HUMANETICS®
Innovative Solutions

BIORID CERTIFICATION TEST UPDATE

7/17/2015

GTR7 IG meeting

Agenda

- Existing Certification Tests
- Gen-X development
- Material replacement

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Existing Certification Tests

- Tests
  - Spine quasi-static setup
    - Set springs and thorax/lumbar shape adjustment
  - Jacket only impact
    - Control jacket stiffness
  - Pelvis only impact, bottom
    - Control pelvis stiffness
  - Dummy without head restraint
    - Set damper, verify correct spring & shape adjustments

Existing Certification Tests

Jacket Only Impact

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FC

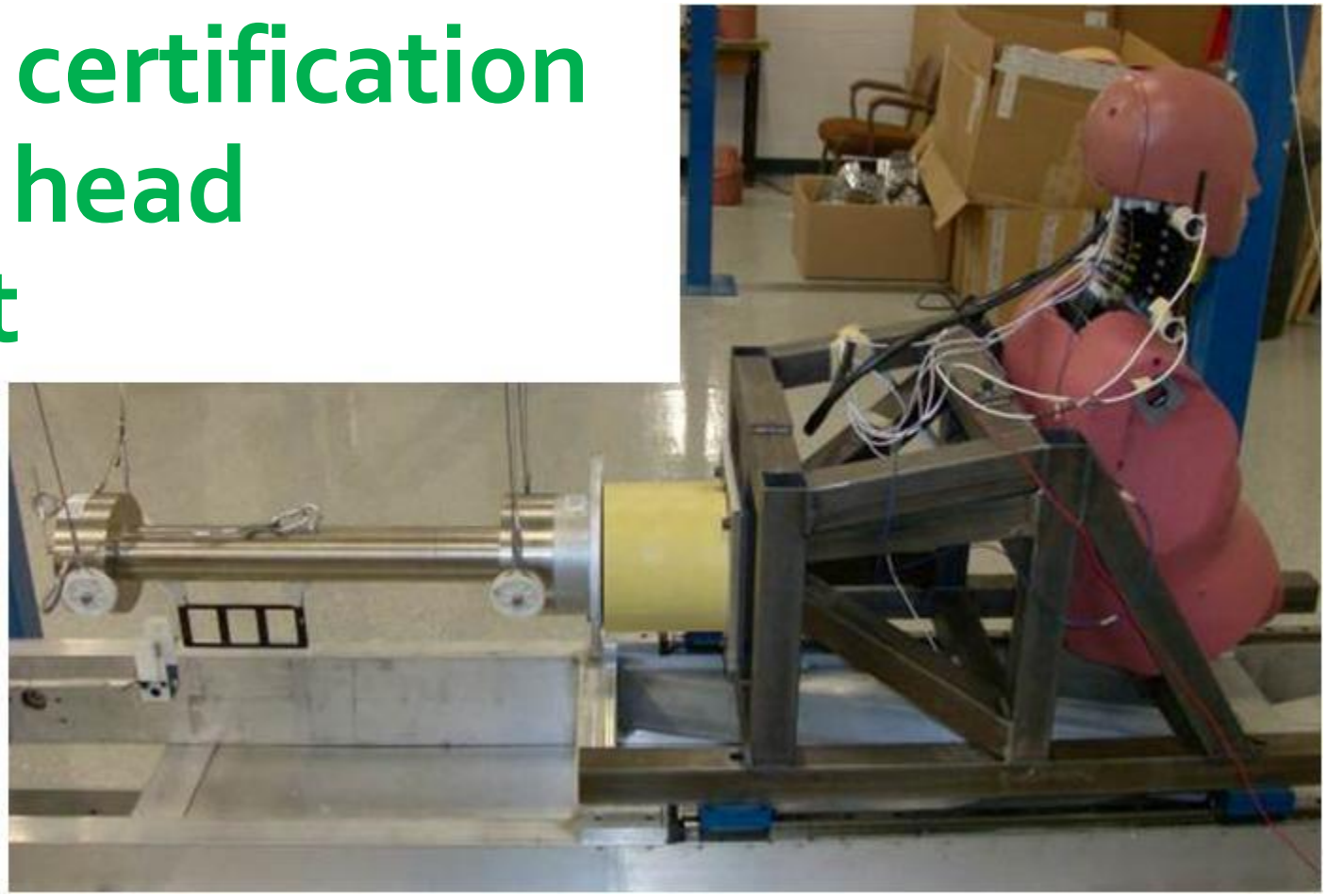
Existing Certification Tests

Pelvis Impact – bottom

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Existing Certification Tests

Dummy certification without head restraint



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Existing Certification Tests

- Status
  - All have corridors
  - New dummies tested to all corridors
    - Optional for dummy re-certifications
  - All in Mutual Resolution Draft
    - Bernie is crafting regulatory language

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Test Development

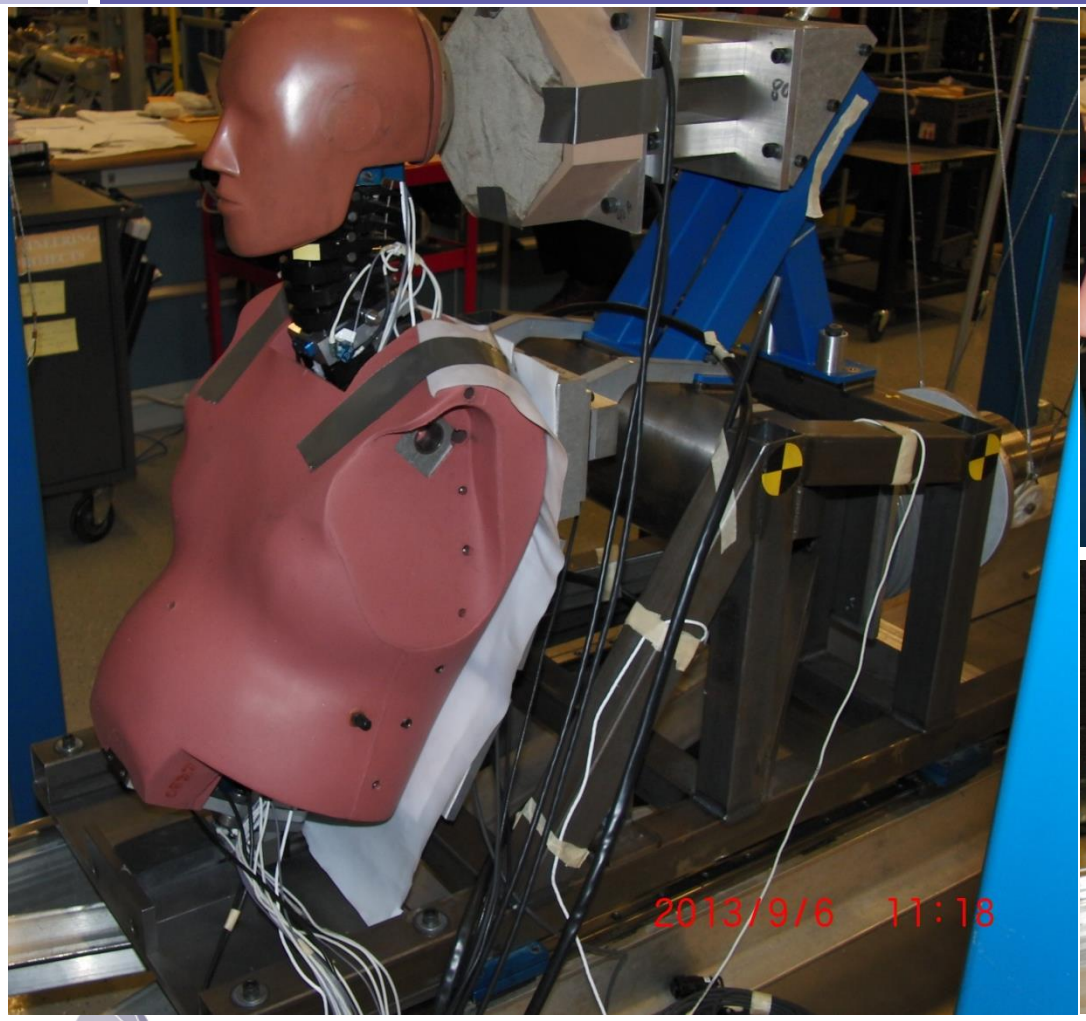
- History
  - Prior mini-sled with head restraint was not sensitive enough to dummy differences
  - Hypotheses
    - Need stiffer head restraint pad
    - Need spine straightening
    - Full back support with sliding
  - Developed new test equipment and procedures to be very sensitive to dummy differences

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

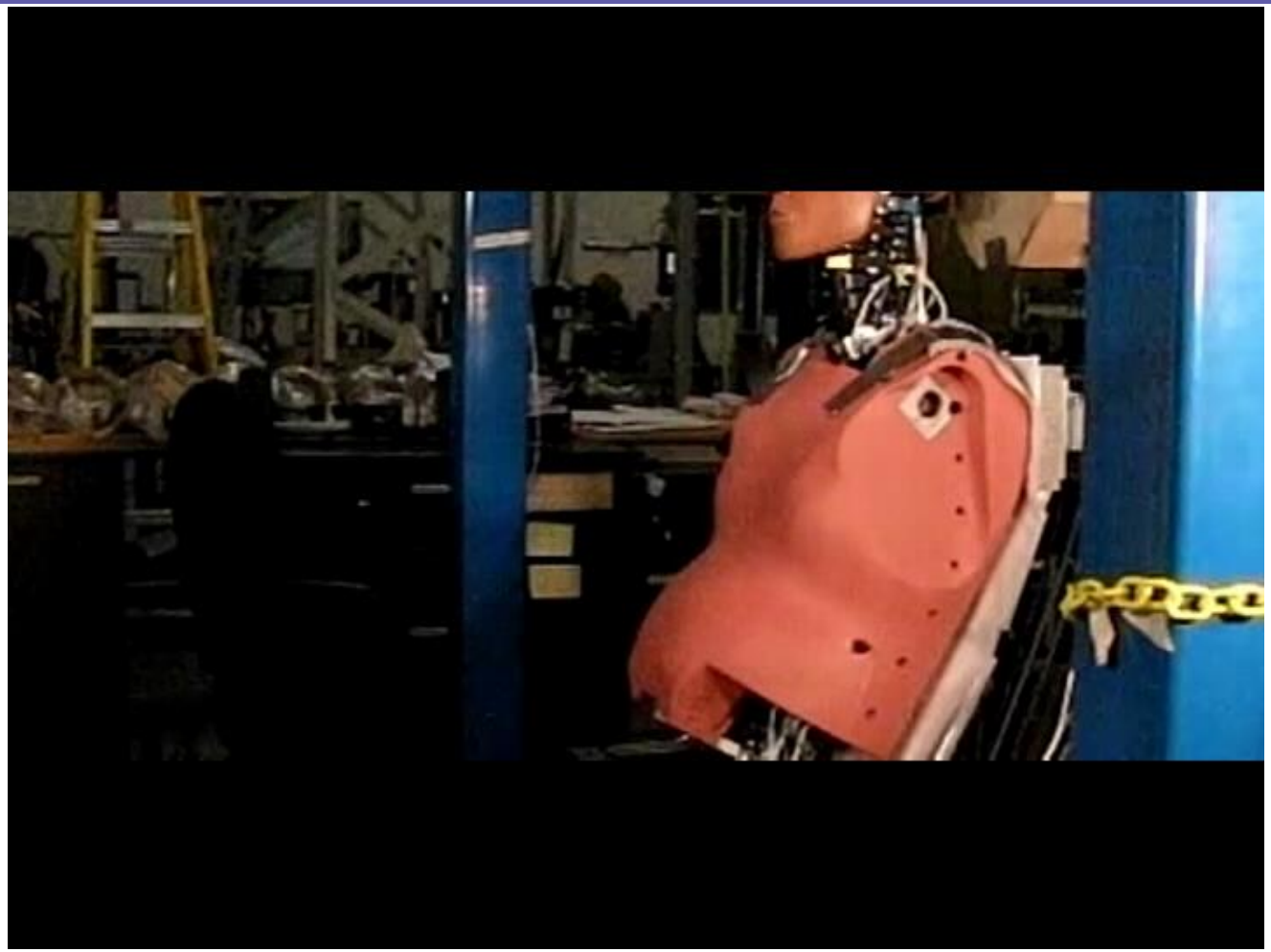
Gen-X

- Multi-segment full back support
- Base of spine can translate X and rotate Y
- Double teflon between dummy & sled to reduce friction
- Fairly stiff head restraint surface
- Same pendulum and energy transfer device

Gen-X



Gen-X



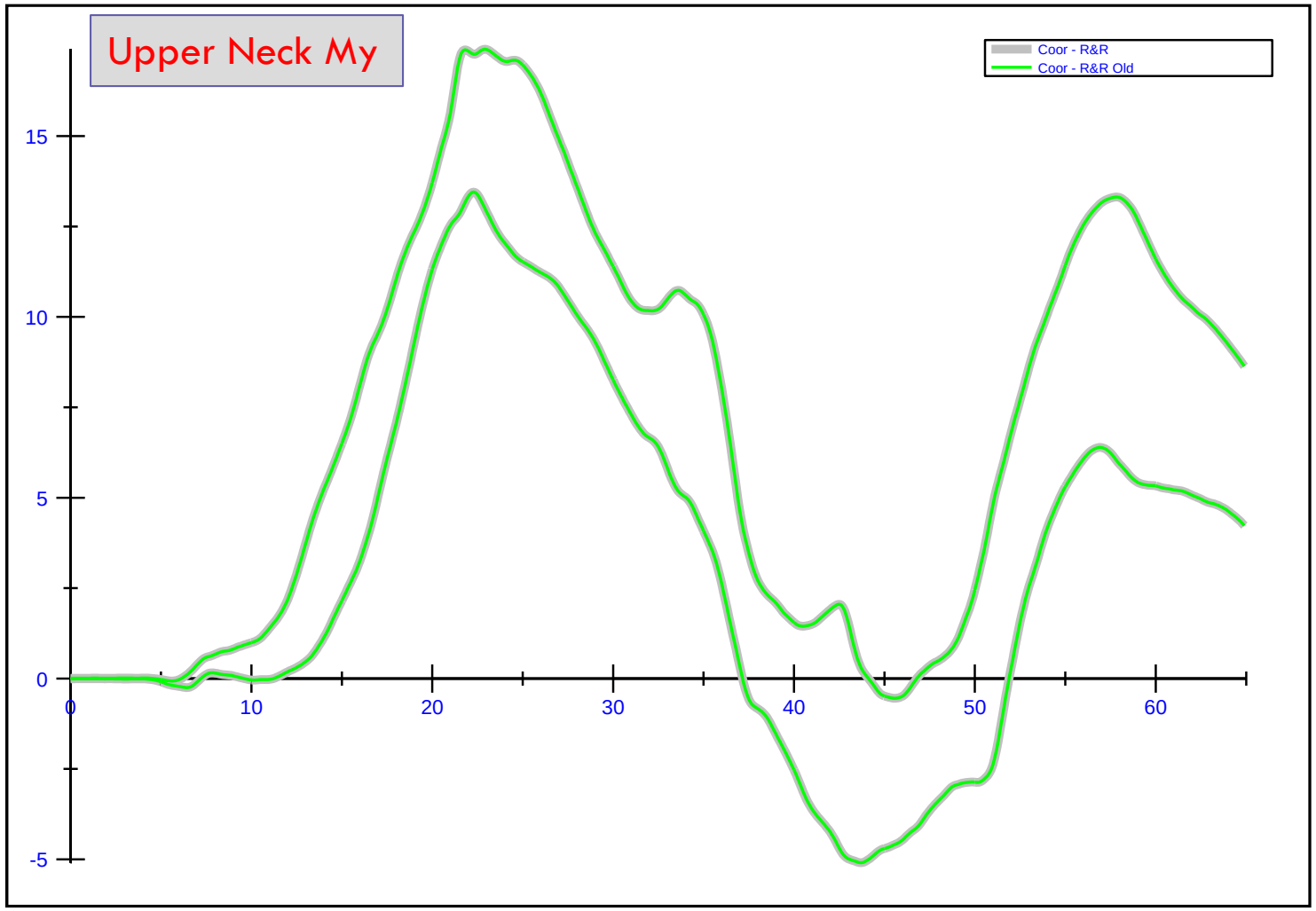
Gen-X

- Development progression
  - Developed equipment, procedures
    - Adjusted to be very sensitive to dummy differences
  - Initial trials with bumper stiffness, jackets
    - Could detect differences
  - Baselined 3 of 4 dummies from BAST R&R series as target to develop target range for all channels available
    - These dummies were determined to have acceptable R&R in a lab seat sled series (Dec. 2012 meeting)
    - Next slide gives an example

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Example R&R corridor

- Average time histories +/- 2 standard deviations
- Provides target for dummies



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Development

- VRTC had 2 dummies for injury criteria development
  - 0073 & DI8599
  - Appeared to perform differently in seats
  - Brought back to investigate with Gen-X
- Extensive testing done on Gen-X
  - Jacket, torsion pin, spine segment
    - Differences could be detected, but no single cause found

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Development

- Spine refurbished
  - New bumpers
    - to match compression targets from R&R dummies
  - Complete inspection
  - Verified spine setups
- Further Gen-X still showed differences
  - Dummy 0100 also tested in mix to see how it matched refurbished dummies

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Development

- Additional changes found during testing
  - Repair wear in 0073 damper
  - Repaired dummy 0100 Lower Neck (T1) load cell
    - Internal short to ground causing noise, erratic signal
  - Correct error in Lower Neck (T1) load cell data collection in Humanetics lab
    - Error in setup for DAS bridge completion selection caused bad data, varied with load cell
    - *NOT a load cell problem, strictly a measurement error!*

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Development

- Returned all 3 dummies to VRTC
  - Did small series multiple seats
- Their testing was inconclusive for R&R or injury criteria
  - Next, larger test series planned
- Brought dummies back for interim full certification and Gen-X test series
  - Testing on 0100 was different from other dummies or original testing
    - Found loose bolt at lumber load cell (allowed rocking)
    - Cable ties holding instrumentation bundle too tight
      - Redoing with looser attachment changed performance!

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X

- Sent dummies back to VRTC
- VRTC did their seat test series
- Brought dummies back to Humanetics for post certification & Gen-X
  - Gen-X complete
  - Certification tests still to be done

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

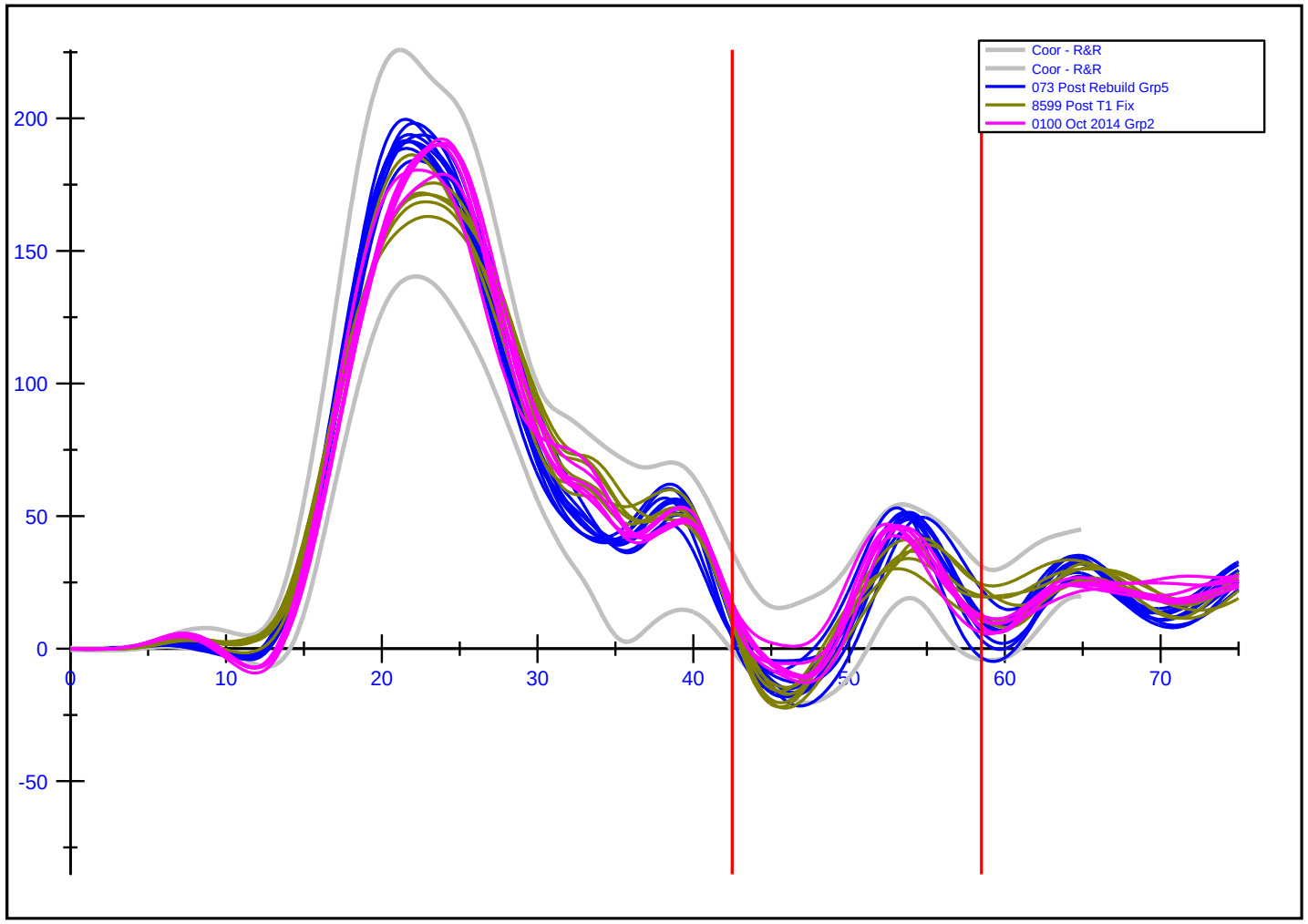
Pre Series Testing

All 3 dummies overlaid before first VRTC test series shows how they compare to each other and BAST R&R dummies

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

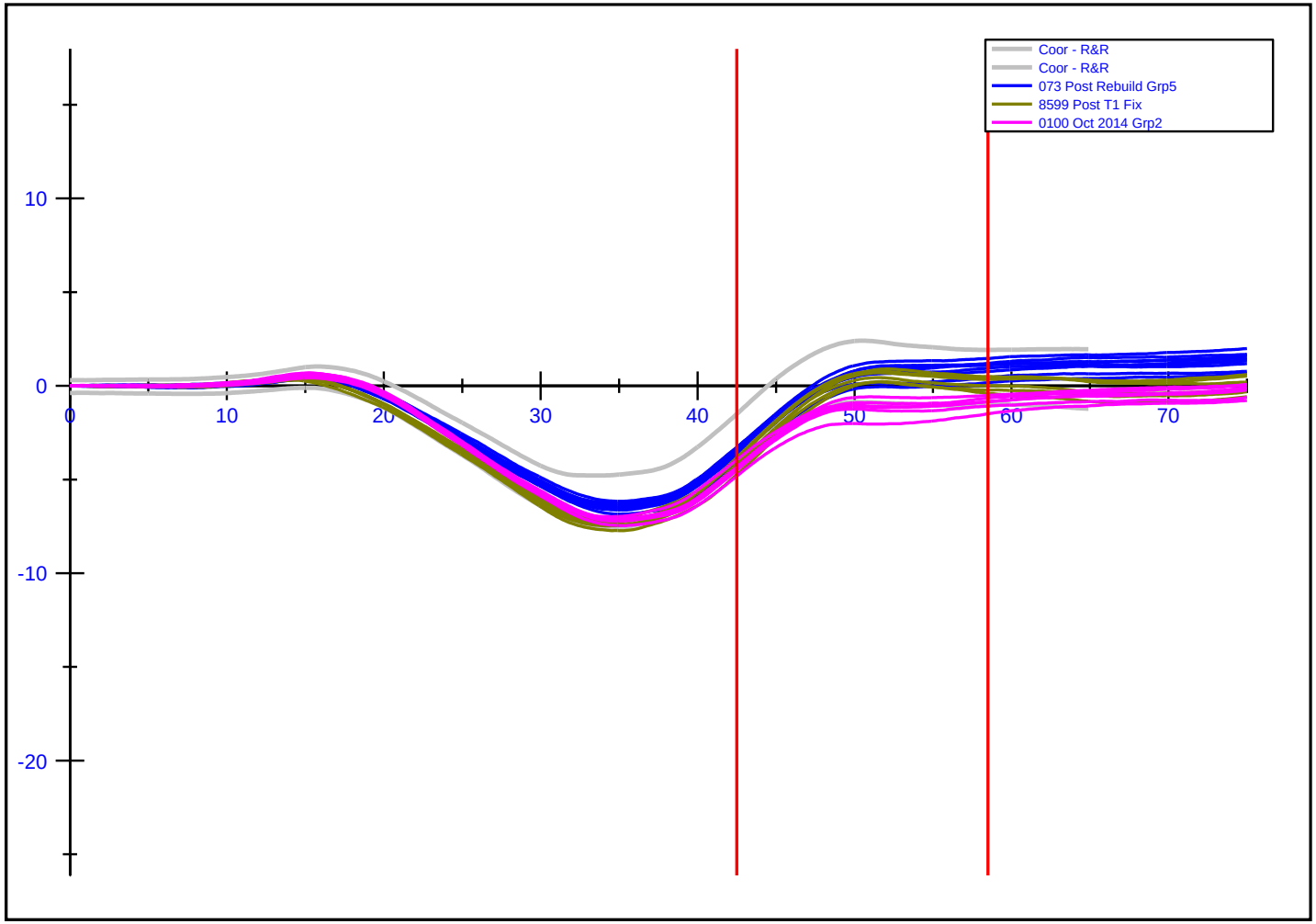
T1 X Accel.



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

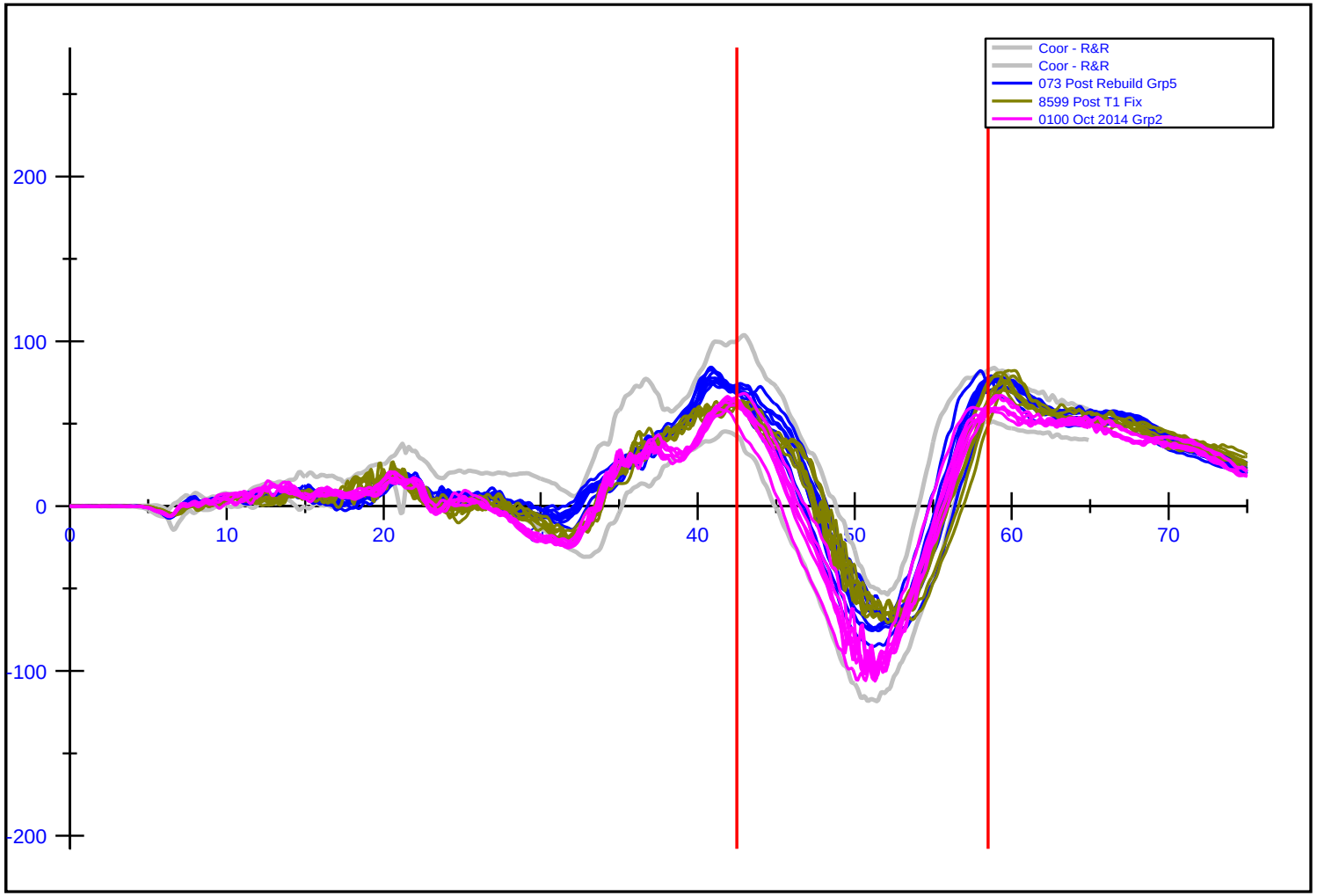
Head to T1 Rotation



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

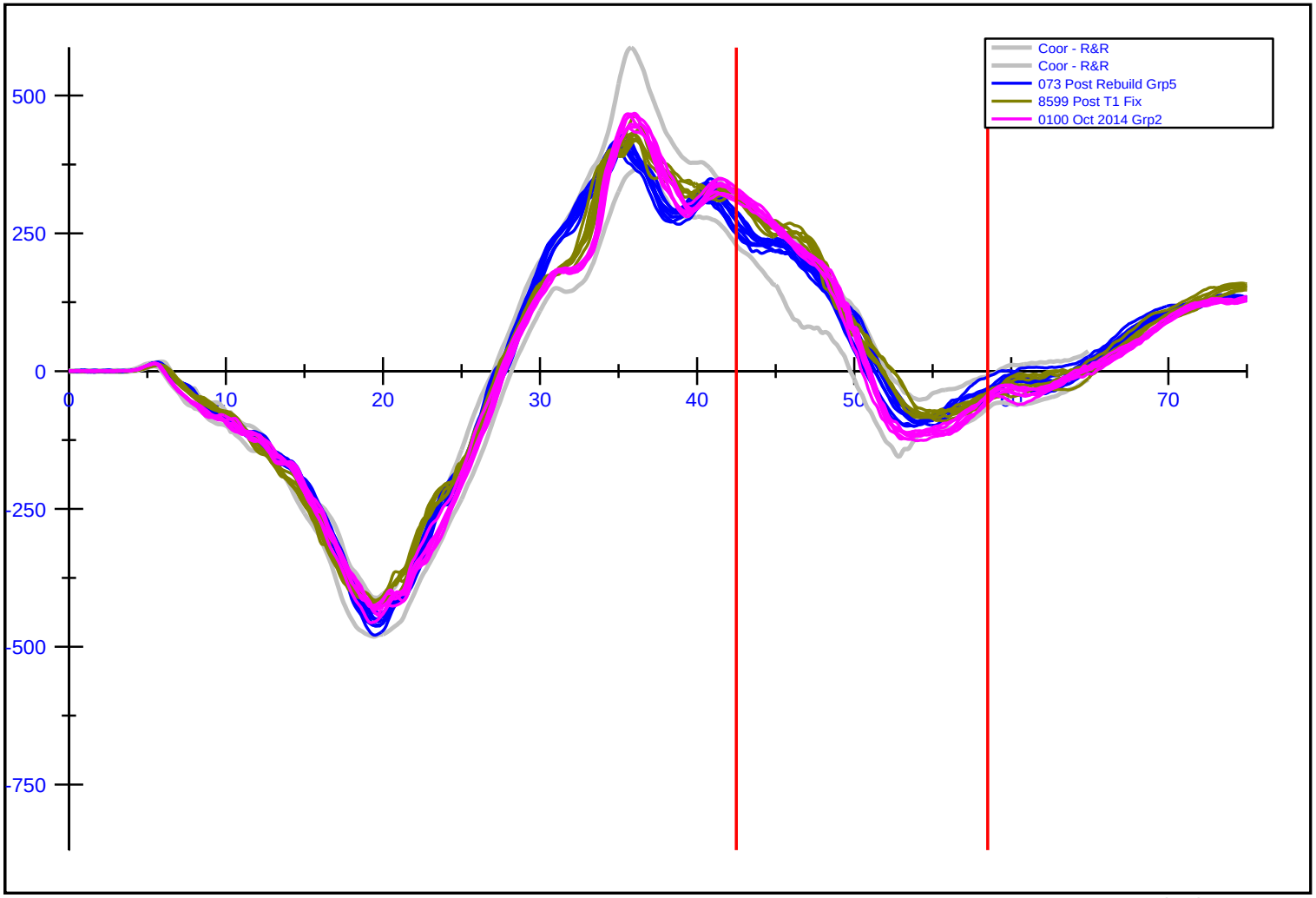
Upper Neck FX



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

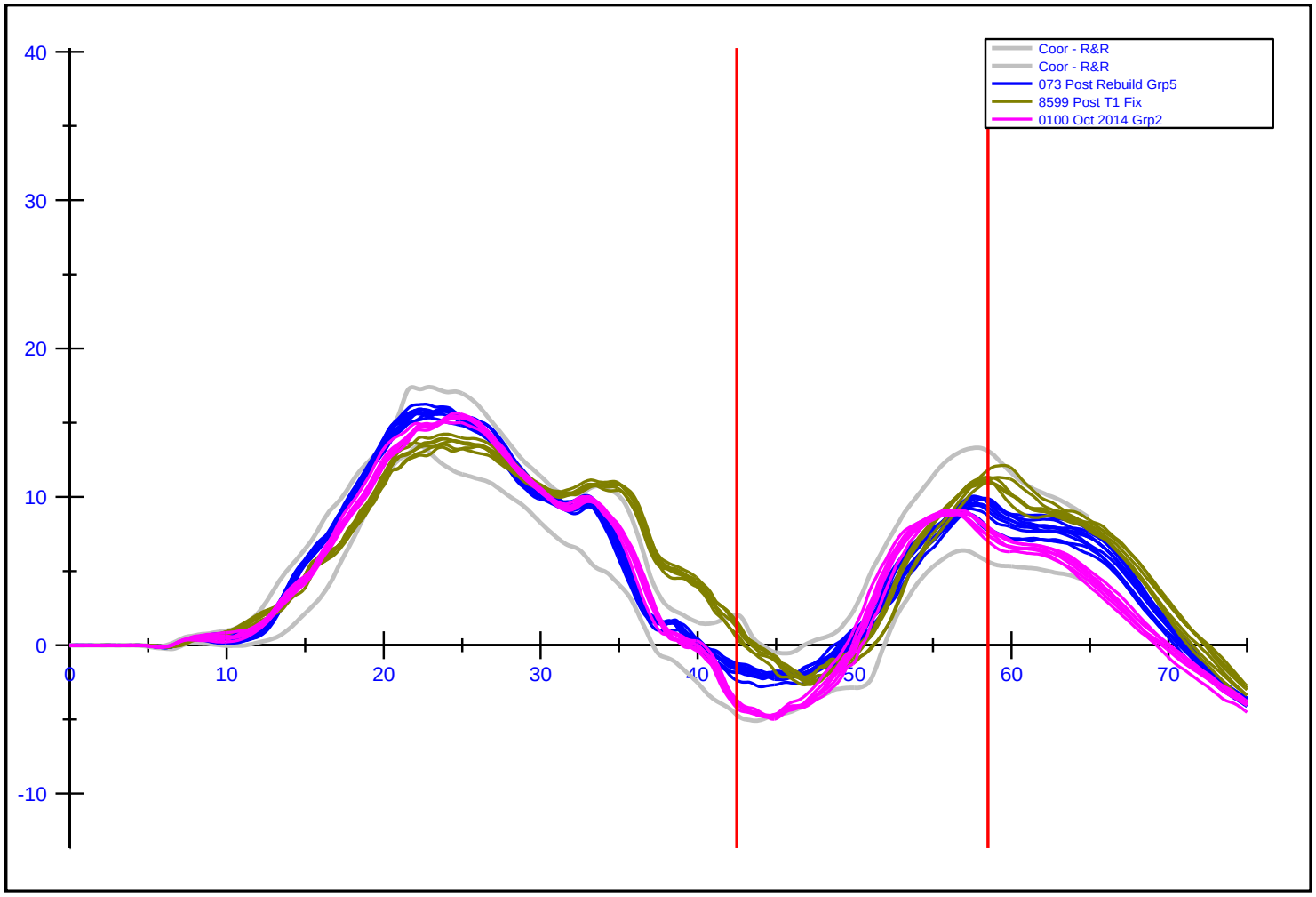
Upper Neck FZ



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

Upper Neck MY



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

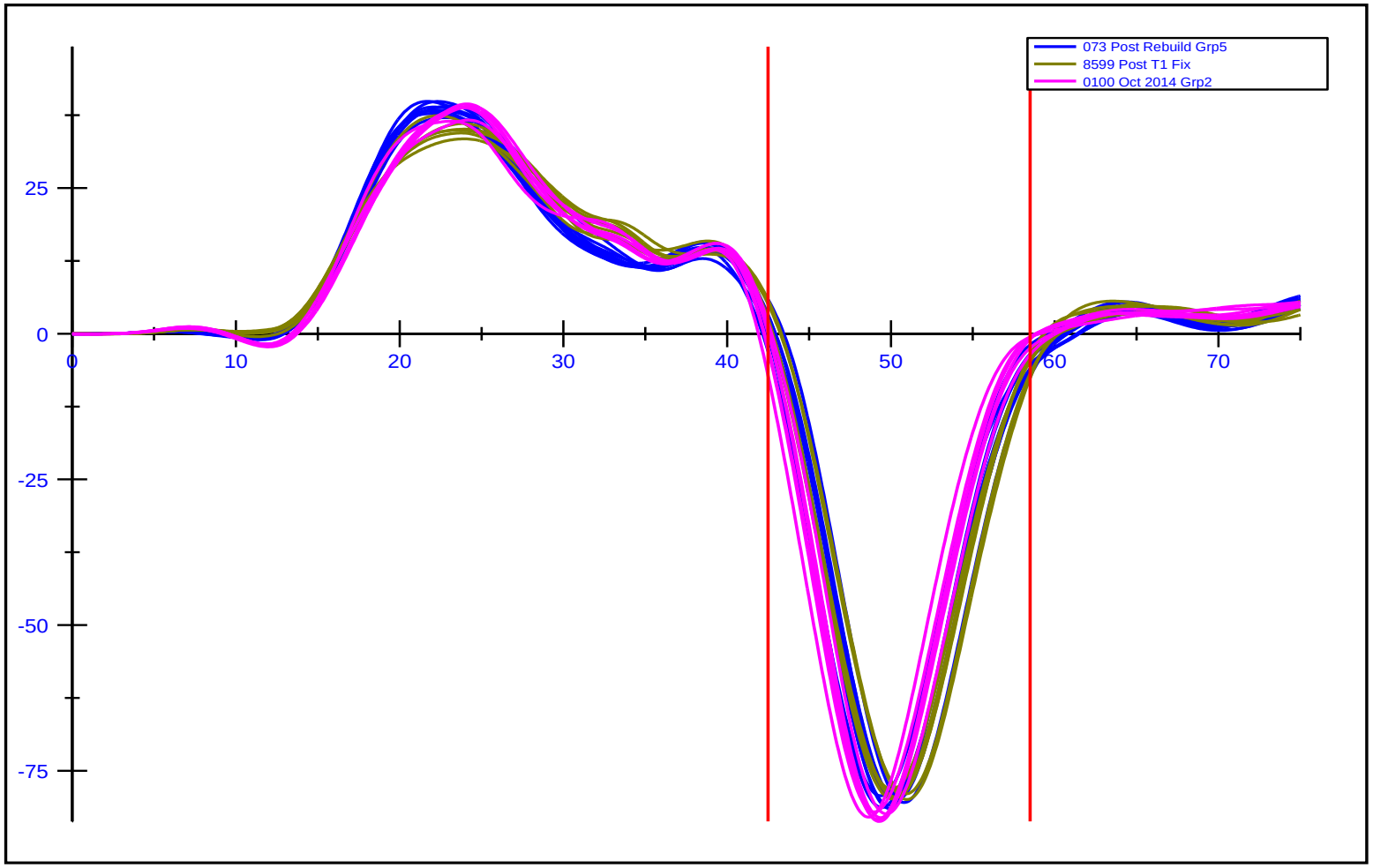
Gen-X, VRTC Series: All Pre

Lower neck load cell channels not available (data collection error).

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: All Pre

NIC



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Pre, Mid, Post on Dummy 0073

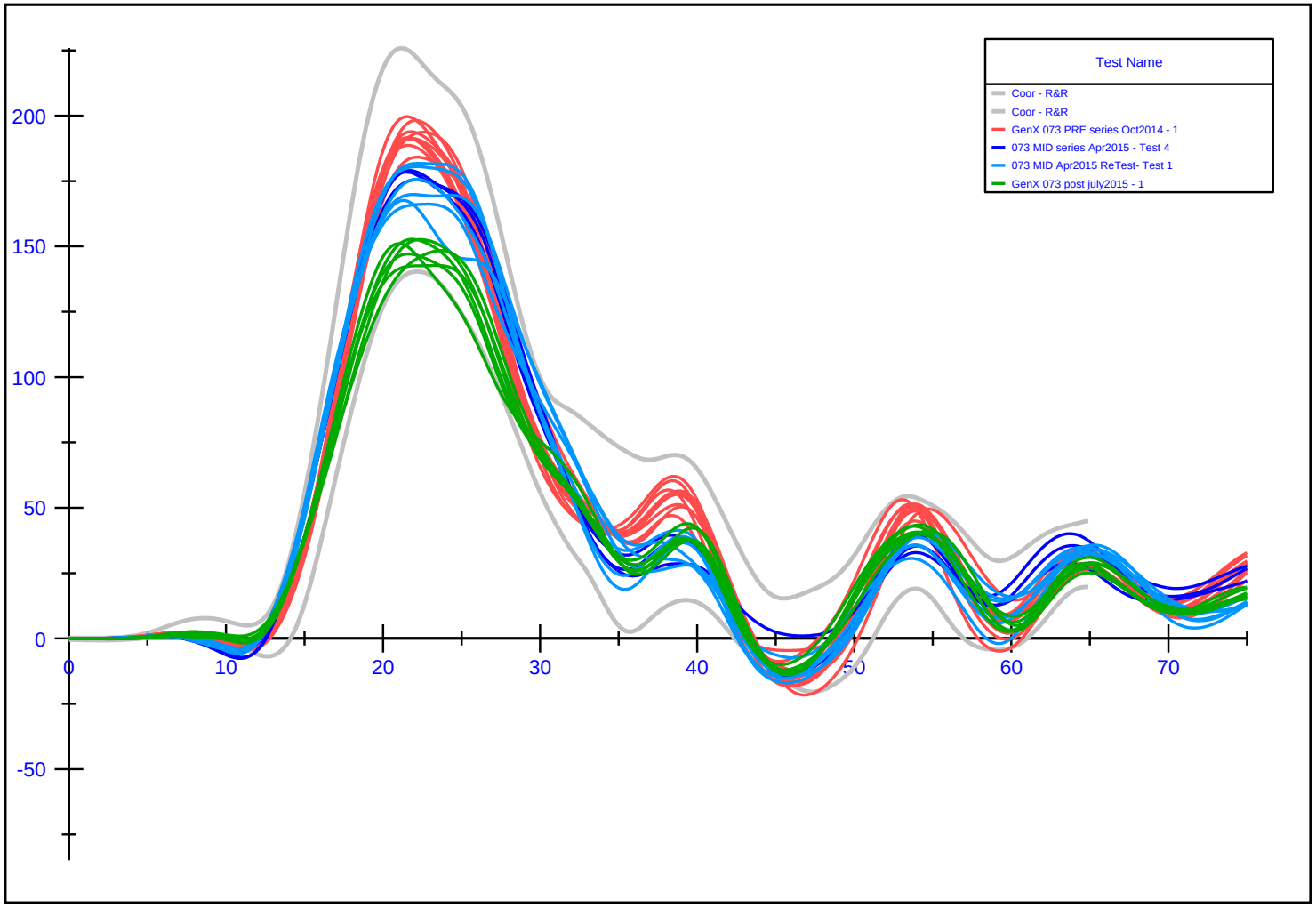
Just one dummy, 0073, overlaid pre, mid, post VRTC testing. Shows repeat testing as well as possible change over time.

Other dummies show very similar trends.

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

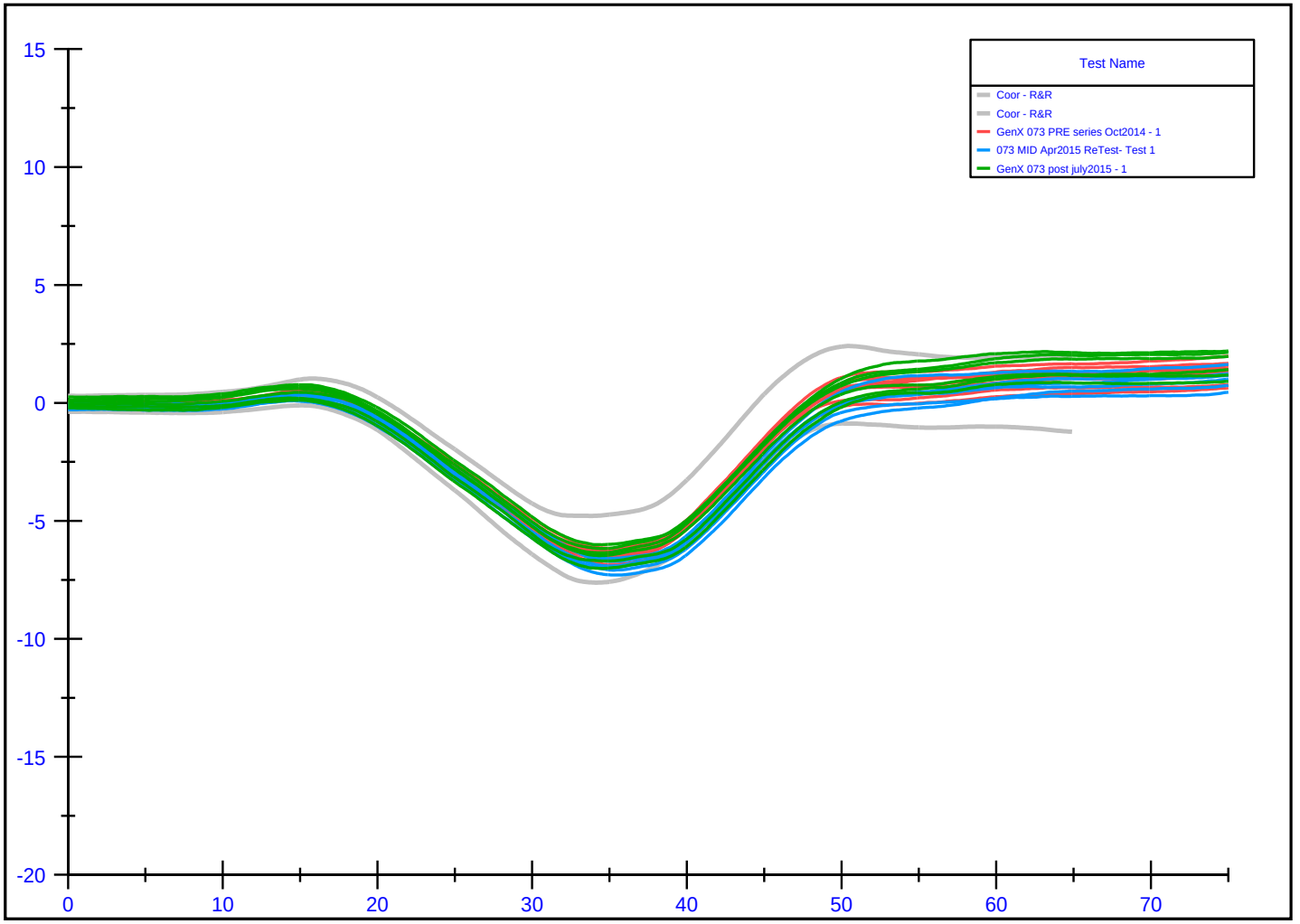
T1 X Accel.



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

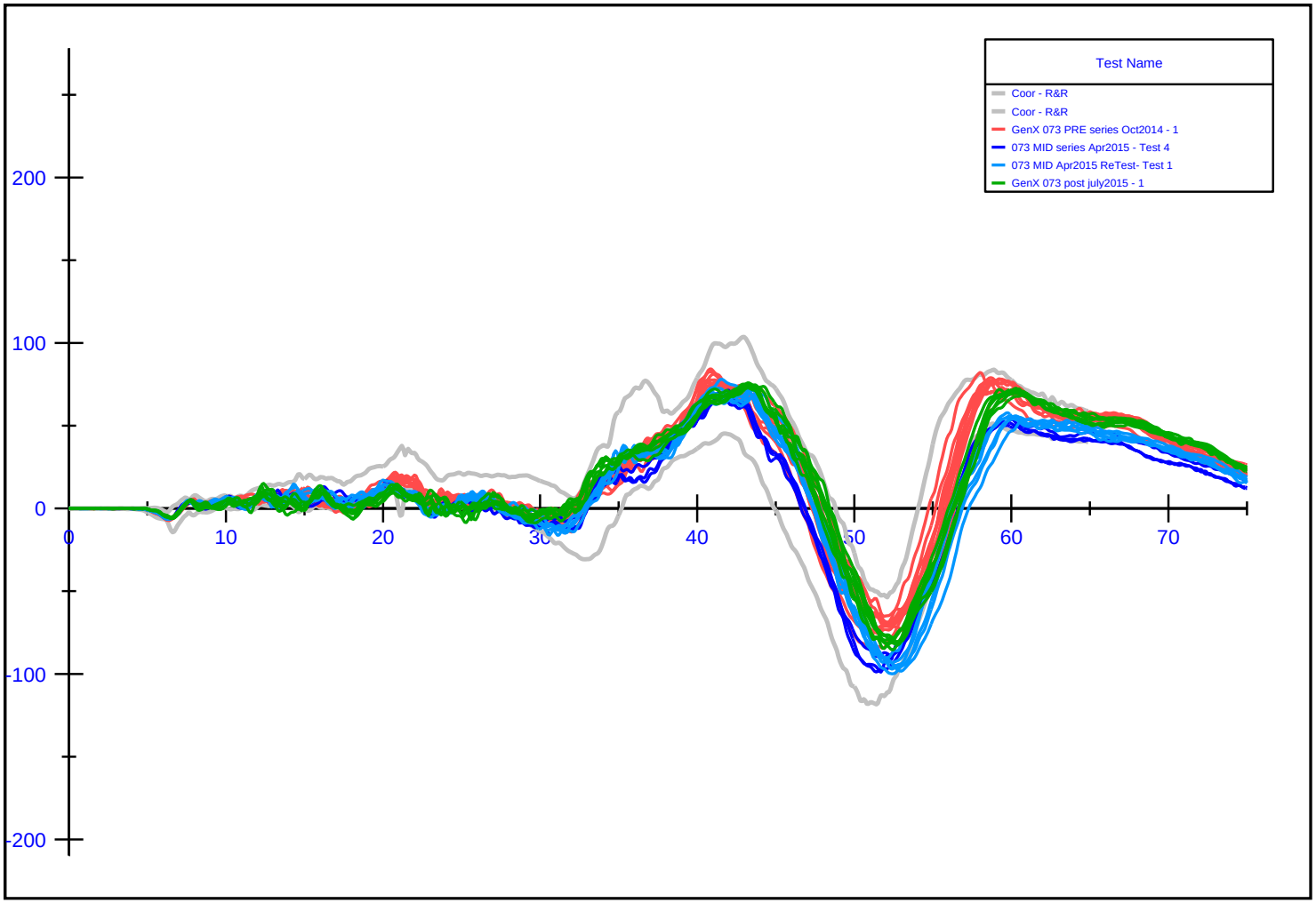
Head to T1 Rotation



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

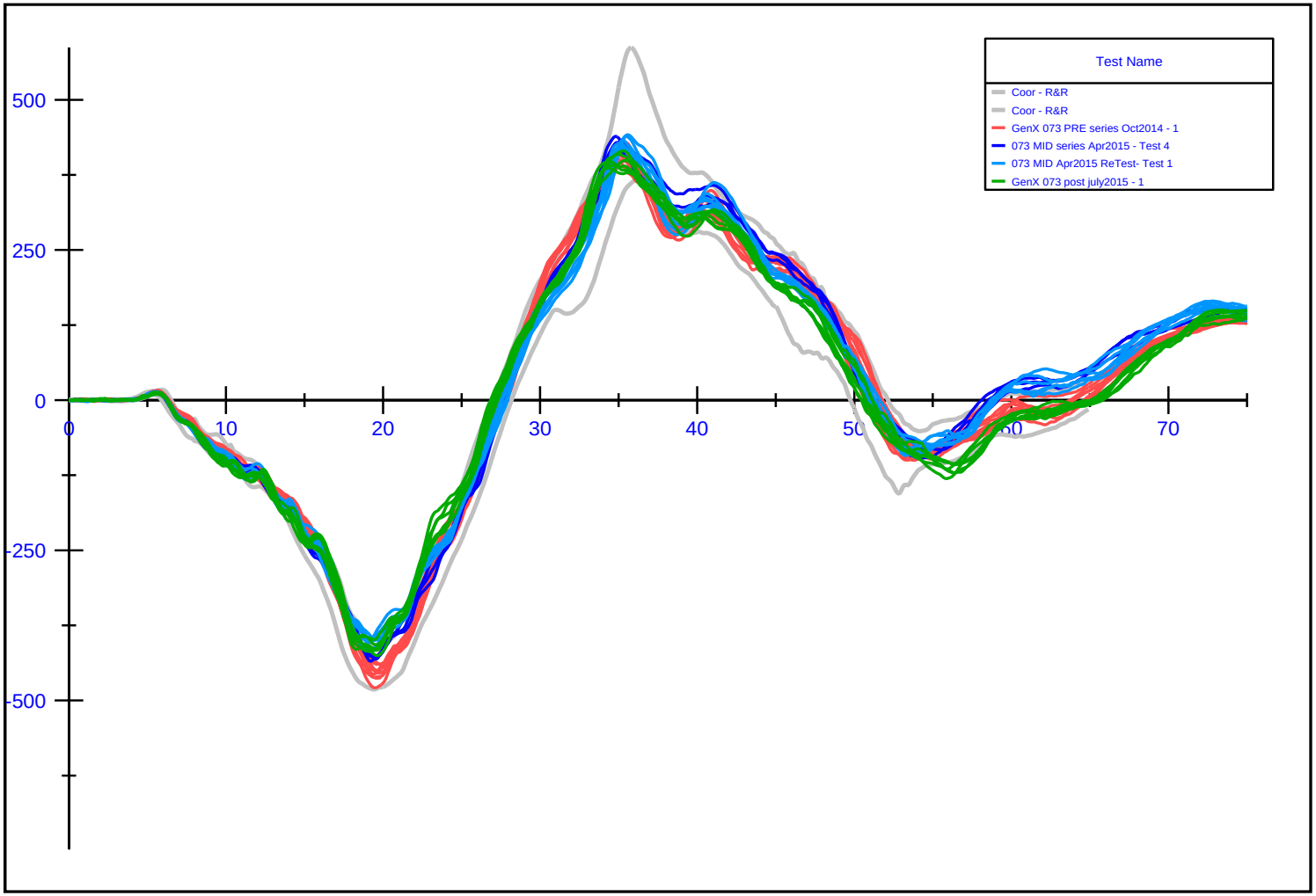
Upper Neck FX



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

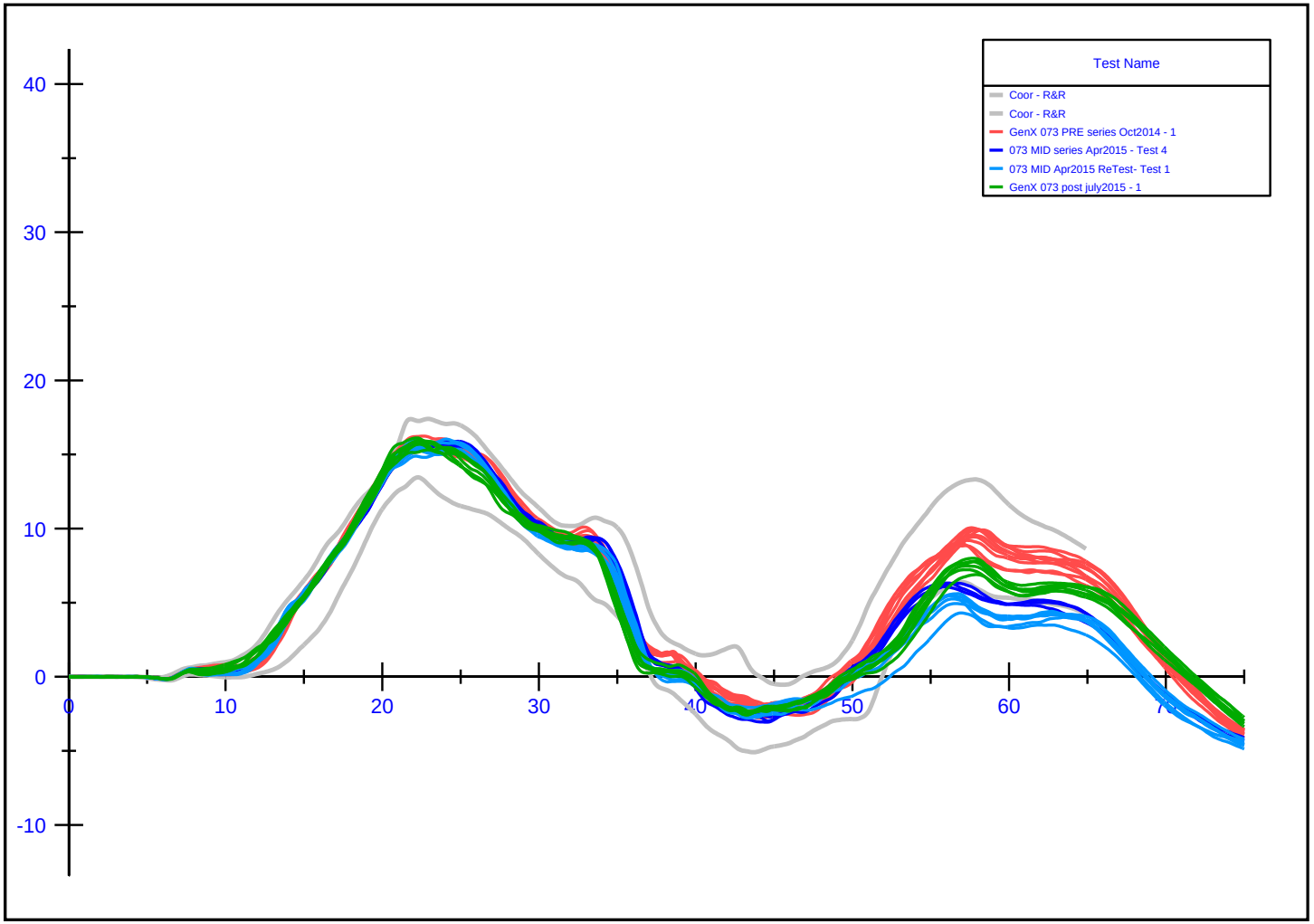
Upper Neck FZ



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

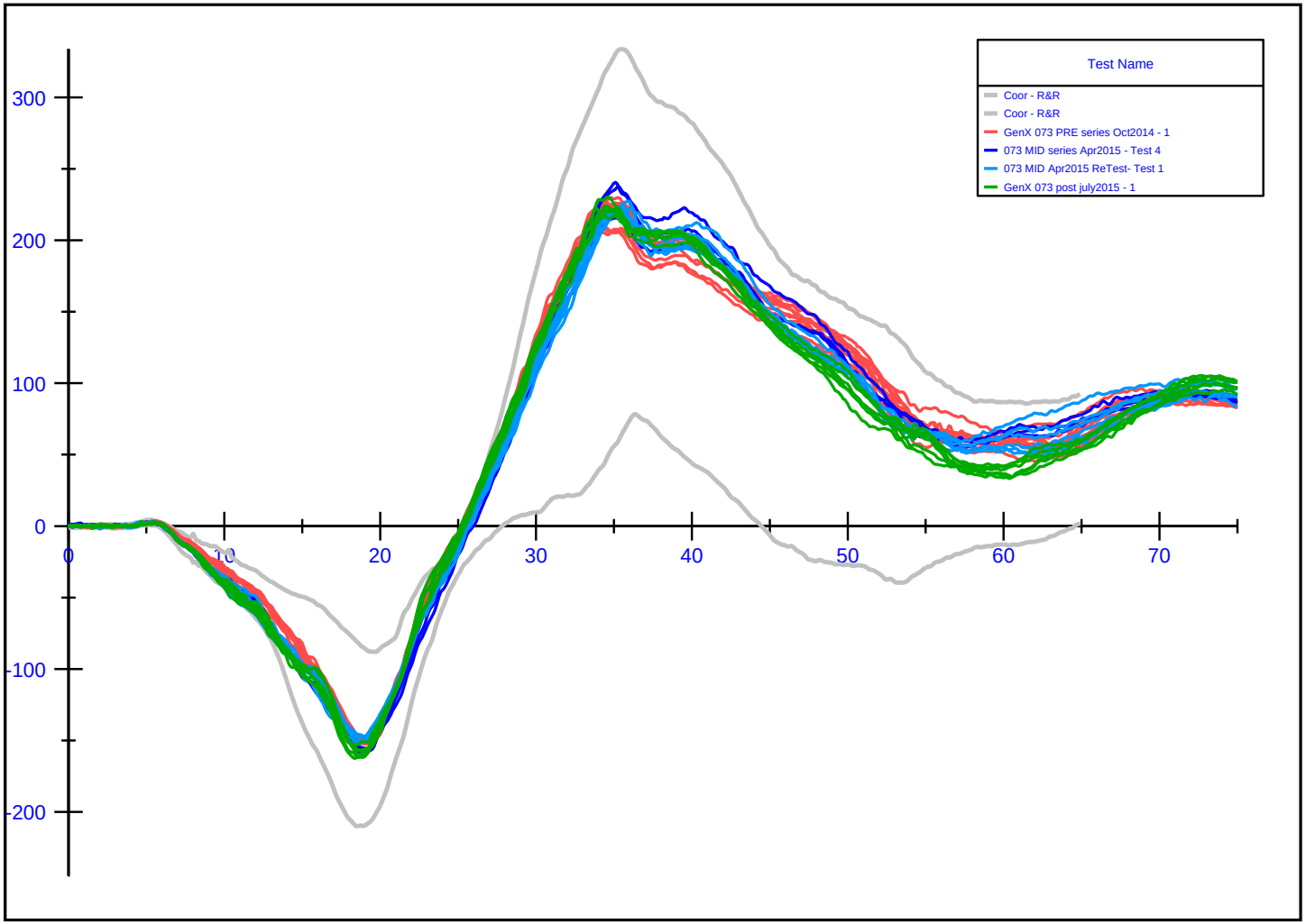
Upper Neck MY



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

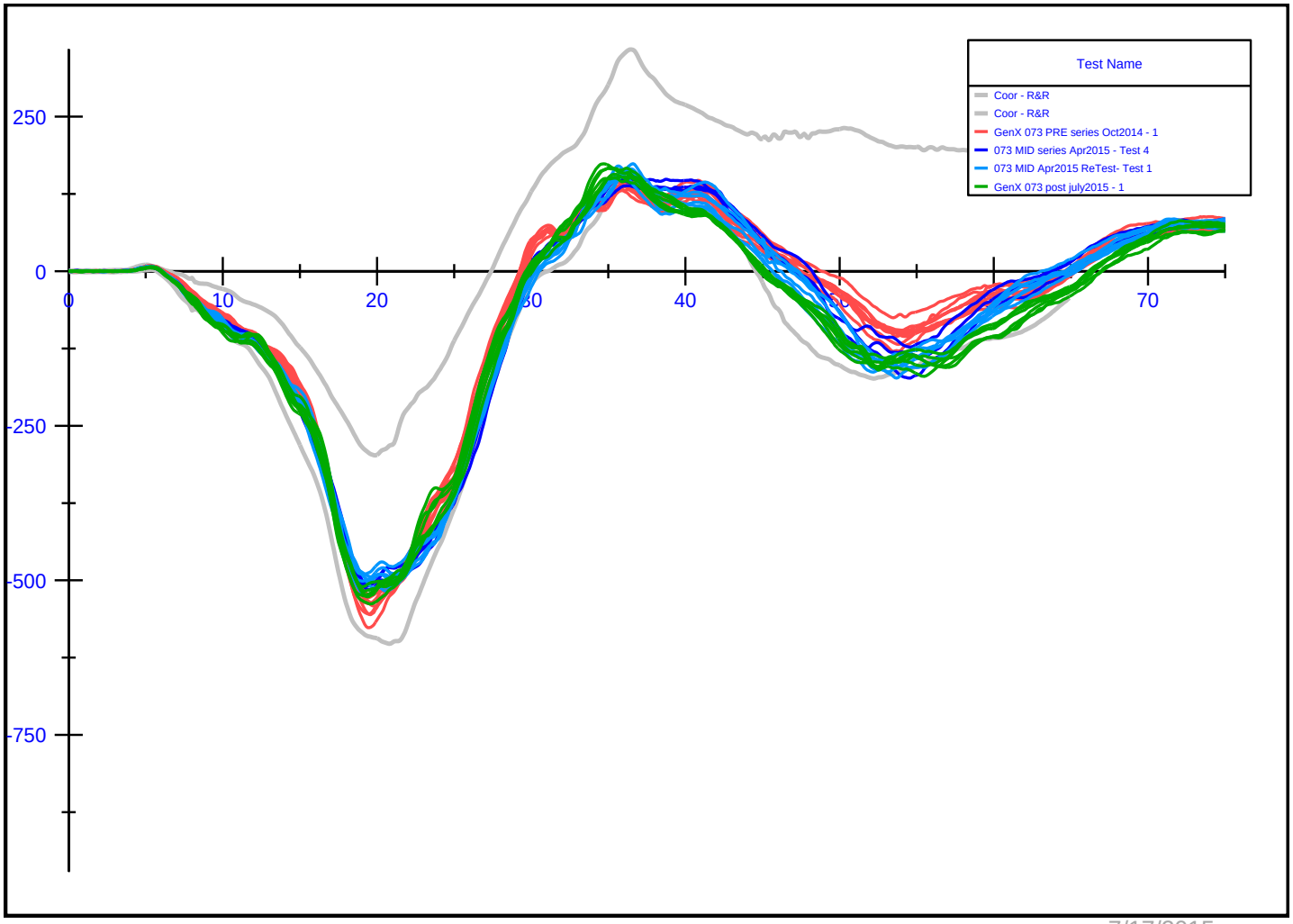
Lower Neck T1 FX



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

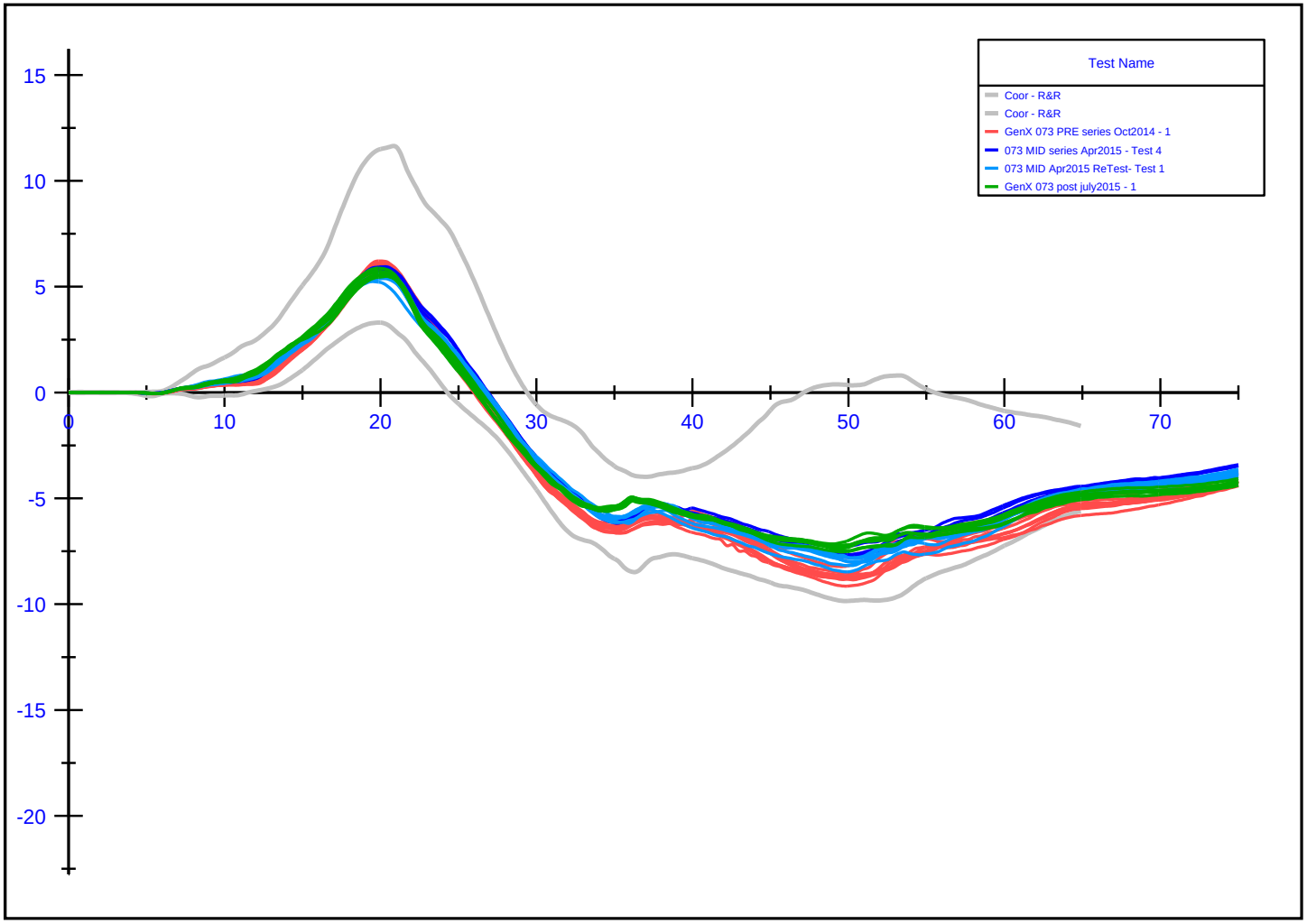
Lower Neck T1 FZ



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

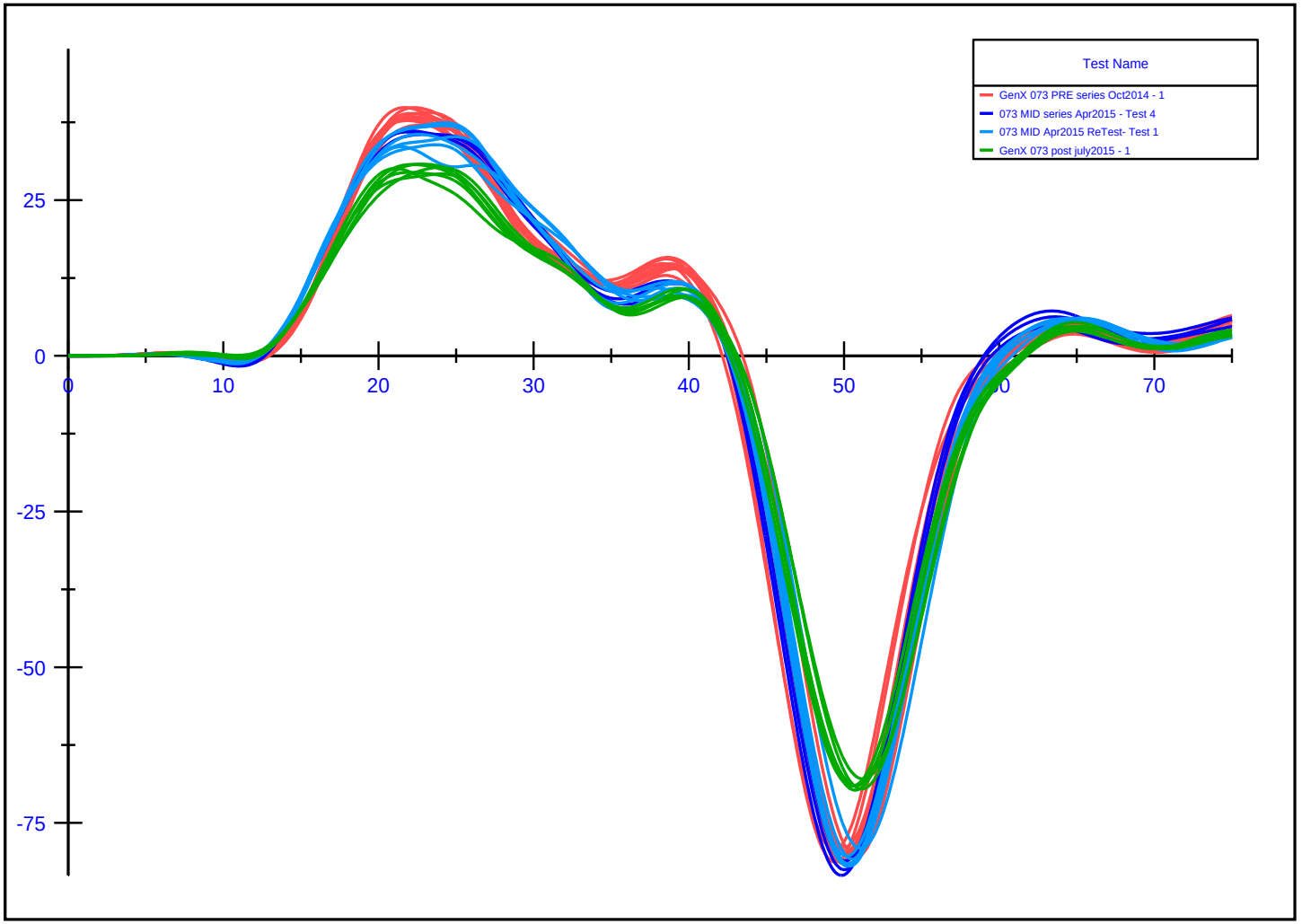
Lower Neck T1 MY



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: 0073 Pre, Mid, Post

NIC



©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X, VRTC Series: CV %

- CV calculated for critical channel peaks
- Repeatability
- Reproducibility
  - Pre
  - Mid
  - Post
  - Combined
- Only samples show

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

073

073 at POST-series -- CUT OFF = 65ms						
Stats - Names	Min - Mean	Min - Std Dev	Min - %CV	Max - Mean	Max - Std Dev	Max - %CV
Probe Accelerometer						
T1 X Acceleration				149.12	3.87	2.59
T1 Z Acceleration	-91.05	2.89	-3.17	62.12	3.95	6.35
Upper Neck FX	-82.23	2.63	-3.20	74.69	1.24	1.66
Upper Neck FZ	-413.50	9.39	-2.27	399.56	10.89	2.73
Upper Neck MY				15.78	0.27	1.74
Lower Neck T1 FX	-158.53	3.44	-2.17	223.05	4.21	1.89
Lower Neck T1 FZ	-161.75	8.66	-5.35	523.43	9.39	1.79
Lower Neck T1 MY	-7.33	0.14	-1.96	5.63	0.15	2.68
L1 Lumbar X Accelerometer	-60.71	3.81	-6.27	153.20	2.78	1.81
T8 Thorax X Accelerometer	-143.53	2.62	-1.83			
C4 Thorax X Accelerometer				179.37	4.17	2.32
Head X Accelerometer				372.31	2.19	0.59
Head Z Accelerometer	-87.80	1.92	-2.19	93.30	1.85	1.98
Pelvis X Accelerometer				84.99	2.57	3.02
Pelvis Z Accelerometer				70.14	1.80	2.56
Head ARS	-267.45	8.62	-3.22	703.83	7.31	1.04
T1 ARS	-335.48	10.51	-3.13	808.41	2.67	0.33
T8 ARS	-268.96	10.30	-3.83	235.16	11.53	4.90
L1 ARS	-363.02	6.94	-1.91			
Pelvis ARS	-558.22	14.74	-2.64	288.75	11.53	3.99
Head Contact Switch						
Probe Force				14,343	52.37	0.37
Head to T1 Differential Velocity						
Head to T1 Rotation	-6.45	0.36	-5.65			
Head Angle				13.52	0.44	3.23
T1 Angle				12.77	0.10	0.78
T8 Angle						
L1 Angle						
Pelvis Angle						
Pelvis to T1 Differential Velocity				1201.28	13.90	1.16
Pelvis to T1 Rotation						
NIC				30.09	0.65	2.15

073

073 for ENTIRE-series -- CUT OFF = 65ms						
Stats - Names	Min - Mean	Min - Std Dev	Min - %CV	Max - Mean	Max - Std Dev	Max - %CV
Probe Accelerometer						
T1 X Acceleration				175.08	17.80	10.17
T1 Z Acceleration	-106.63	10.68	-10.02	76.23	10.24	13.44
Upper Neck FX	-83.94	10.94	-13.04	74.98	4.56	6.09
Upper Neck FZ	-428.65	24.62	-5.74	415.96	16.03	3.85
Upper Neck MY				15.74	0.27	1.70
Lower Neck T1 FX	-154.31	4.47	-2.90	223.09	7.59	3.40
Lower Neck T1 FZ	-524.85	20.33	-3.87	153.55	12.49	8.13
Lower Neck T1 MY	-8.03	0.60	-7.51	5.79	0.27	4.62
L1 Lumbar X Accelerometer	-157.46	7.64	-4.85	56.45	5.66	10.03
T8 Thorax X Accelerometer	-144.10	2.46	-1.70			
C4 Thorax X Accelerometer				180.29	10.78	5.98
Head X Accelerometer				406.16	20.19	4.97
Head Z Accelerometer	-89.70	4.41	-4.92	86.71	4.37	5.04
Pelvis X Accelerometer				87.08	2.58	2.96
Pelvis Z Accelerometer				70.96	2.14	3.02
Head ARS	-283.80	24.72	-8.71	712.46	15.19	2.13
T1 ARS	-329.35	23.57	-7.16	796.46	14.42	1.81
T8 ARS	-284.43	19.24	-6.76	241.67	13.72	5.68
L1 ARS	-376.35	21.13	-5.61			
Pelvis ARS	-559.40	20.03	-3.58	287.59	11.66	4.06
Head Contact Switch						
Probe Force				14,207	181.88	1.28
Head to T1 Differential Velocity						
Head to T1 Rotation	-6.60	0.34	-5.11			
Head Angle				13.09	0.47	3.57
T1 Angle				12.69	0.24	1.90
T8 Angle						
L1 Angle						
Pelvis Angle						
Pelvis to T1 Differential Velocity				1208.55	14.33	1.19
Pelvis to T1 Rotation						
NIC				35.34	3.51	9.94

ALL

ALL – PRE Series -- CUT OFF = 65ms						
Stats - Names	Min - Mean	Min - Std Dev	Min - %CV	Max - Mean	Max - Std Dev	Max - %CV
Probe Accelerometer						
T1 X Acceleration				185.32	10.19	5.50
T1 Z Acceleration	-110.03	7.59	-6.89	71.15	5.49	7.71
Upper Neck FX	-80.74	15.93	-19.73	74.69	7.35	9.84
Upper Neck FZ	-441.07	17.23	-3.91	431.00	21.90	5.08
Upper Neck MY				15.12	0.91	6.02
Lower Neck T1 FX	-159.08	5.92	-3.72	233.27	18.19	7.80
Lower Neck T1 FZ	-531.38	19.11	-3.60	185.11	67.09	36.24
Lower Neck T1 MY	-7.98	0.63	-7.85	5.99	0.16	2.66
L1 Lumbar X Accelerometer	-142.78	13.39	-9.38	55.56	3.37	6.07
T8 Thorax X Accelerometer	-141.74	4.30	-3.03			
C4 Thorax X Accelerometer				171.19	11.47	6.70
Head X Accelerometer				418.24	4.96	1.19
Head Z Accelerometer	-90.69	4.01	-4.42	91.51	7.45	8.14
Pelvis X Accelerometer				89.01	3.07	3.45
Pelvis Z Accelerometer				68.60	2.69	3.93
Head ARS	-337.62	27.12	-8.03	750.40	38.82	5.17
T1 ARS	-340.54	27.18	-7.98	793.64	15.60	1.97
T8 ARS	-287.52	26.12	-9.08	212.12	39.30	18.53
L1 ARS	-353.65	48.05	-13.59			
Pelvis ARS	-559.53	28.13	-5.03	272.37	19.93	7.32
Head Contact Switch						
Probe Force				14,320	273.16	1.91
Head to T1 Differential Velocity						
Head to T1 Rotation	-6.92	0.45	-6.55			
Head Angle				12.77	0.62	4.88
T1 Angle				12.77	0.37	2.91
T8 Angle						
L1 Angle						
Pelvis Angle						
Pelvis to T1 Differential Velocity				1183.54	60.39	5.10
Pelvis to T1 Rotation						
NIC				37.53	1.87	4.97

ALL

ALL at POST-series -- CUT OFF = 65ms						
Stats - Names	Min - Mean	Min - Std Dev	Min - %CV	Max - Mean	Max - Std Dev	Max - %CV
Probe Accelerometer						
T1 X Acceleration				145.87	5.65	3.87
T1 Z Acceleration	-91.11	4.71	-5.16	69.05	9.84	14.24
Upper Neck FX	-84.35	12.73	-15.10	70.80	4.72	6.67
Upper Neck FZ	-422.45	22.14	-5.24	430.59	39.37	9.14
Upper Neck MY				14.99	0.73	4.90
Lower Neck T1 FX	-165.66	8.00	-4.83	236.19	17.54	7.42
Lower Neck T1 FZ	-219.64	73.33	-33.39	526.44	33.27	6.32
Lower Neck T1 MY	-7.07	0.55	-7.83	5.83	0.29	4.93
L1 Lumbar X Accelerometer	-58.42	4.10	-7.03	158.25	5.91	3.74
T8 Thorax X Accelerometer	-145.53	2.86	-1.96			
C4 Thorax X Accelerometer				166.59	15.60	9.36
Head X Accelerometer				376.95	5.47	1.45
Head Z Accelerometer	-89.19	4.51	-5.05	100.11	6.41	6.40
Pelvis X Accelerometer				84.14	3.47	4.13
Pelvis Z Accelerometer				73.08	2.72	3.72
Head ARS	-296.43	26.84	-9.05	747.87	42.51	5.68
T1 ARS	-350.65	44.32	-12.64	845.52	37.76	4.47
T8 ARS	-267.34	9.26	-3.46	221.54	22.83	10.31
L1 ARS	-374.45	15.48	-4.13			
Pelvis ARS	-556.01	42.52	-7.65	294.58	21.04	7.14
Head Contact Switch						
Probe Force				14,344	56.76	0.40
Head to T1 Differential Velocity						
Head to T1 Rotation	-7.16	0.68	-9.44			
Head Angle				13.23	0.55	4.17
T1 Angle				13.27	0.52	3.94
T8 Angle						
L1 Angle						
Pelvis Angle						
Pelvis to T1 Differential Velocity				1253.11	64.16	5.12
Pelvis to T1 Rotation						
NIC				29.64	1.01	3.40

ALL

ALL at ENTIRE-series -- CUT OFF = 65ms						
Stats - Names	Min - Mean	Min - Std Dev	Min - %CV	Max - Mean	Max - Std Dev	Max - %CV
Probe Accelerometer						
T1 X Acceleration				172.42	18.33	10.63
T1 Z Acceleration	-106.56	11.09	-10.41	74.99	10.74	14.32
Upper Neck FX	-94.16	21.37	-22.70	66.47	11.83	17.80
Upper Neck FZ	-430.25	20.80	-4.83	435.48	30.76	7.06
Upper Neck MY				14.86	0.79	5.29
Lower Neck T1 FX	-161.28	8.57	-5.31	228.06	23.74	10.41
Lower Neck T1 FZ	-531.54	25.56	-4.81	188.97	61.07	32.32
Lower Neck T1 MY	-7.40	0.80	-10.76	5.92	0.25	4.20
L1 Lumbar X Accelerometer	-157.03	12.60	-8.02	56.43	5.15	9.13
T8 Thorax X Accelerometer	-143.65	4.58	-3.19			
C4 Thorax X Accelerometer				179.23	22.71	12.67
Head X Accelerometer				406.68	20.14	4.95
Head Z Accelerometer	-88.53	5.36	-6.06	89.59	9.58	10.69
Pelvis X Accelerometer				87.75	3.87	4.41
Pelvis Z Accelerometer				73.14	5.69	7.78
Head ARS	-309.89	32.32	-10.43	741.89	39.54	5.33
T1 ARS	-339.13	39.99	-11.79	835.53	42.87	5.13
T8 ARS	-275.11	19.00	-6.91	213.18	34.37	16.12
L1 ARS	-371.70	31.06	-8.36			
Pelvis ARS	-566.94	36.74	-6.48	291.51	23.37	8.02
Head Contact Switch						
Probe Force				14,340	177.00	1.23
Head to T1 Differential Velocity						
Head to T1 Rotation	-7.16	0.54	-7.54			
Head Angle				12.82	0.69	5.34
T1 Angle				13.28	0.67	5.05
T8 Angle						
L1 Angle						
Pelvis Angle						
Pelvis to T1 Differential Velocity				1234.35	69.58	5.64
Pelvis to T1 Rotation						
NIC				35.09	3.75	10.70

Gen-X Development – Next?

- Status of VRTC dummies
  - Dummies have reasonable fit to target R&R dummy corridors (pre & post)
  - Dummies good R&R most channels pre & post
  - Something changed on all dummies between mid & post
    - Testing or dummy change? Probably testing as all changed in same way, similar amplitude
- Wait to see results of VRTC sled series
  - This test might be much more sensitive than seat test

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Gen-X Next Steps

- Repeat Post Test Gen-X to determine what changed in testing
  - Also do certification tests
- If VRTC testing looks good
  - Use all data collected and problems investigated to determine what channels to use and try to create a troubleshooting guide
  - Use R&R dummies & these 3 VRTC series dummies to establish Gen-X corridors
    - Heavily focused on 3 VRTC series dummies used to establish injury criteria
  - Finalize Mutual Resolution procedure, with draft corridors
  - Get equipment out for other regions and companies to try
  - Collect data on many dummies to improve corridors & troubleshooting guide

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Material Replacement

- All bumper materials are obsolete
- New molds built to better control geometry
- Compression targets established for all bumpers
- Some of the bumpers have replacements matching targets
- Remainder are in works
- Materials look very good

©2015 Humanetics Innovative Solutions Inc. Confidential & Proprietary [MK-FO-00001C REV B]

Questions?

© 2015 Humanetics Innovative Solutions, Inc.

This presentation is the proprietary property of Humanetics Innovative Solutions, Inc; a registered company in Plymouth, Michigan, USA. The report includes confidential information. Disclosure, use, copying, or distribution of this information without the written authorization of Humanetics Innovative Solutions is prohibited.