of six bearings.

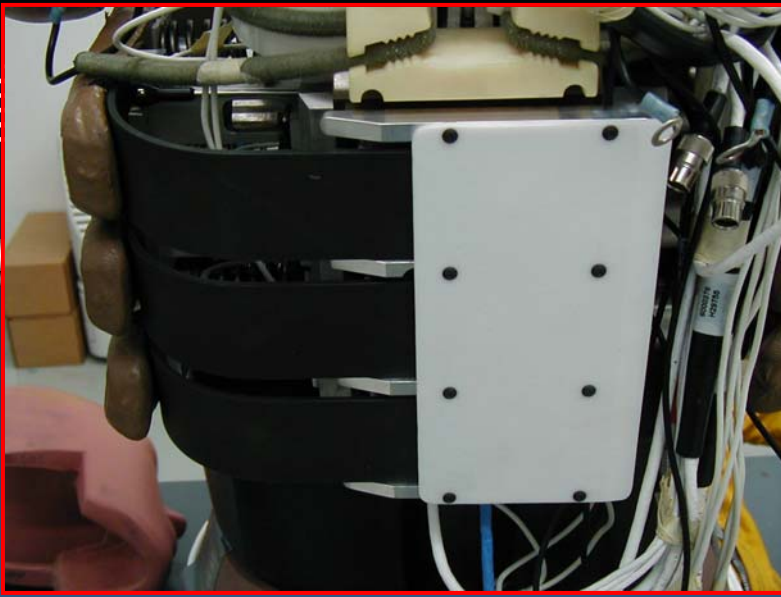
Teflon washer, two per each bearing



Back plate modified to accommodate needle bearings and shaft

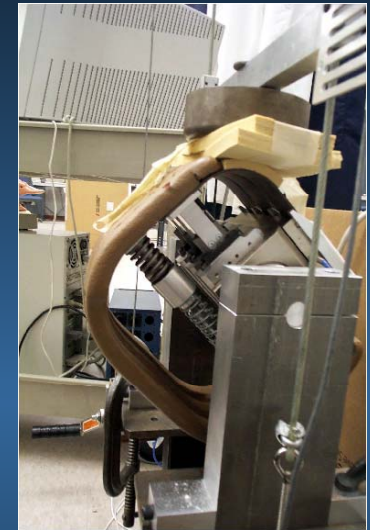


ES-2 Rib Extensions



ES-2 Rib Extensions Design Evaluation

- **Mechanical performance component tests (FTSS)**
 - Full dummy pendulum
 - Rib drop tests
- **Durability/Repeatability sled test (4 completed)**
 - Low speed rigid flat wall
 - High speed padded wall
 - Low speed abdominal offset rigid wall
 - Low speed thoracic offset rigid wall



■ **Crash Tests**

COMPLETED
PLANNED

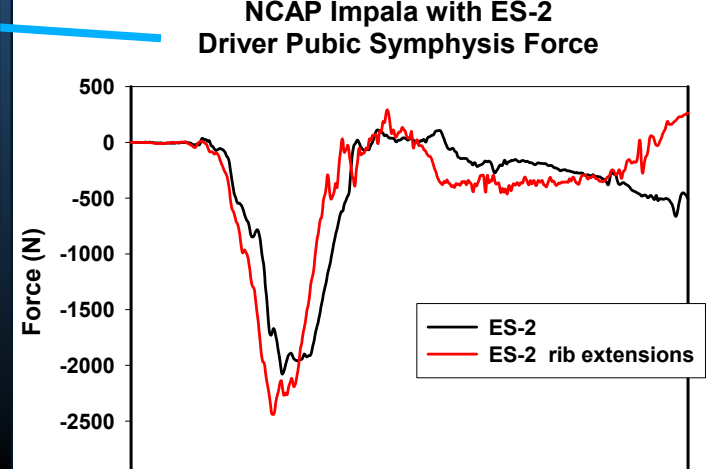
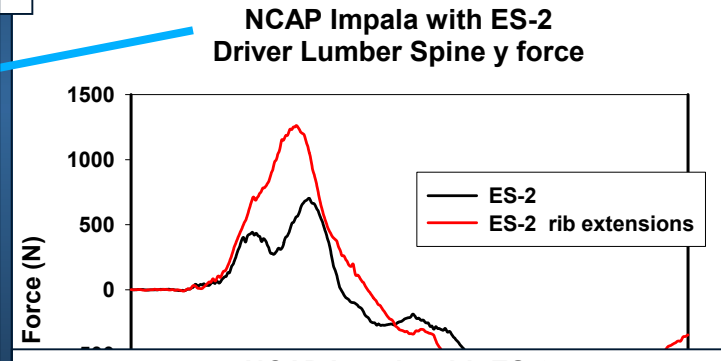
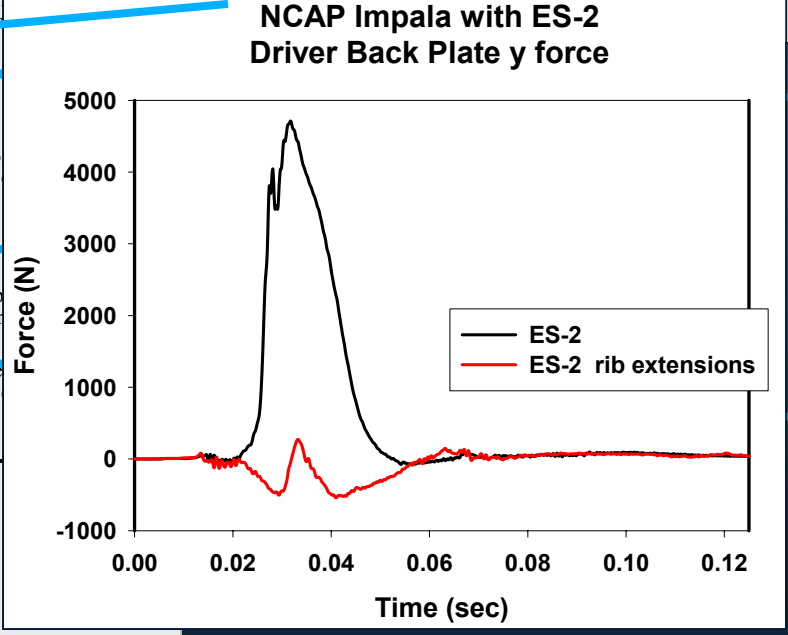
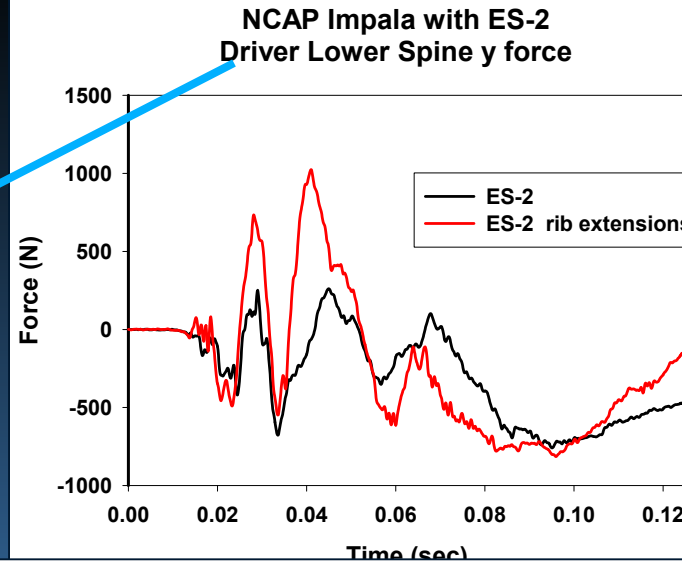
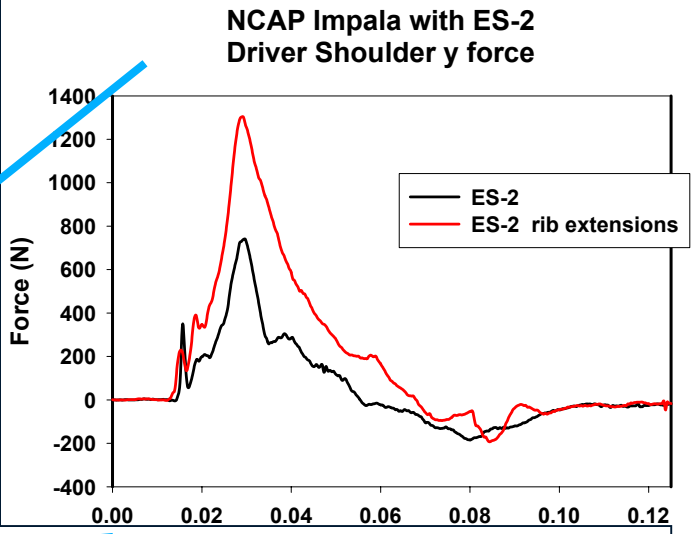
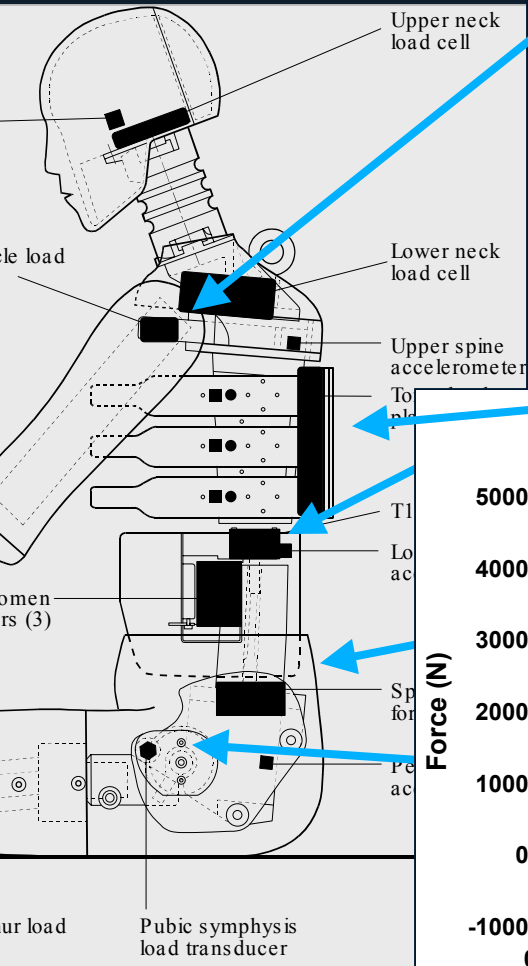
ES-2 with rib extensions	
VEHICLE	Configuration
2002 Impala	US Side NCAP
2001 Focus	US Side NCAP
2003 Corolla	US Side NCAP
1999 Maxima	Oblique Pole
1999 Prizm	F150 striking vehicle at FMVSS 214 speed/angle

Latest ES-2 Testing: Main Findings

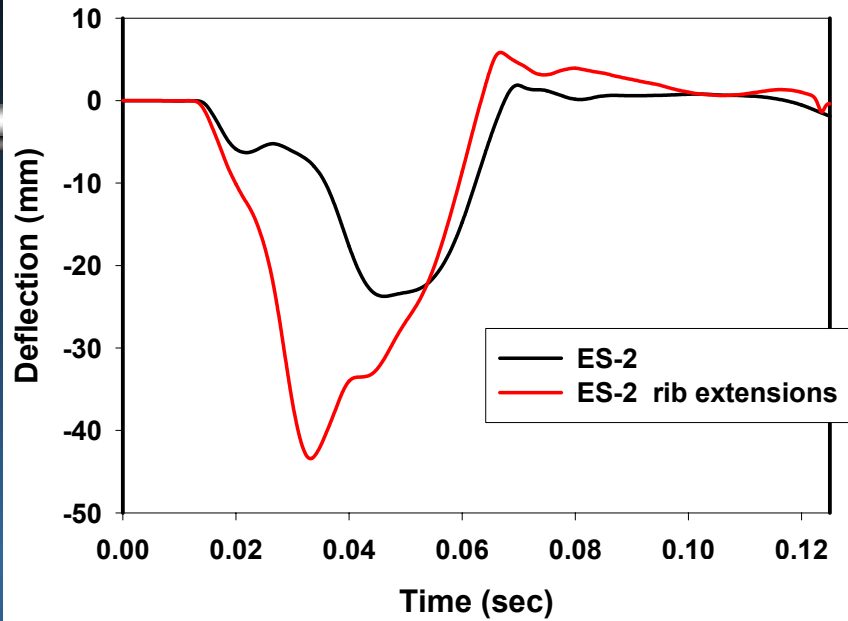
- **New rib extension design upgrade from FTSS addresses seat/back plate “grabbing”**
- **Both standard and rib extension design durable and within calibration corridors**
- **Both standard and rib extension design ES-2 demonstrated good repeatability in sled and crash tests**
- **ES-2 demonstrated good reproducibility in sled tests conducted to-date**

- **Comparison of standard ES-2 and ES-2 with rib extension design results: 2002 Chevy Impala US Side NCAP test**

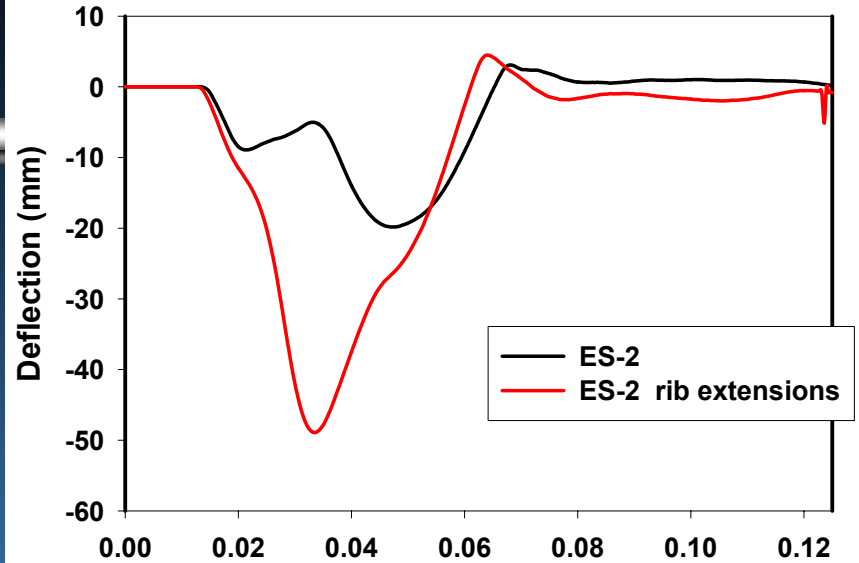
IMPALA Test Results



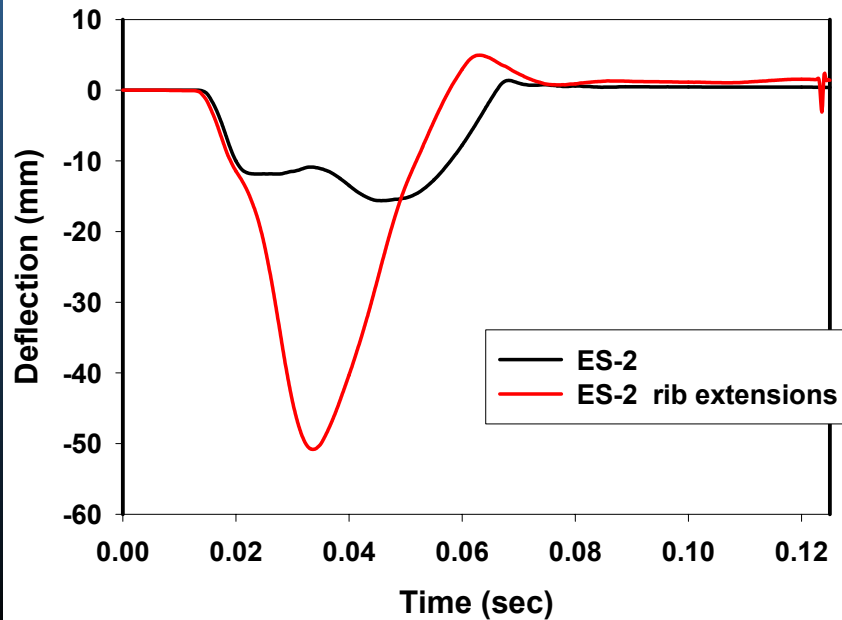
**NCAP Impala with ES-2
Driver Upper Rib Deflections**



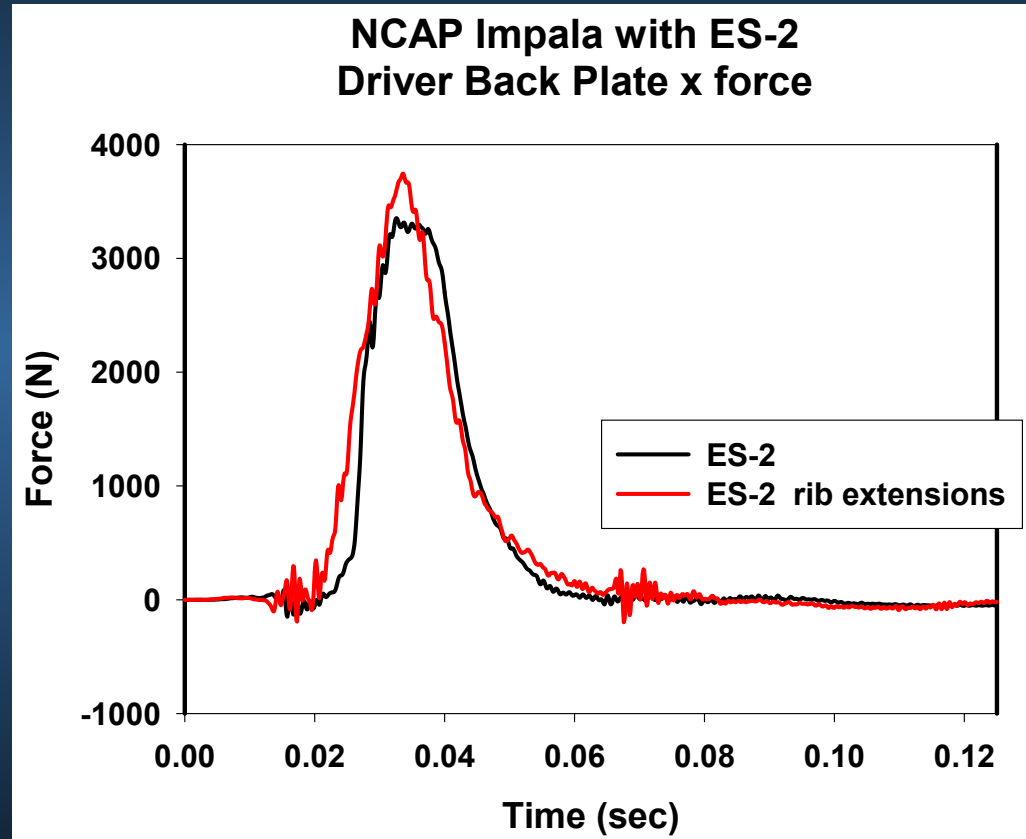
**NCAP Impala with ES-2
Driver Mid Rib Deflections**



**NCAP Impala with ES-2
Driver Lower Rib Deflections**

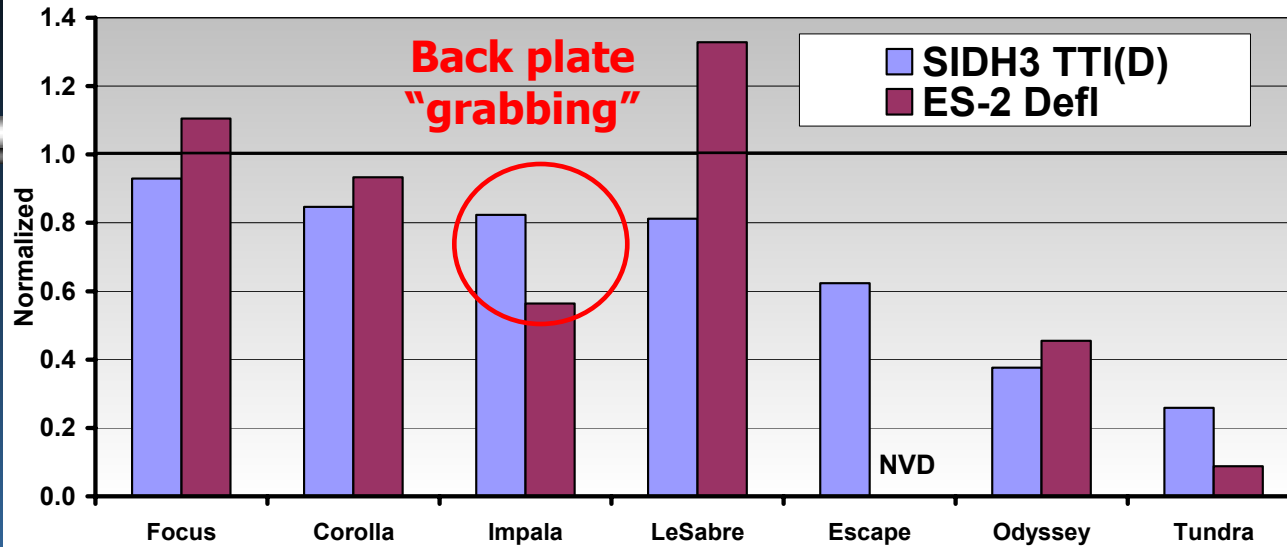


Interaction of dummy with forward motion of Impala seat basically unchanged!



2002 Side NCAP Fleet Performance Tests- Driver

ES-2 rib deflection vs SID TTI(D)



Thorax

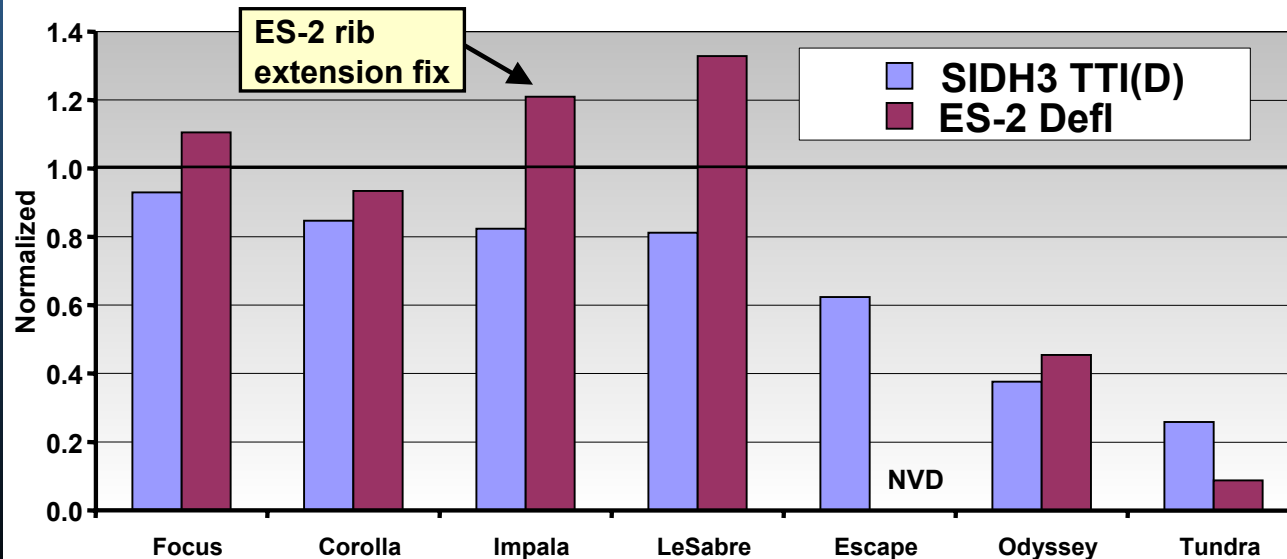
EU/214 Criteria Limits

TTI=85/90

Defl=42 mm

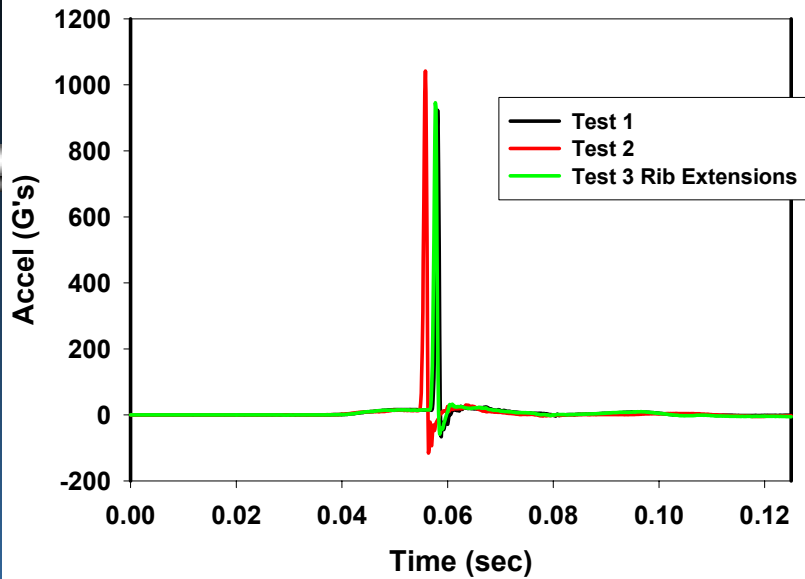
2002 Side NCAP Fleet Performance Tests- Driver

ES-2 rib deflection vs SID TTI(D)

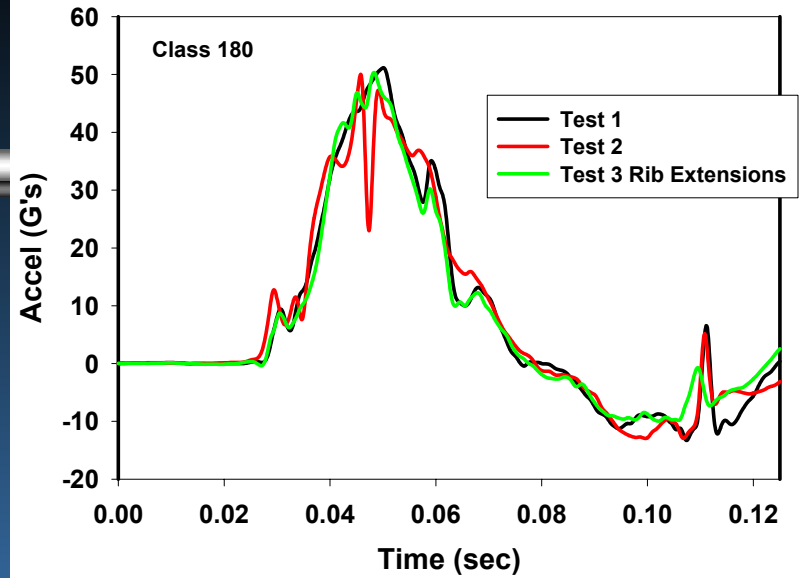


- **ES-2 dummy responses from repeat oblique pole tests with 1999 Maxima**

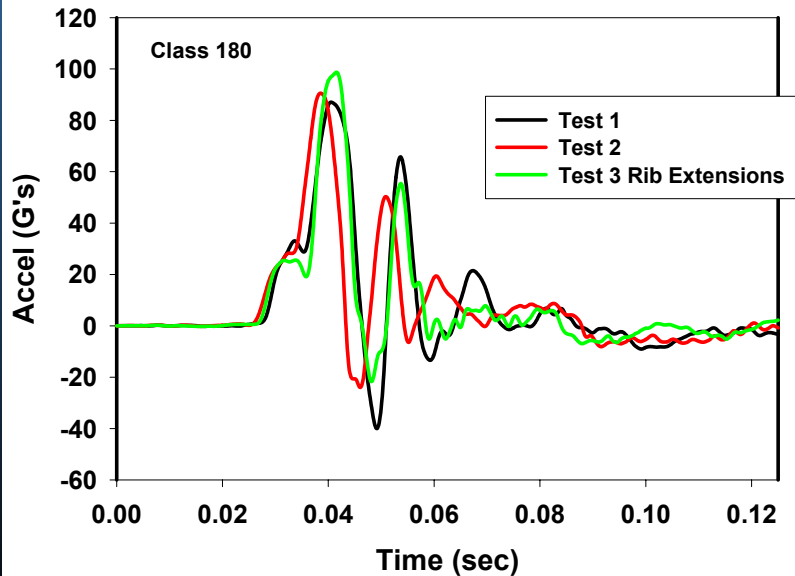
Maxima Oblique Pole Tests with ES-2
Driver Head y G's



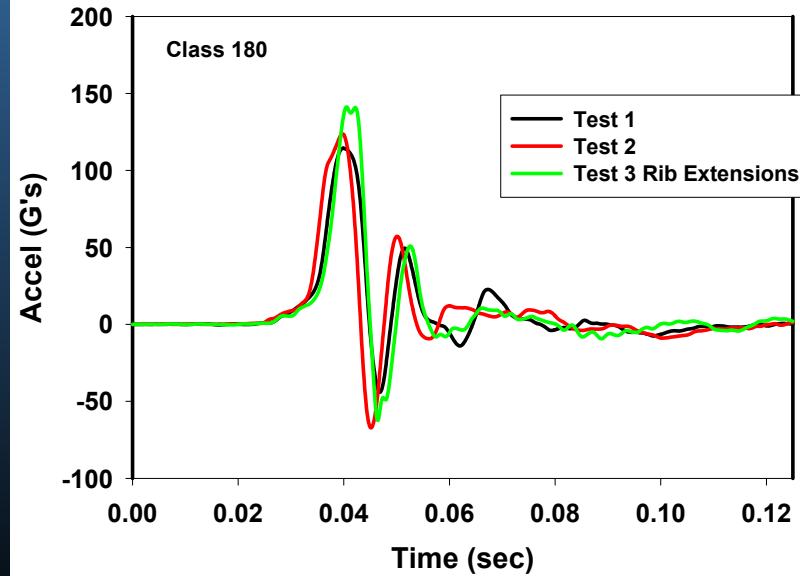
Maxima Oblique Pole Tests with ES-2
Driver Upper Spine y G's



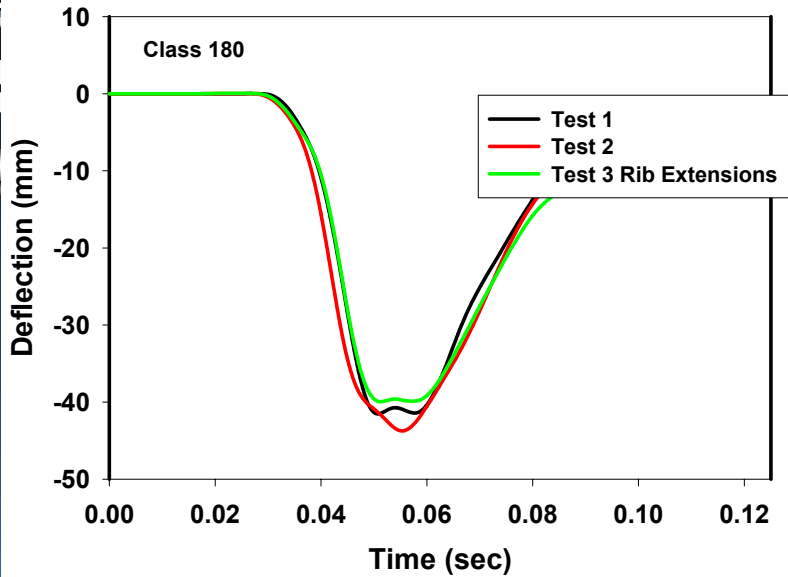
Maxima Oblique Pole Tests with ES-2
Driver Upper Rib y G's



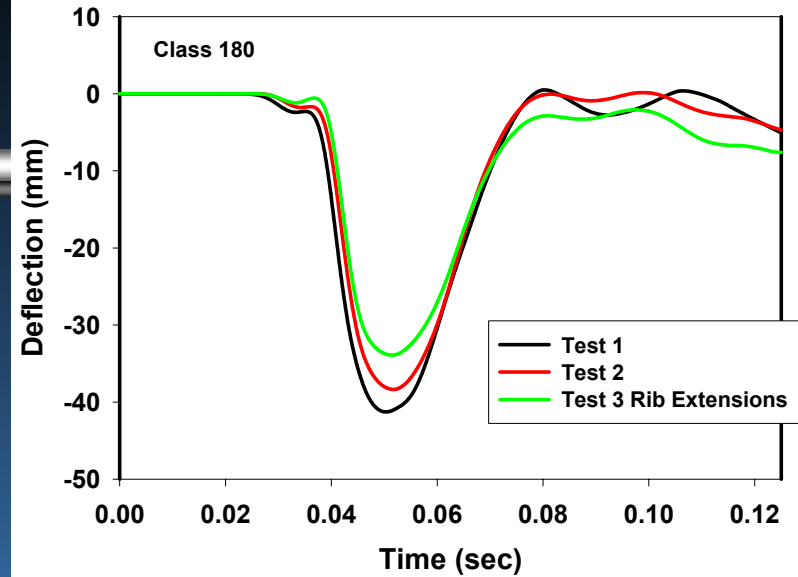
Maxima Oblique Pole Tests with ES-2
Driver Lower Rib y G's



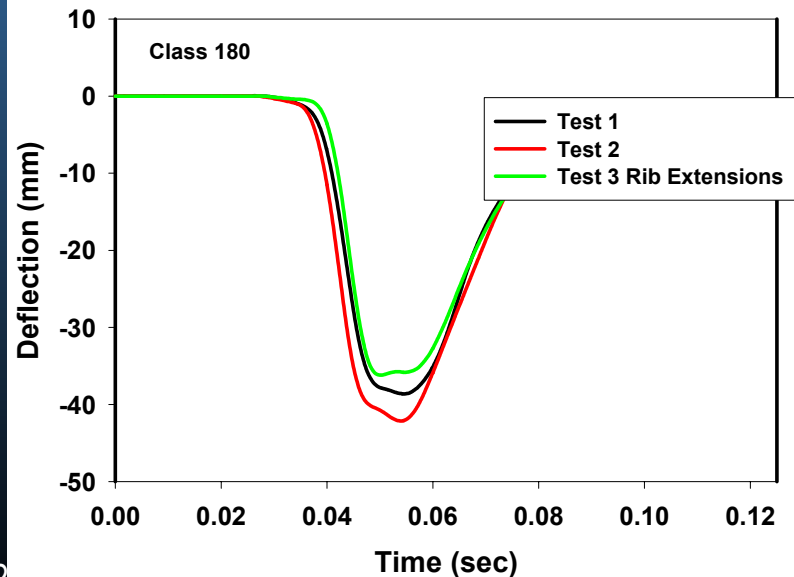
Maxima Oblique Pole Tests with ES-2
Driver Upper Rib Deflection



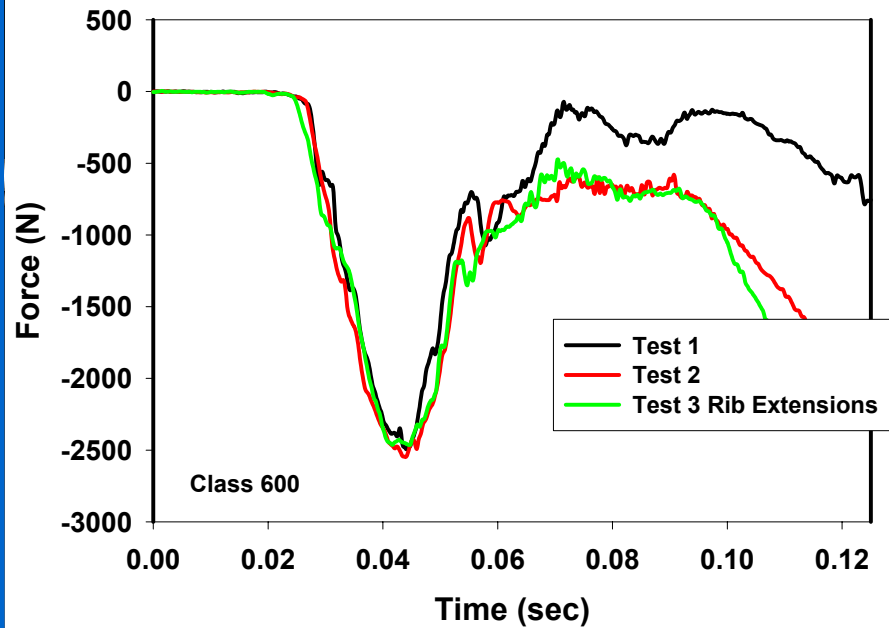
Maxima Oblique Pole Tests with ES-2
Driver Lower Rib Deflection



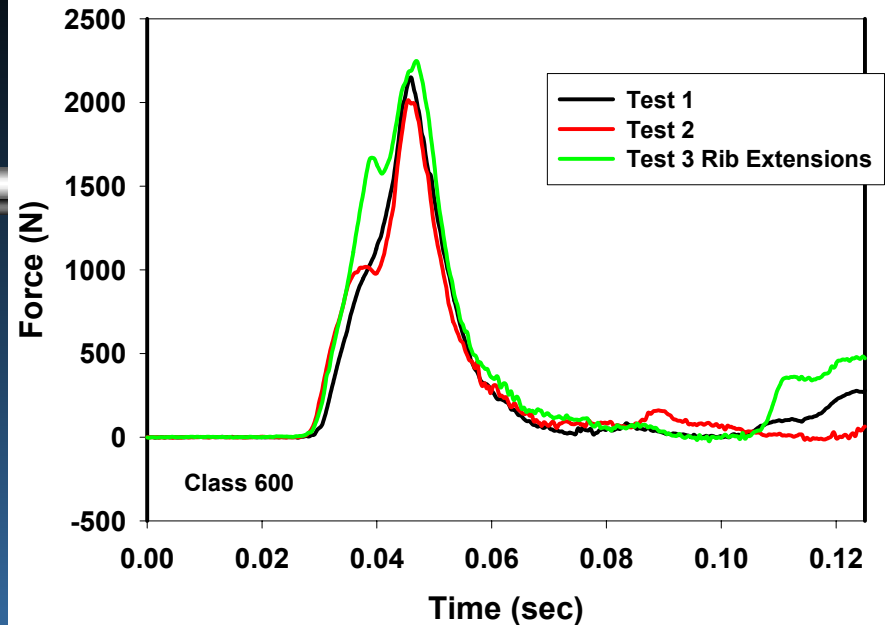
Maxima Oblique Pole Tests with ES-2
Driver Mid Rib Deflection



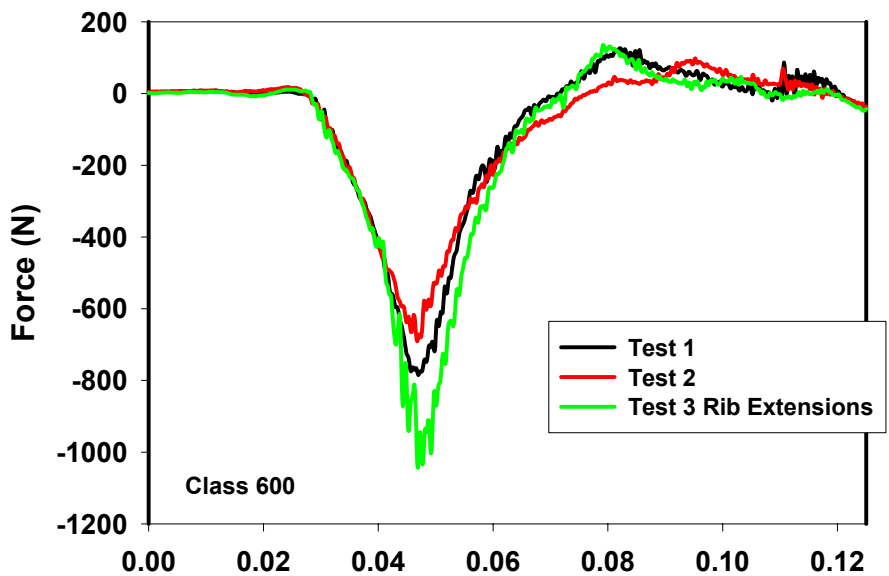
Maxima Oblique Pole Tests with ES-2
Driver Pubic Symphysis Force



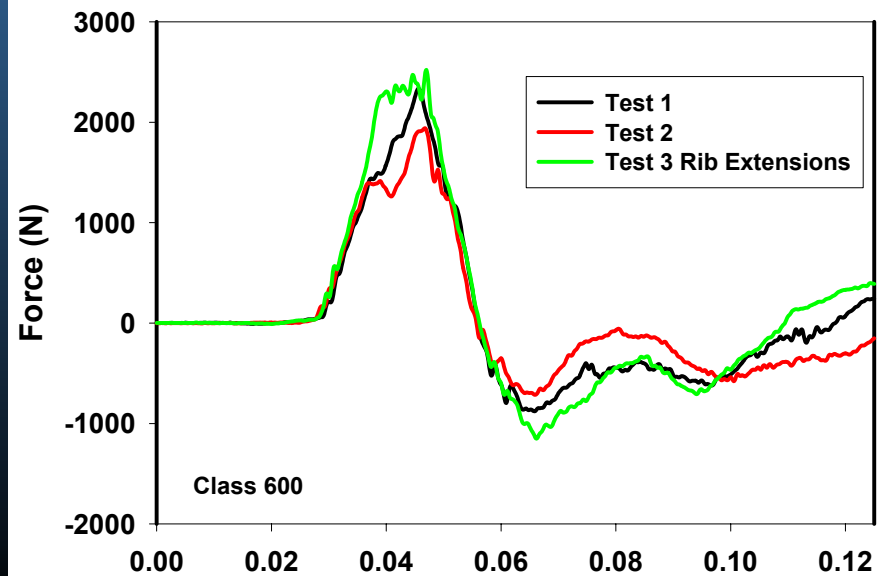
Maxima Oblique Pole Tests with ES-2
Driver Abdomen Summed Loads



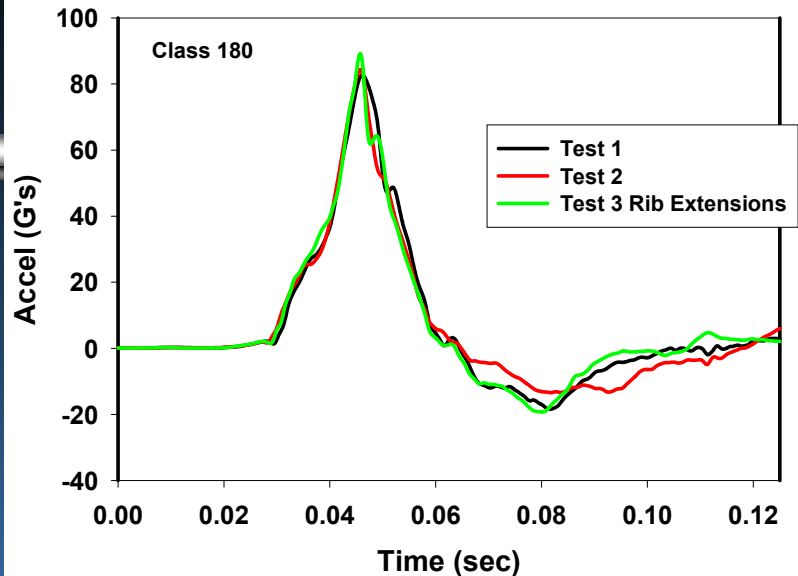
Maxima Oblique Pole Tests with ES-2
Driver back plate y force



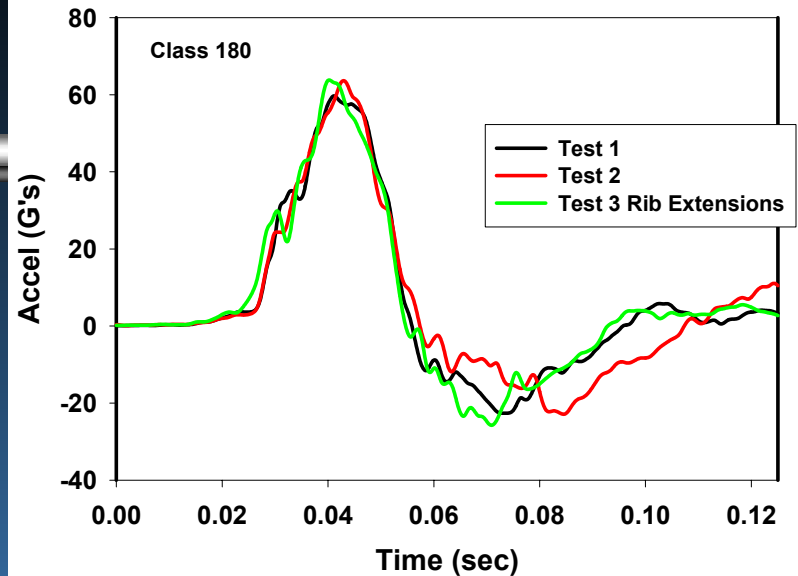
Maxima Oblique Pole Tests with ES-2
Driver Lower Spine y force



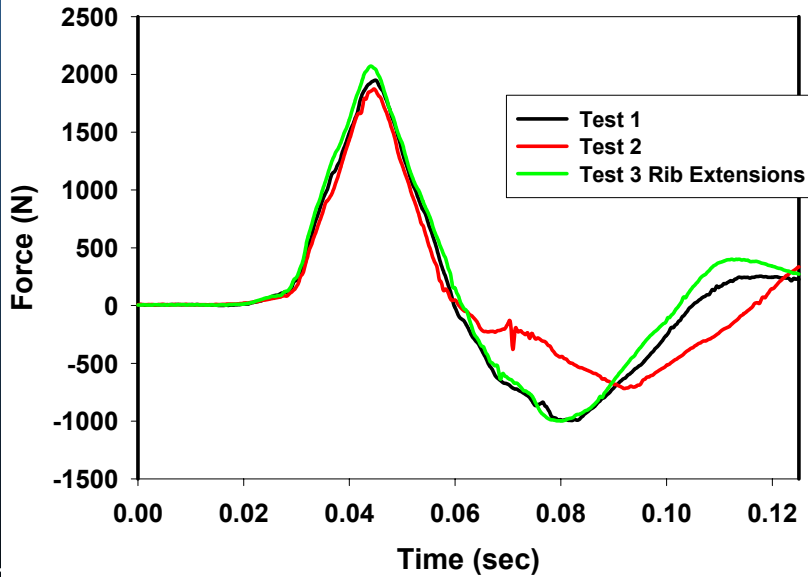
**Maxima Oblique Pole Tests with ES-2
Driver Lower Spine y G's**



**Maxima Oblique Pole Tests with ES-2
Driver Pelvic G's**



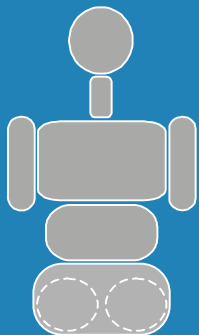
**Maxima Oblique Pole Tests with ES-2
Driver Lumbar Spine y force**



Thorax Offset Sled Test

Initial Assessment of Reproducibility

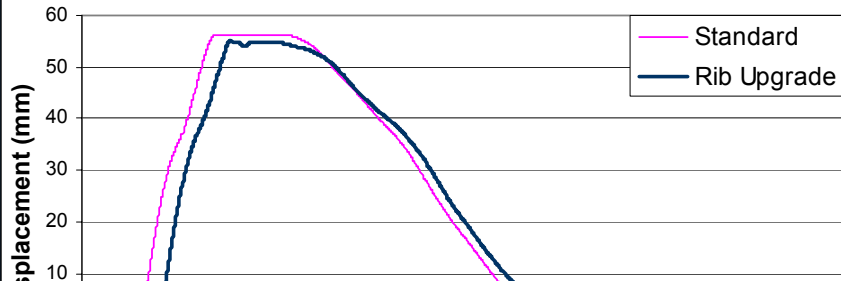
Setup



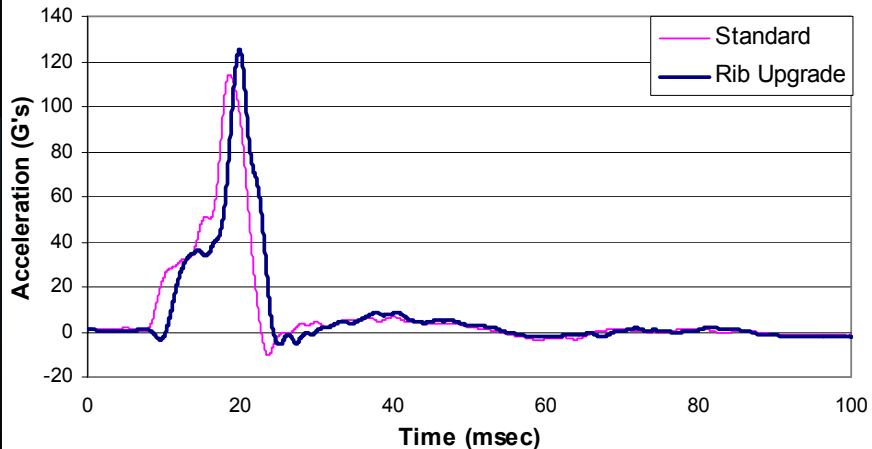
Condition:

•6.8 m/s rigid thorax offset

Rigid Low Thorax offset - Upper Rib deflection



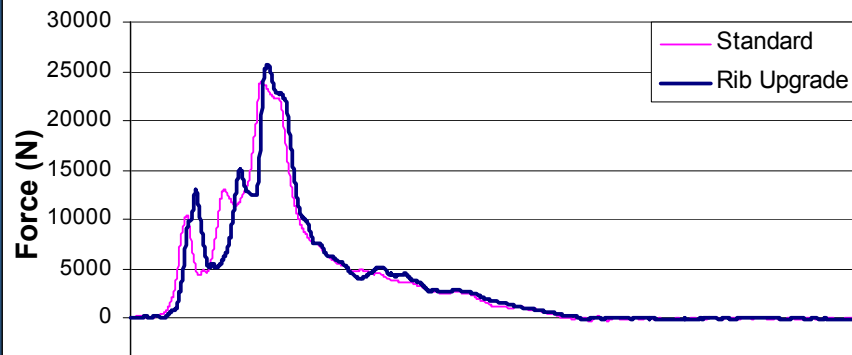
Rigid Low Thorax offset - T12 Y acceleration



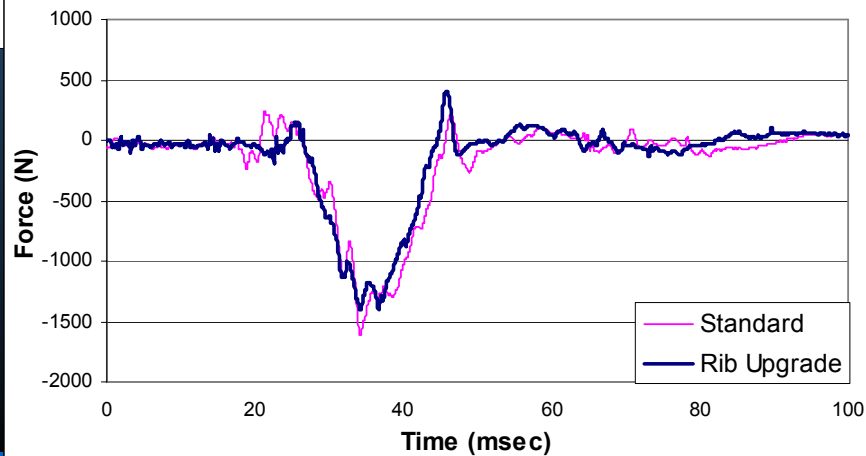
Standard – ES-2 010

Rib Upgrade – ES-2 009

Rigid Low Thorax offset - Thorax load wall

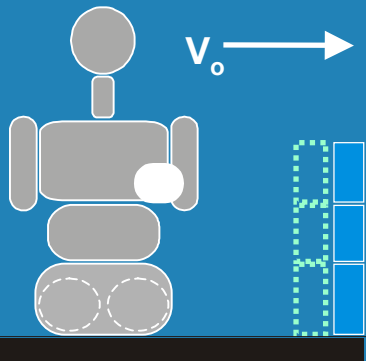


Rigid Low Thorax offset - Pubic Fy



Flat Wall Sled Tests

Setup



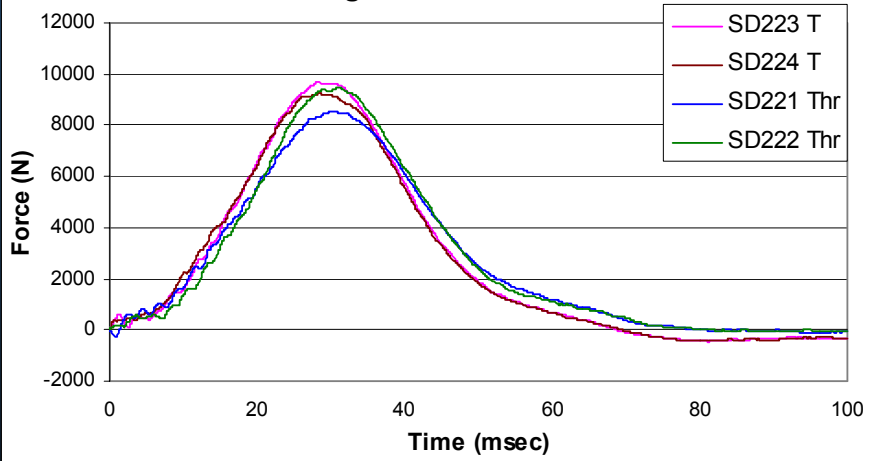
Conditions:

•8.9 m/s padded

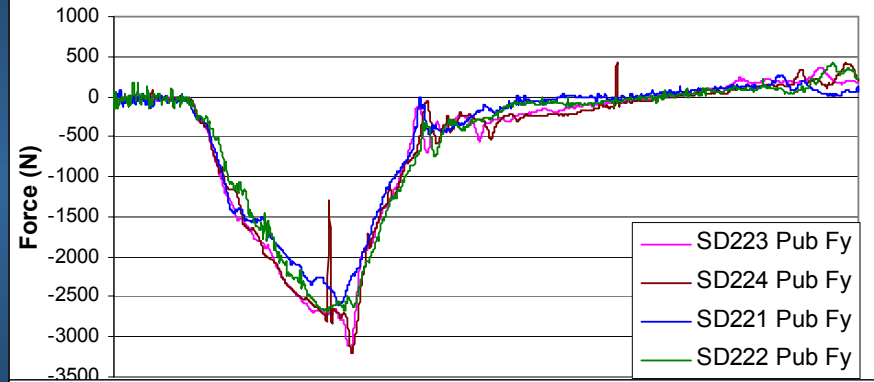
Initial Assessment of Reproducibility

- SD 221-222 ES-2 009
- SD 223-224 ES-2 010

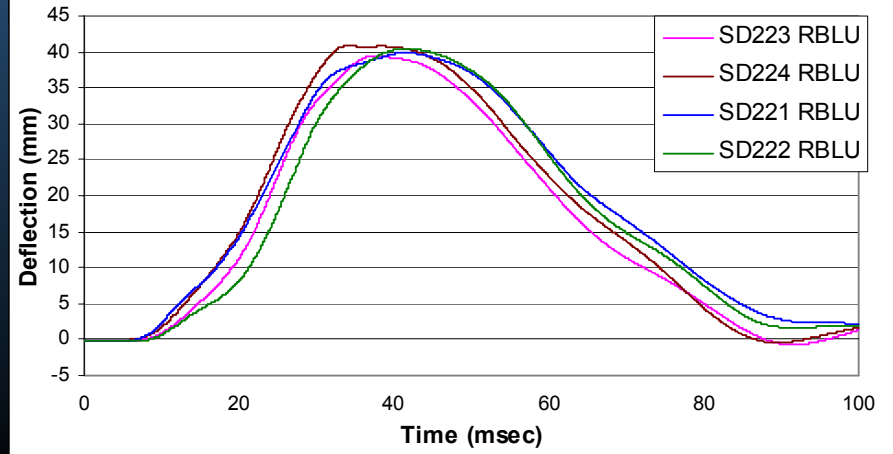
Padded High Flat - Thorax load wall



Padded High Flat - Pubic Fy



Padded High Flat - Upper Rib Deflection



Planned ES-2 Testing

- **Additional testing of Biofidelity for ES-2 with rib extension design underway**
- **Validation of crash test response of ES-2 rib extension design**
- **oblique side impact pole seating procedure development tests**

ES-2 with rib extensions	
VEHICLE	Configuration
2002 Impala	US Side NCAP
2001 Focus	US Side NCAP
2003 Corolla	US Side NCAP
1999 Maxima	Oblique Pole
1999 Prizm	F150 striking vehicle at FMVSS 214 speed/angle

COMPLETED

PLANNED

THANK YOU!

