

NHTSA TEST REPORT

COVER PAGE

Title of Study	Automated Vehicle Occupant Kinematics
Test Performer	TRI: University of Michigan Transportation Research Institute
Test Reference Number	AV2105
Contract Number	DTNH22-15-D-00017
Test Date	February 15, 2021

Test ID: AV2105
Dates Performed: February 15, 2021
Personnel: CSM, NRO, ACB, LWZ, MLS, KJB

Test Type: PMHS frontal impact with 45 degree back reclined posture, 3-point belt, 32kph deltaV

Purpose of Test: Determine cadaver kinematic and injury response data for occupants in seating configurations that may be present in automated driving systems (ADS).

Comments: The subject sustained numerous skeletal fractures, confirmed with a post-test computed tomography (CT) scan and autopsy. Injuries included five T-spine fractures (T1, T4, T10, T11, T12), a sacrum fracture, manubrium fracture, and multiple rib fractures resulting in bilateral flail chest. Maximum AIS 2015 score was 5 due to bilateral flail chest.

To achieve the correct pelvis positioning, the following steps were taken:

1. Taped around the knees to prevent leg splay
2. Taped the knees to the seat to prevent the pelvis from sliding forward
3. Taped the feet to the floor to prevent leg splay

Tape was also used on the head and arms to secure the positioning prior to testing. All tape was cut ~90% before testing. The tape broke apart upon impact and did not appear to influence kinematics.

Subject Information

Cadaver No.:	WSU711
Sex:	Male
Age:	85
Stature (cm):	169.7
Mass (kg):	71.1
BMI (kg/m ²):	24.7
BMD (mg/cc):	103.9
Cause of death:	Aortic valve sentosis, CHF, A-fib, coronary artery disease
Relevant medical history:	Wired sternum healed, left knee replacement
Anomaly:	N/A

Anthropometric Measurements

Cadaver Number	WSU711	Bicep Circumference (cm)	25.5
Age (yrs)	85	Elbow Circumference (cm)	24.8
Gender (M/F)	M	Forearm Circumference (cm)	22.8
Mass (kg)	71.1	Wrist Circumference (cm)	16.0
Stature (cm)	169.7	Thigh Circumference (cm)	47.6
Acromial Shoulder Height (cm)	146.5	Lower Thigh Circumference (cm)	42.8
Vertex To Symphysis (cm)	84.8	Knee Circumference (cm)	42.0
Waist Height (cm)	95.0	Calf Circumference (cm)	33.8
Biacromial Breadth (cm)	32.0	Ankle Circumference (cm)	25.6
Chest Breadth (cm)	19.7	Neck Circumference (cm)	43.8
Waist Breadth (cm)	15.6	Scye To Shoulder Circ. (cm)	41.2
Hip Breadth (cm)	31.8	Chest Circumference (cm)	104.5
Shoulder To Elbow (cm)	34.6	Waist Circumference (cm)	93.8
Forearm-Hand Length (cm)	45.9	Buttock Circumference (cm)	97.3
Tibial Height (cm)	41.9	Bizygomatic Breadth (cm)	10.3
Ankle Height (cm)	7.8	Menton-Sellion Length (cm)	13.2
Avg Foot Breadth (cm)	8.9	Trochanter Breadth (cm)	29.1
Avg Foot Length (cm)	24.1	Crotch Height (cm)	75.5
Head To Trochanter (cm)	75.1	Waist Back Length (cm)	45.0
Head Length (cm)	18.0	Left Foot Breadth (cm)	9.0
Head Breadth (cm)	15.0	Right Foot Breadth (cm)	8.8
Head Height (cm)	20.9	Left Foot Length (cm)	24.3
Chest Depth (cm)	19.7	Right Foot Length (cm)	23.9
Waist Depth (cm)	15.6		
Buttock Depth (cm)	16.5		

Subject Positioning Targets



Visualization of subject positioning showing skeletal landmarks used for positioning. Note that the skull and pelvis are shown for visualization and reference only, and do not represent the actual subject geometry.

Target Positioning Equations:

	Calculation
Pelvis angle rel. vertical:	$84.8 - (1.37 * \text{Subject BMI}) + (0.331 * \text{Nominal Back Posture})$
Thorax angle rel. vertical:	$8.8 - (0.67 * \text{BMI}) + (0.919 * \text{Nominal Back Posture})$
Head angle rel. vertical:	$-31.6 + (0.584 * \text{BMI}) + (0.907 * \text{Nominal Back Posture})$
Distance between knees:	$-459 + (0.35 * \text{Subject Stature}) + (6 * \text{BMI})$

Note: target positioning equations are derived from analysis of volunteer data gathered at UMTRI (Reed et al., 2019).

Subject inputs for positioning equations:

Positioning Inputs	Value
Nominal Back Angle (relative to vertical)	45°
Subject BMI (kg/m ²)	24.7
Subject Stature (mm)	1697

Achieved and target positioning targets:

	Achieved Value	Target	Tolerance
Pelvis angle rel. vertical (side view angle of vector hip joint – L5/S1 joint)	66.0°	65.3°	5°
L/R ASIS Fore-aft (X)	-0.8	0	5
L/R ASIS Lateral (Y)	0.7	0	5
L/R ASIS Vertical (Z)	6.4	0	10
Hip centers relative Seat H-Pt X	-1.6	0	15 mm
Thorax angle rel. vertical (side view angle of vector T12/L1– C7/T1 joints)	36.7	35.1	3°
T1/T12 Lateral (Y)	-0.1	0	
Head angle relative to vertical (side view angle of tracion to infraorbitale, +=eyes above ears)	26.7	23.9	3°
L/R Tracion Lateral (Y)	-1.9	0	5 mm
L/R Tracion Vertical (Z)	-2.7	0	5 mm
L/R Heels (X)	4.8	0	5 mm
Distance between heels (Y)	308	300 mm	20 mm
Distance between knee centers (Y)	288	281 mm	20 mm

Subject Position

	Region	X (mm)	Y (mm)	Z (mm)
ASIS Right	Pelvis	-40.0	129.0	-74.5
ASIS Left	Pelvis	-39.2	-126.0	-80.9
Pubic Symphysis	Pelvis	57.9	6.6	-33.6
T1 Spinous Process	Spine	-453.4	0.7	-276.3
T12 Spinous Process	Spine	-282.9	-6.5	32.0
Glabella	Head	-315.6	-1.1	-508.5
Tragion Right	Head	-386.2	71.4	-445.0
Tragion Left	Head	-385.2	-76.2	-442.3
Infraorbitale Right	Head	-323.6	35.1	-477.8
Infraorbitale Left	Head	-319.6	-33.4	-473.9
Trochanterion Right	Leg	0.3	167.1	18.4
Trochanterion Left	Leg	7.5	-162.6	21.7
Center Back of Heel Right	Leg	588.0	161.6	320.5
Center Back of Heel Left	Leg	592.8	-146.1	312.6
Malleolus Lateral Right	Leg	639.6	204.3	261.7
Malleolus Lateral Left	Leg	648.6	-210.9	257.7
Malleolus Medial Right	Leg	649.6	135.1	227.6
Malleolus Medial Left	Leg	661.3	-142.2	235.0
Femoral Condyle, Lateral Right	Leg	380.8	184.6	-74.2
Femoral Condyle, Lateral Left	Leg	378.0	-169.9	-67.3
Suprapatella Right	Leg	403.4	139.6	-123.0
Suprapatella Left	Leg	407.5	-148.0	-97.6

Fixture Position

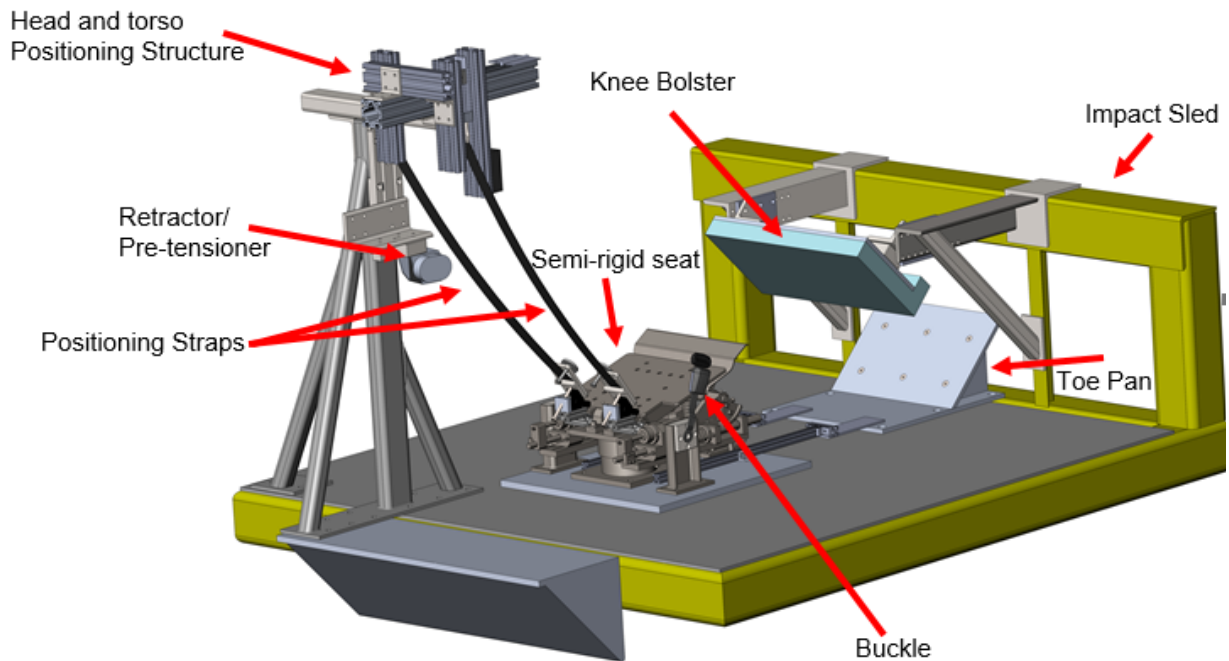
Seatbelt Anchorage Location Relative to Seat H-Point (x+ forward, y+ right, z+ down)			
	X (mm)	Y (mm)	Z (mm)
Left lap belt anchor (xz)	-50.3	-279.5	180.0
Left lap belt anchor (y)	-33.8	-272.6	182.0
Left lap belt web turn	-42.7	-285.9	144.6
Left lap belt ATD contact	4.1	-190.4	-6.8
Left lap belt ASIS	17.5	-123.9	-61.4
Center lap belt ATD	37.1	-3.4	-96.0
Right lap belt ATD contact	-14.1	194.1	-27.4
Right lap belt ASIS	16.4	129.9	-65.5
Buckle web turn	-25.4	224.1	-31.1
Buckle latch center	-29.3	237.6	-4.3
Buckle anchor (xz)	-47.9	287.5	179.0
Buckle anchor (y)	-29.0	270.5	173.2
Lower shoulder belt ATD contact	-41.9	196.0	-46.7
Center should belt ATD	-228.1	0.7	-270.2
Shoulder belt suprasternum	-265.3	-3.3	-292.3
Upper shoulder belt ATD contact	-364.3	-113.1	-322.0
Shoulder belt ret. out	-507.8	-210.7	-362.9
Shoulder belt upper anchor	-587.9	-249.0	-363.3
Knee bolster, foam right aft	656.5	279.4	-175.9
Knee bolster, foam right fore	815.0	284.4	-13.4
Knee bolster right aft	683.3	282.5	-218.7
Knee bolster right fore	854.0	288.2	-47.0

Test Configuration

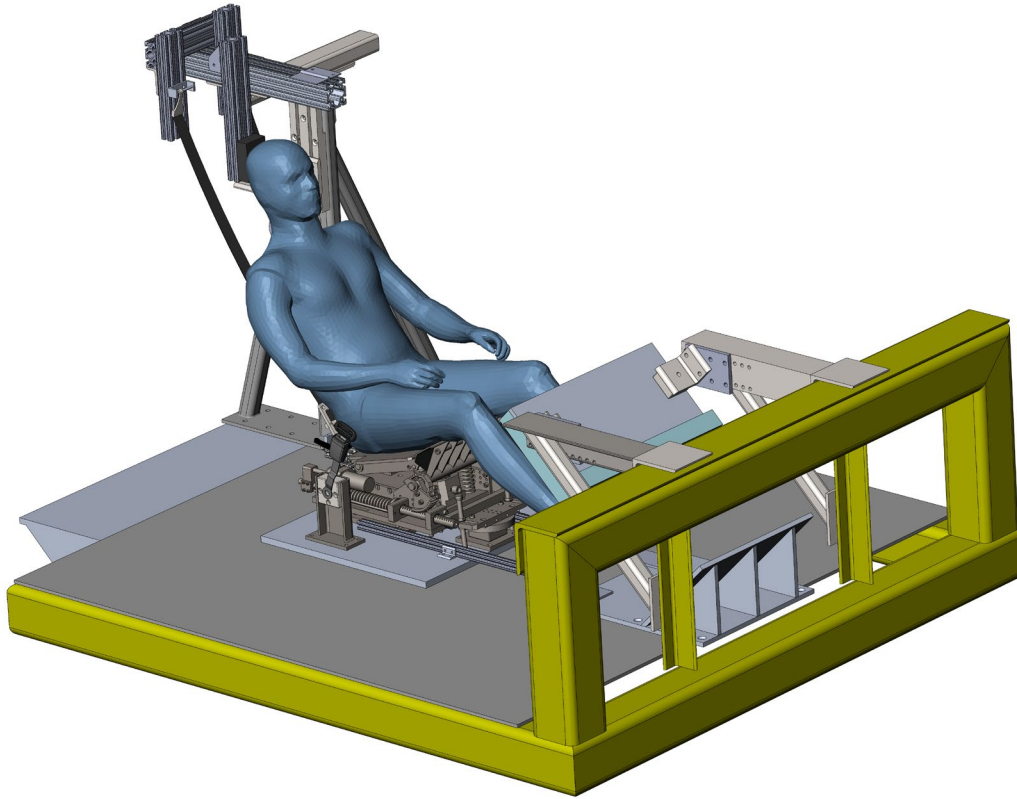
Seat back angle (deg):	45
Target sled delta V (kph):	32
Actual sled delta V (kph):	32.6
Impact angle (deg):	0
Retractor with pre-tensioner load limit (kN):	4.5
Overall sled mass (kg):	1104
Sled Acceleration Pressure (psi):	64.5
Nitrogen Air Spring Pressure (psi):	670

Test Fixture Renderings

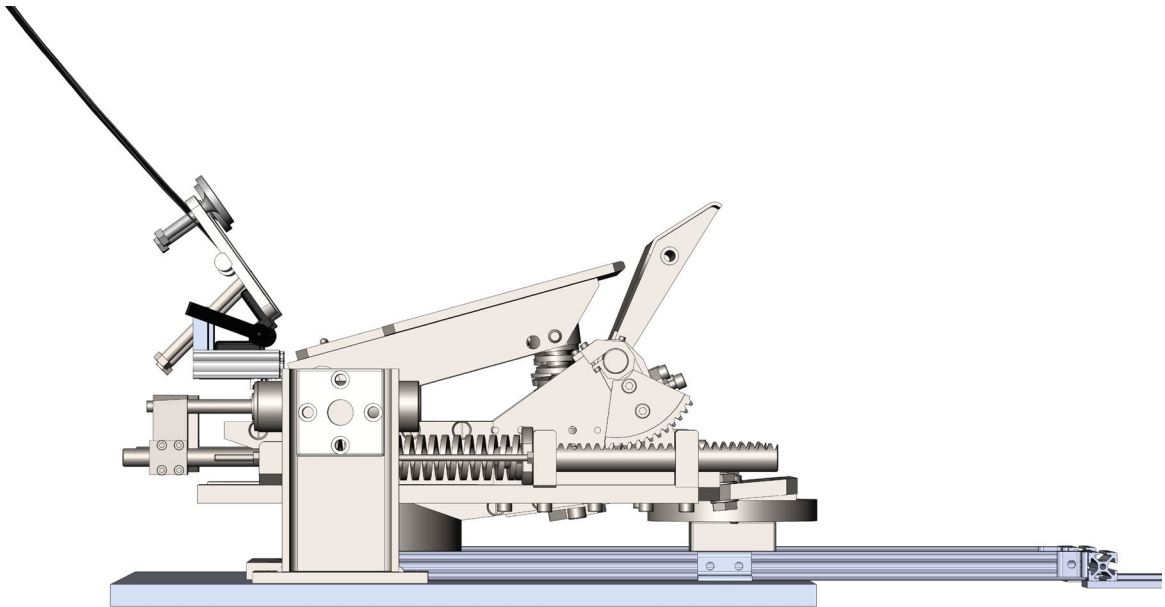
CAD files of the test fixture are located on NHTSA's Biomechanics Database, Test No. 12795.



Rear, right oblique view of the test buck

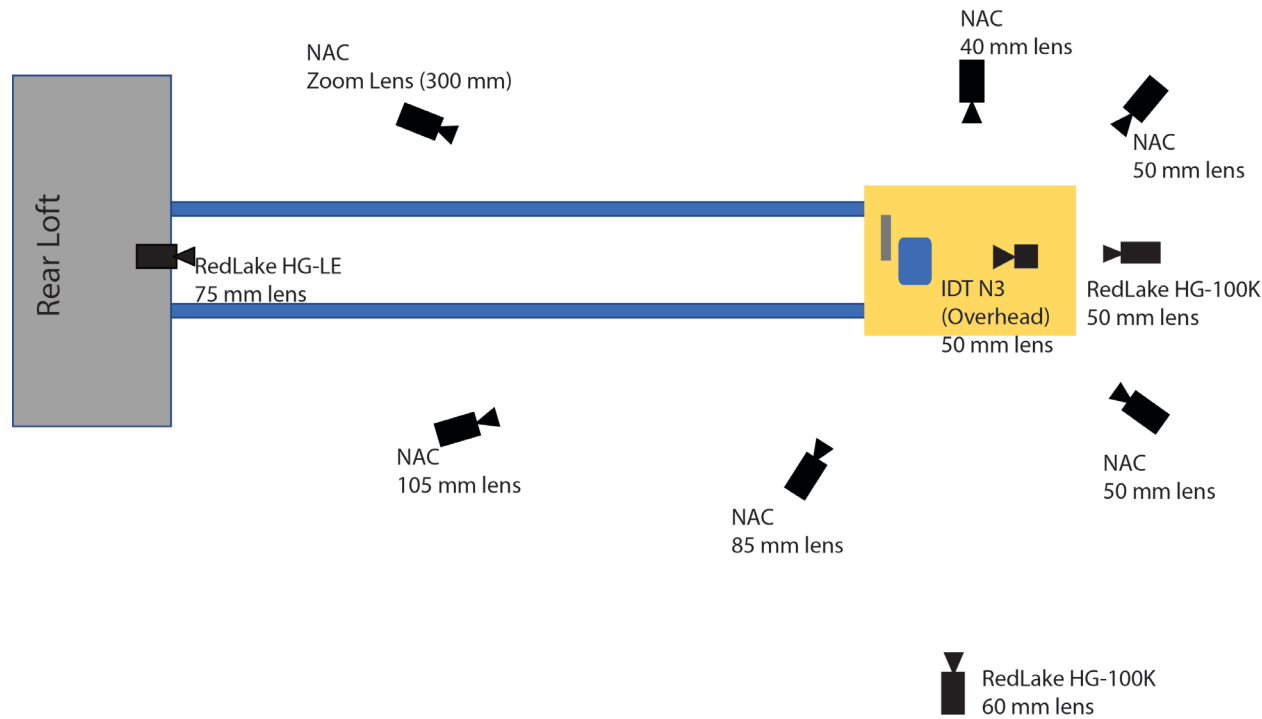


Front, right oblique view of a digital surrogate positioned on the test buck



Lateral view of controlled-response test seat

Test Camera Layout

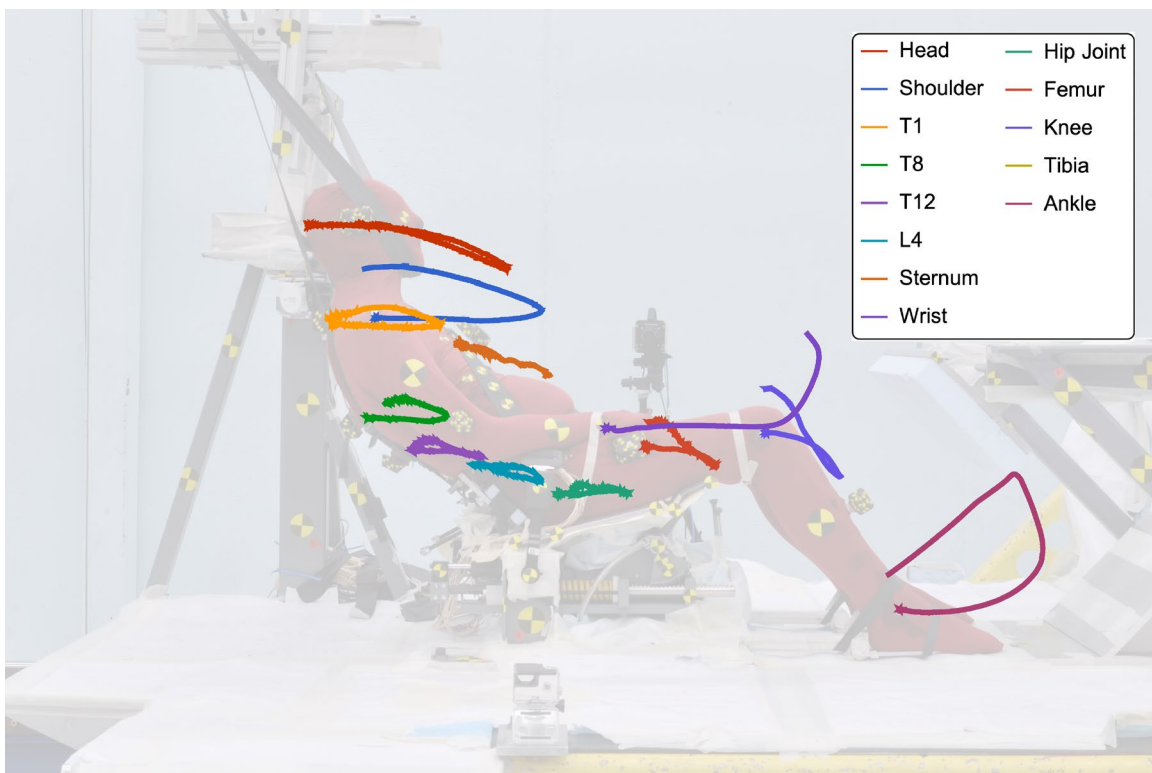


Overhead view of camera setup

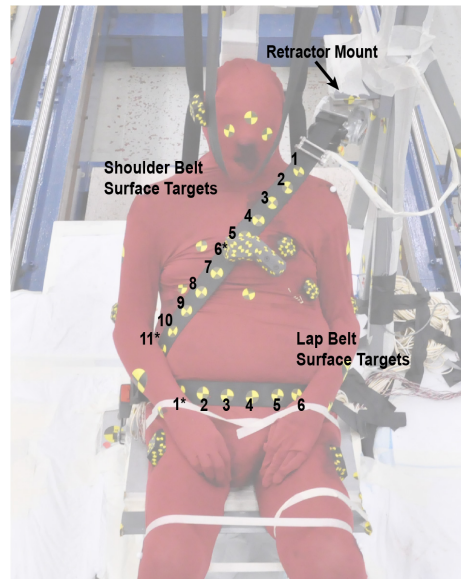
Summary of Results

Sled Delta V:	32.6
Head Maximum Acceleration (g):	44.6
T1 Maximum Acceleration (g):	117.8
T8 Maximum Acceleration (g):	95.6
T12 Maximum Acceleration (g):	120.8
L4 Maximum Acceleration (g):	100.2
Left Iliac Wing Maximum Acceleration (g):	28.1
Right Iliac Wing Maximum Acceleration (g):	N/A
Left Femur Maximum Acceleration (g):	27.5
Right Femur Maximum Accelerating (g):	27.8
Left Tibia Maximum Acceleration (g):	28.1
Right Tibia Maximum Acceleration (g):	61.2
Maximum Left Lap Belt Load (N):	3863.3
Maximum Right Lap Belt Load (N):	5808.2
Maximum Shoulder Belt Load (N):	3759.1
Skeletal Injuries Max AIS Score:	5

Kinematic Tracking



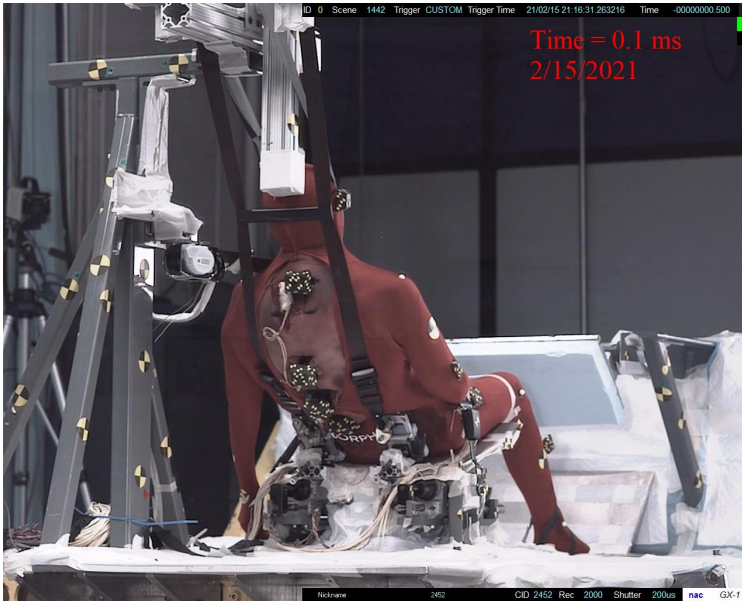
Overlay image of the positioned test subject with kinematic tracking



Overlay image of the positioned test subject with seat belt targets for kinematic tracking

Select Frames From High Speed Video

Camera #1 (Rear1)

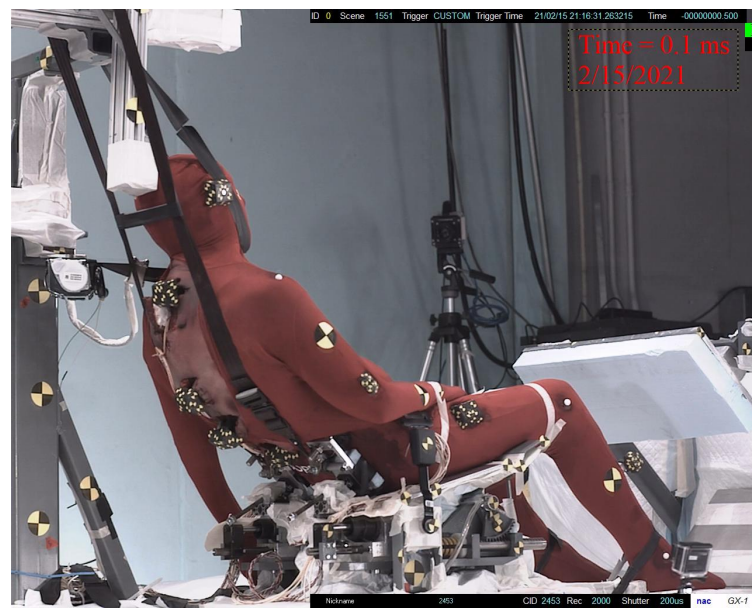


$t = 0 \text{ ms}$

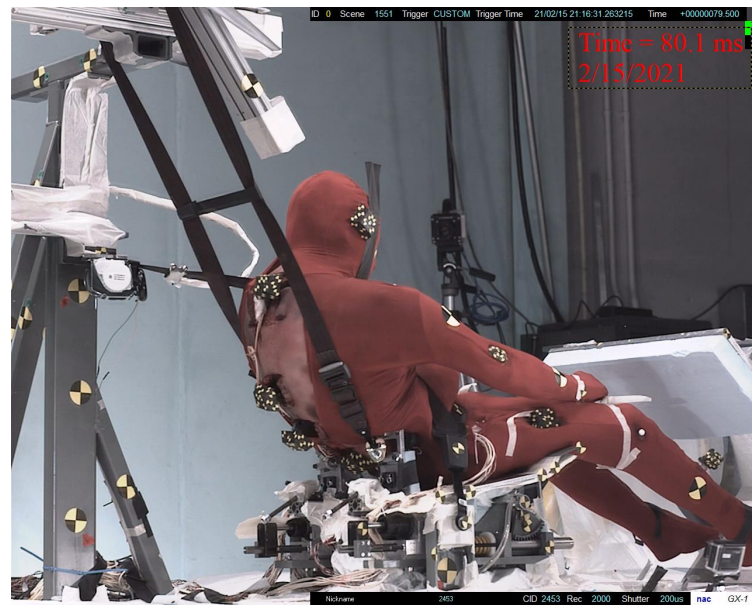


Time of peak seat belt force,
 $t = 80 \text{ ms}$

Camera #2 (Rear2)

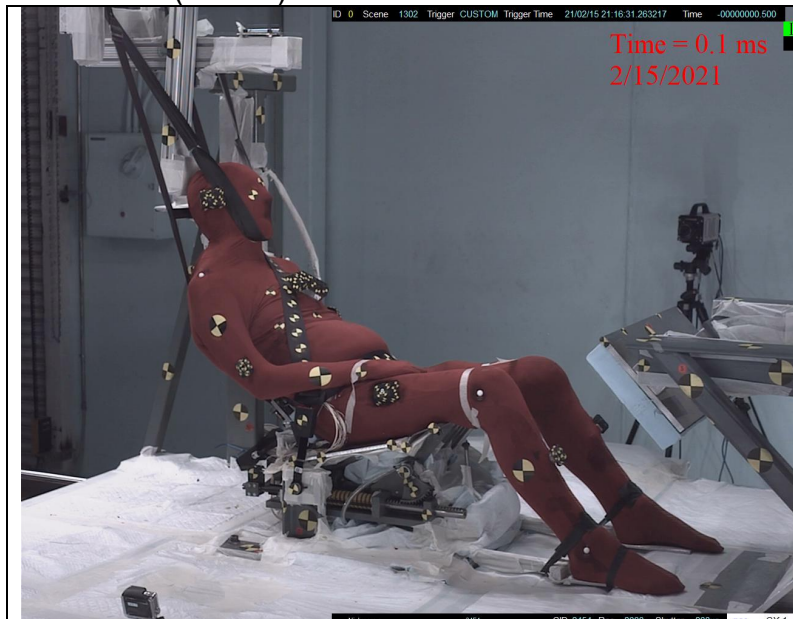


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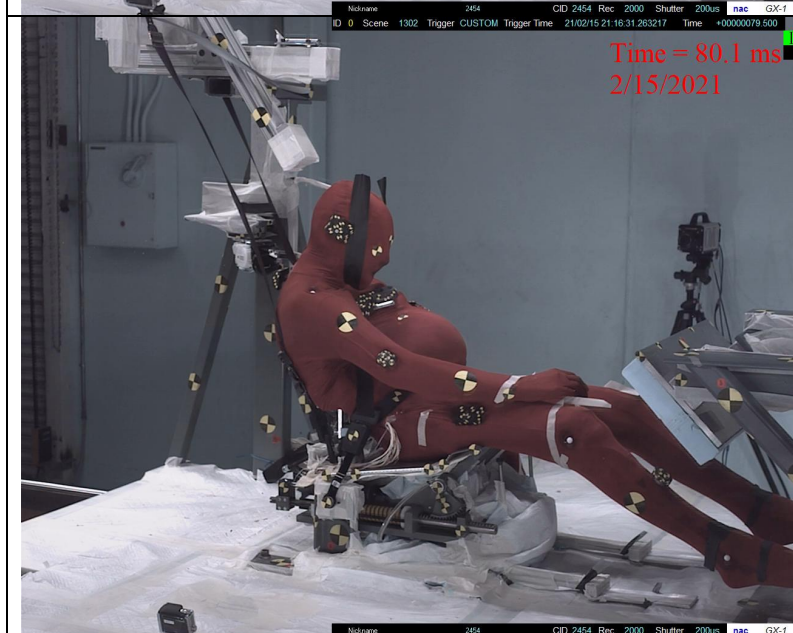


Time of peak seat belt force,
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Camera #3 (Front1)

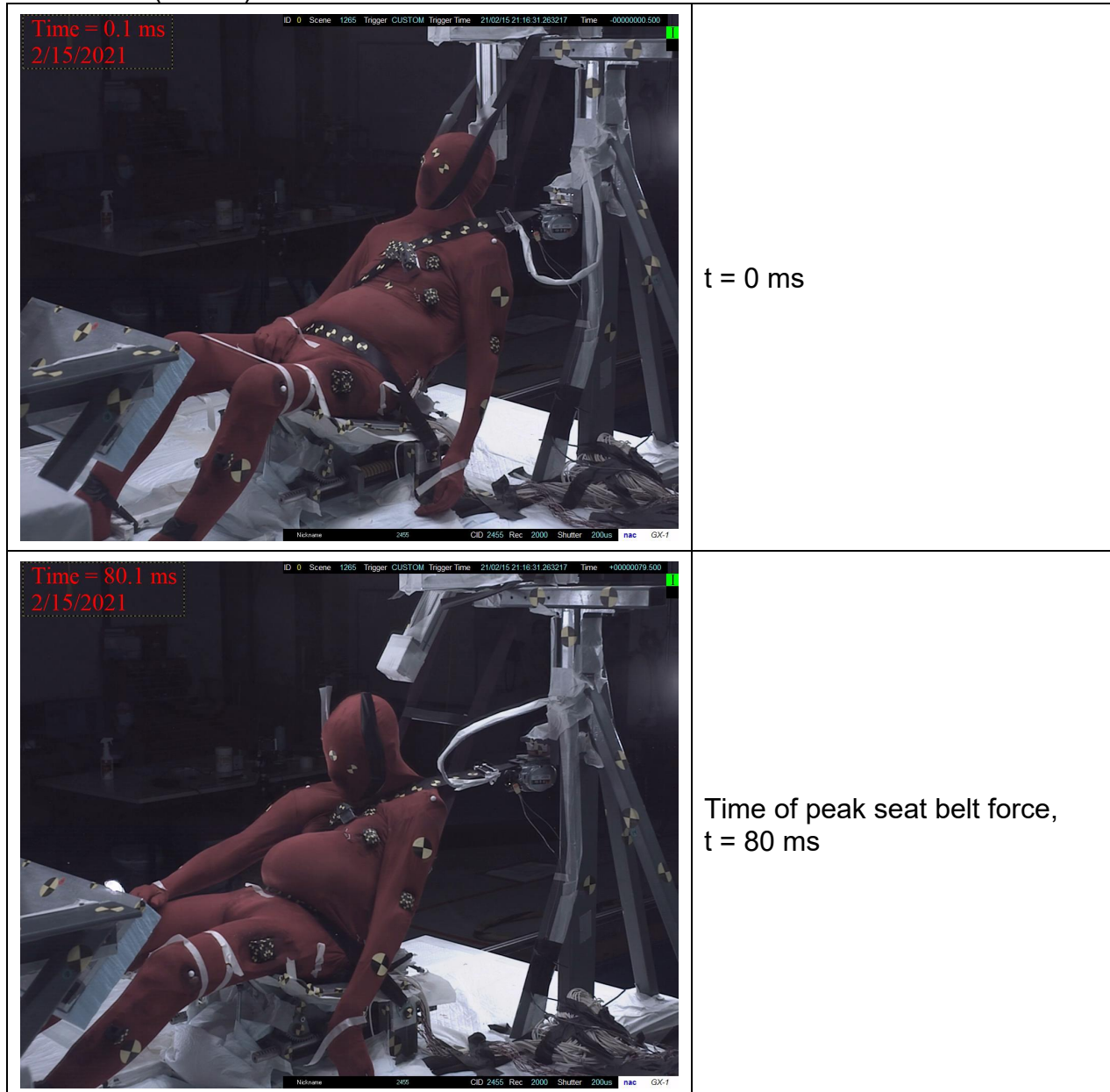


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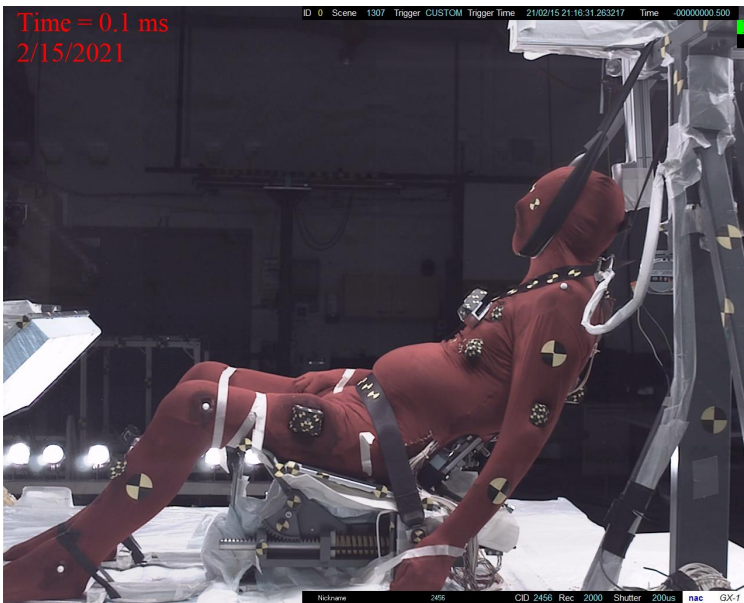


Time of peak seat belt force,
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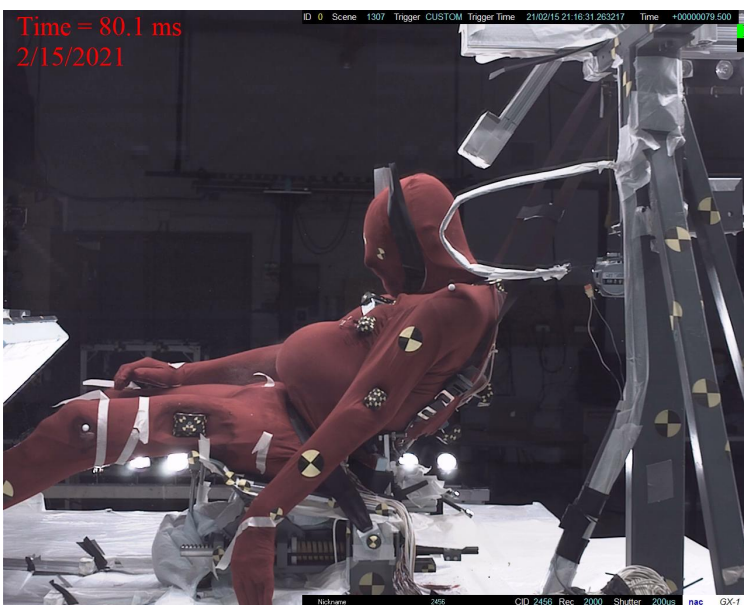
Camera #4 (Front2)



Camera #5 (Left Side)

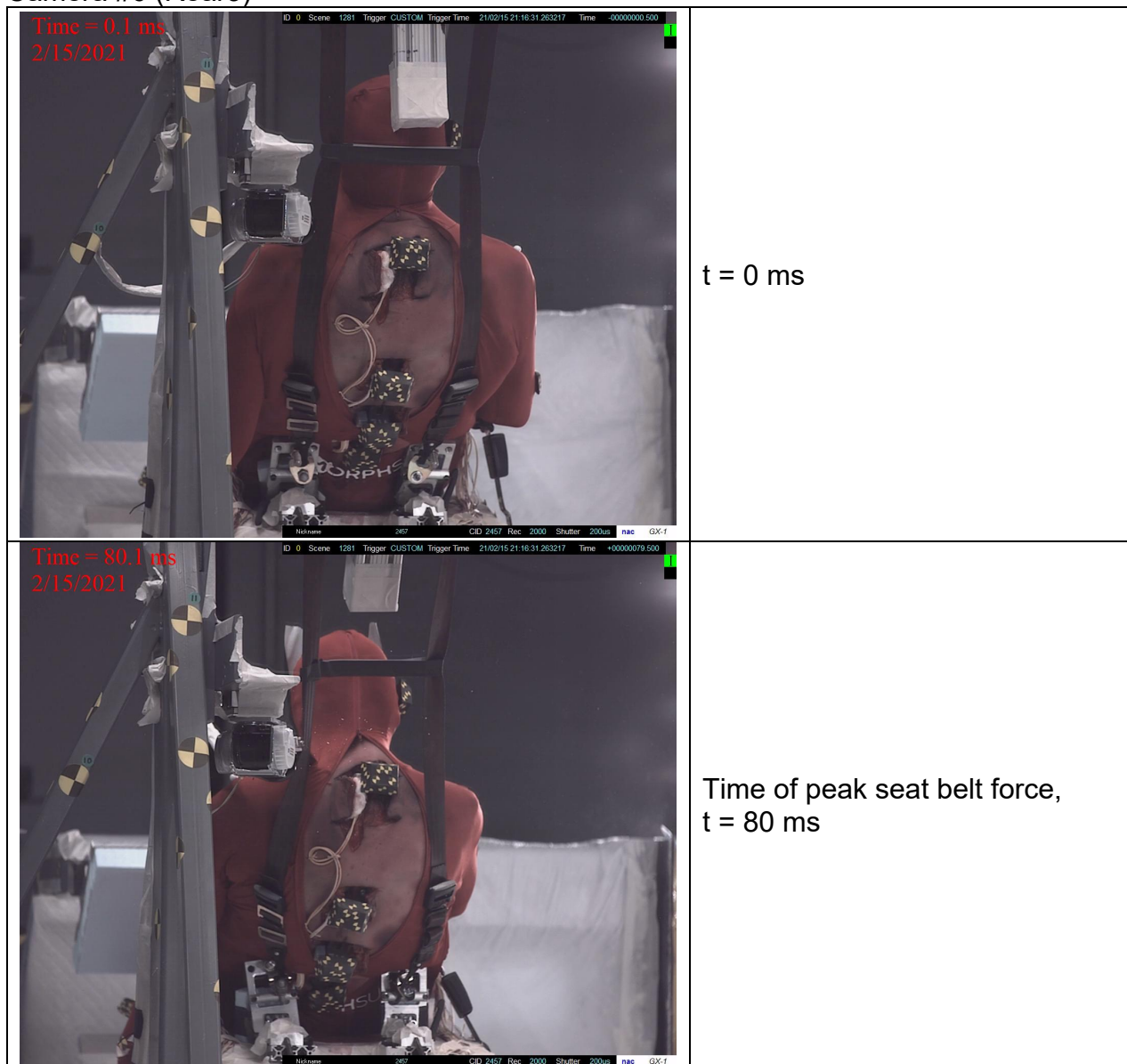


$t = 0 \text{ ms}$

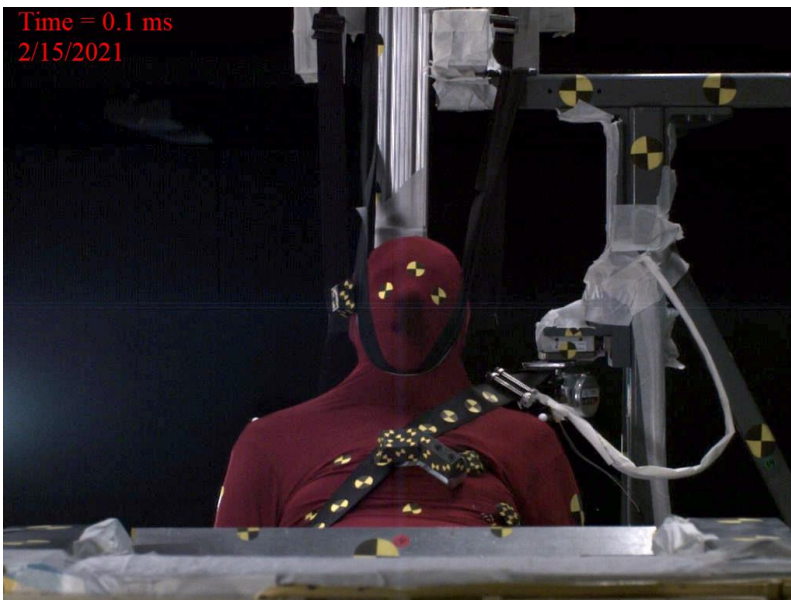


Time of peak seat belt force,
 $t = 80 \text{ ms}$

Camera #6 (Rear3)



Camera #7 (Front3)





$t = 0 \text{ ms}$

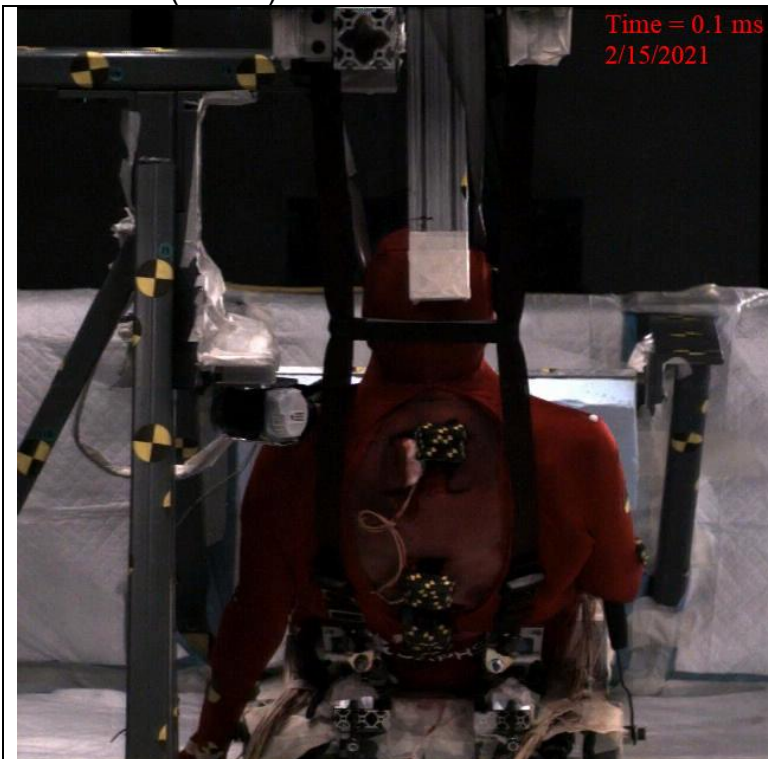


Time of peak seat belt force,
 $t = 80 \text{ ms}$

Camera #8 (Overhead)

			<p>t = 0 ms</p>
			<p>Time of peak seat belt force, t = 80 ms</p>

Camera #9 (Rear4)

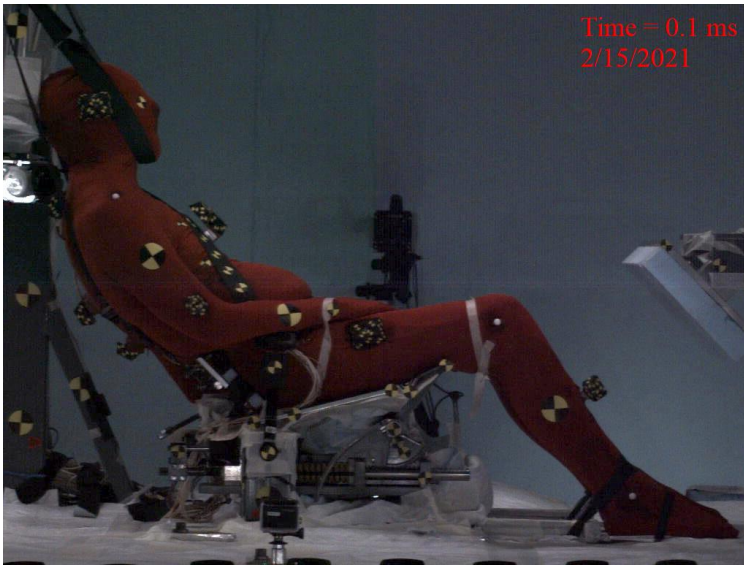


t = 0 ms

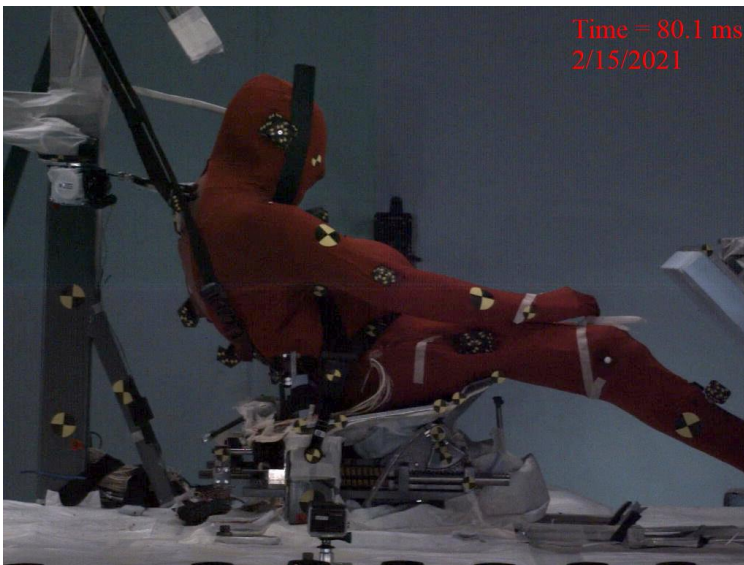


Time of peak seat belt force,
t = 80 ms

Camera #10 (Right Side 1)





$t = 0 \text{ ms}$



Time of peak seat belt force,
 $t = 80 \text{ ms}$

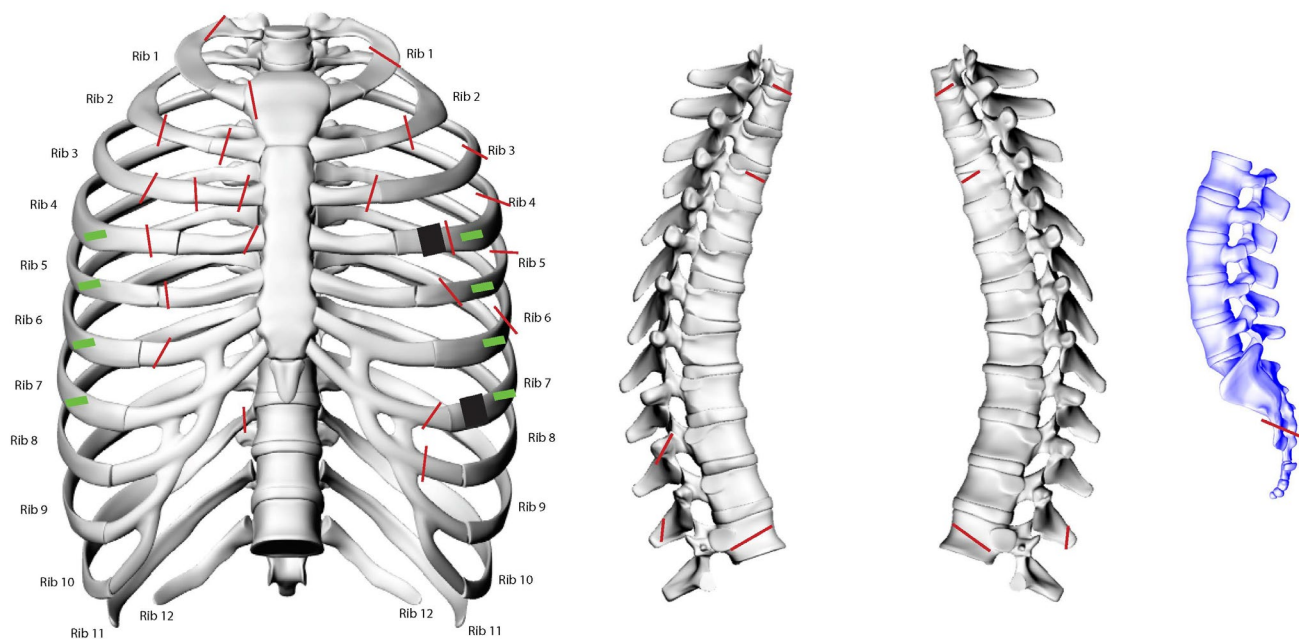
Camera #11 (Right Side 2, GoPro)

 <p>Time = -3200.0 ms 2/15/2021</p>	<p>Initial position before takeoff</p>
 <p>Time = 0.0 ms 2/15/2021</p>	<p>$t = 0$ ms</p>

Injuries

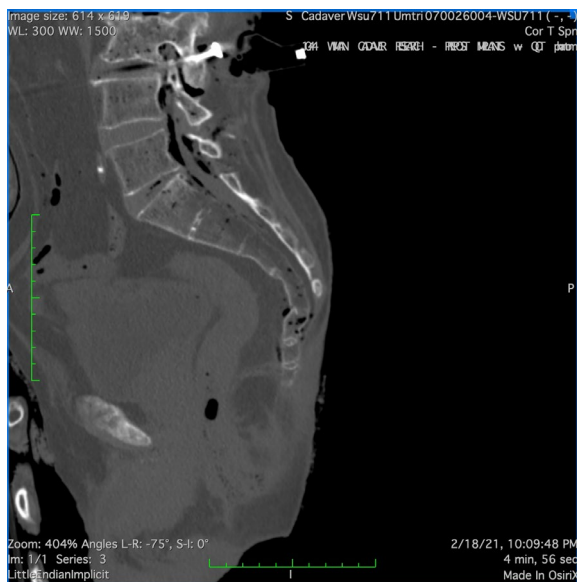
In conjunction with examining images from a post-test computed tomography (CT) scan, an autopsy was performed to confirm skeletal and soft tissue injuries. Skeletal injuries are shown below. Due to time constraints the sacrum fracture was confirmed with CT images only.

Region	Injuries	AIS Severity	AIS Code	AIS Description
Thorax	Manubrium fx	2	450804.2	Manubrium fracture
	Left Side: - Rib 3 anterior fx - Ribs 2, 4-5, 7-8 anterolateral fx - Ribs 1, 3-6 lateral fx	5	450214.5	≥ 3 ribs flail ribs, ribs 3-5 flail, ribs 2, 6-8 single fx
	Right Side: - Ribs 2-4 anterior fx - Ribs 2-6 (x2 rib 3) anterolateral fx - Ribs 1, 9 posterior fx			≥ 3 ribs flail ribs, ribs 2-4 flail, ribs 1, 5, 6, 9 single fx
Spine	T1 anterior inferior endplate fx	2	650432.2	Vertebral flexion
	T4 anterior superior endplate fx	2	650432.2	Vertebral flexion
	T12 endplate fx	2	650430.2	Vertebral extension fracture
	T10 transverse process fx	1	650420.1	Transverse process fracture
	T11 spinous process fx	1	650418.1	Spinous process fx
	Sacrum fx	2	856151.2	Sacrum fracture



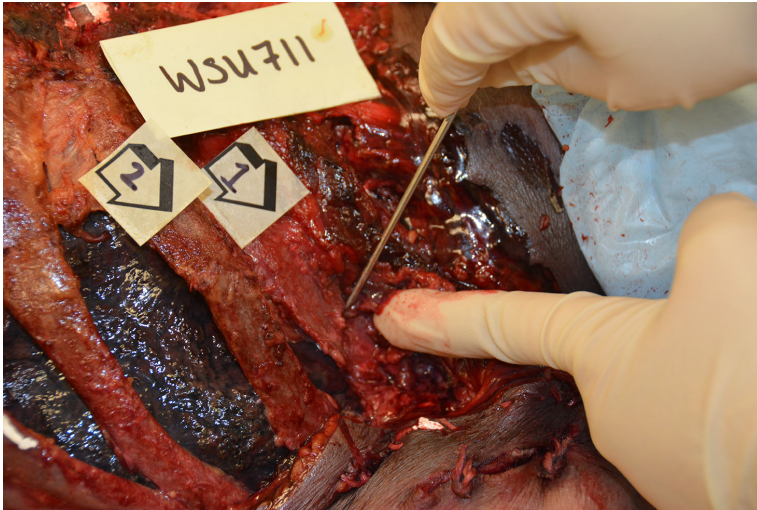
Thoracic (left) and spinal (right) injuries (shown in red)

CT image of sacrum fracture

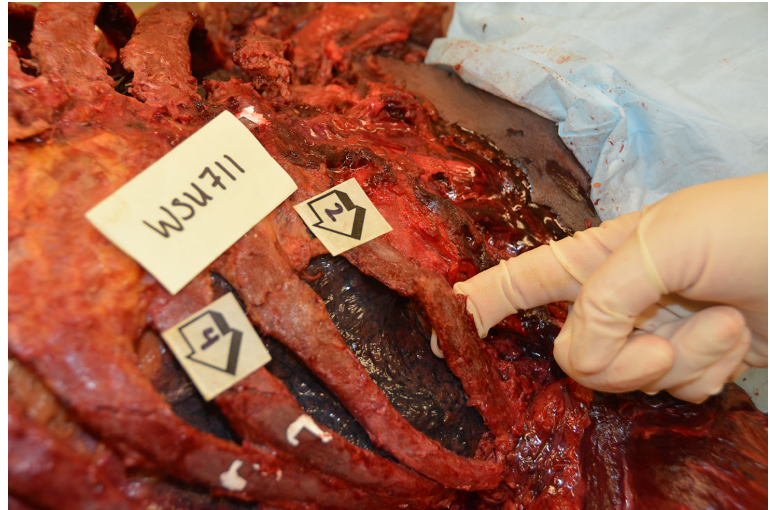


CT image of sacrum fracture in the coronal plane

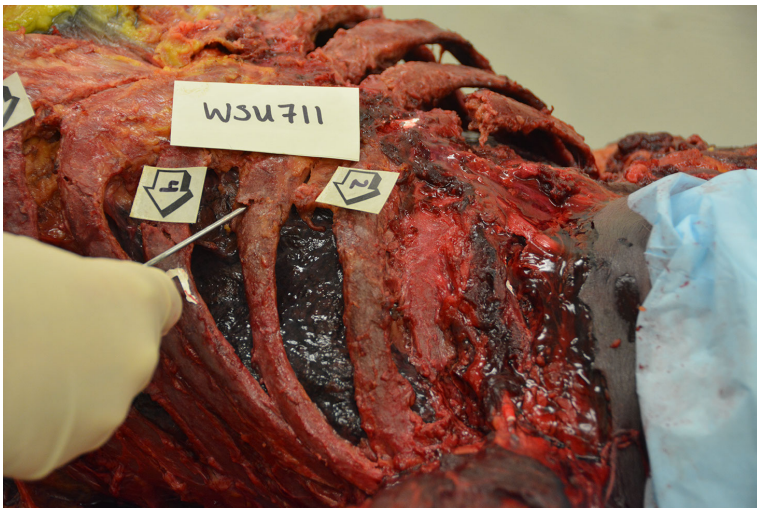
Autopsy Pictures



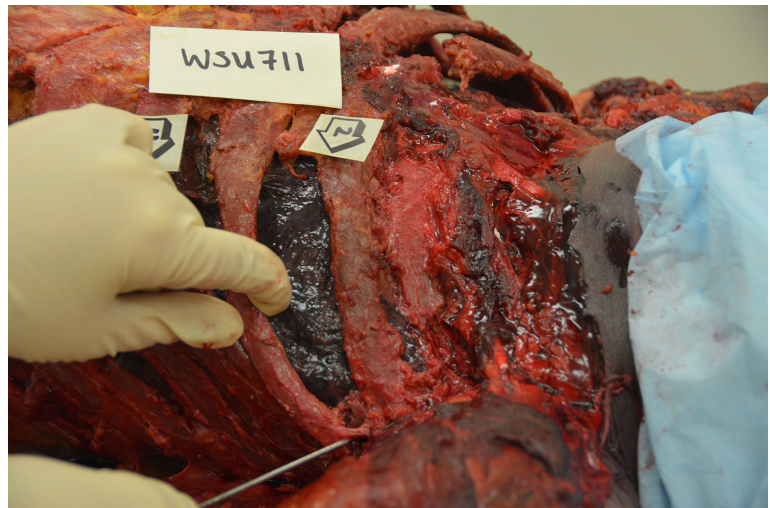
AV2105Autopsy_LeftRib1LatFx.JPG



AV2105Autopsy_LeftRib2AntLatFx.JPG



AV2105Autopsy_LeftRib3AntFx.JPG



AV2105Autopsy_LeftRib3LatFx.JPG



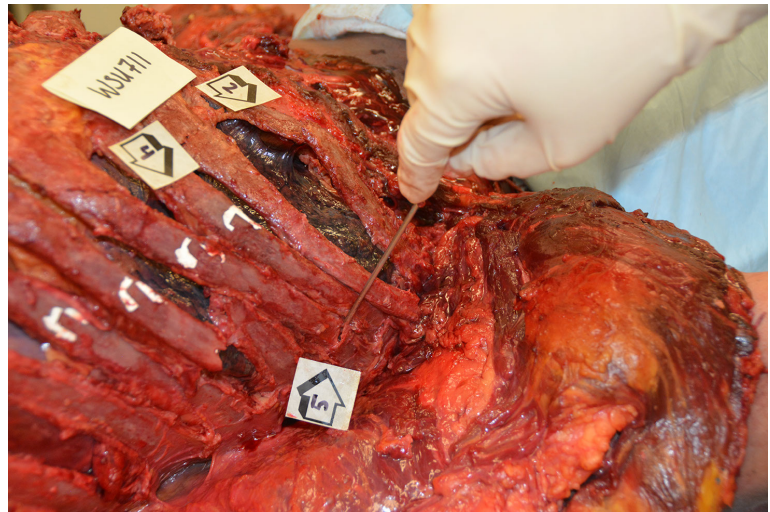
AV2105Autopsy_LeftRib4AntLatFx.JPG



AV2105Autopsy_LeftRib4LatFx.JPG



AV2105Autopsy_LeftRib5AntLatFx.JPG



AV2105Autopsy_LeftRib5LatFx.JPG



AV2105Autopsy_LeftRib6LatFx.JPG



AV2105Autopsy_LeftRib7AntLatFx.JPG



AV2105Autopsy_LeftRib8AntLatFx.JPG



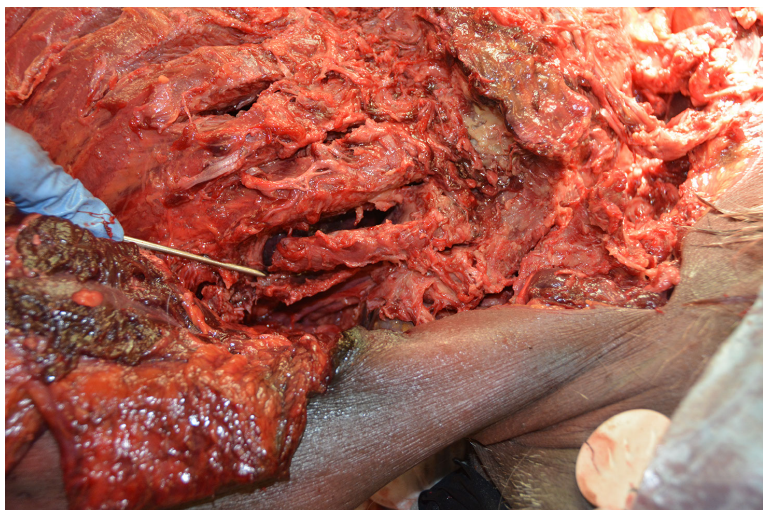
AV2105Autopsy_LeftRibFx.JPG



AV2105Autopsy_ManubriumFx.JPG



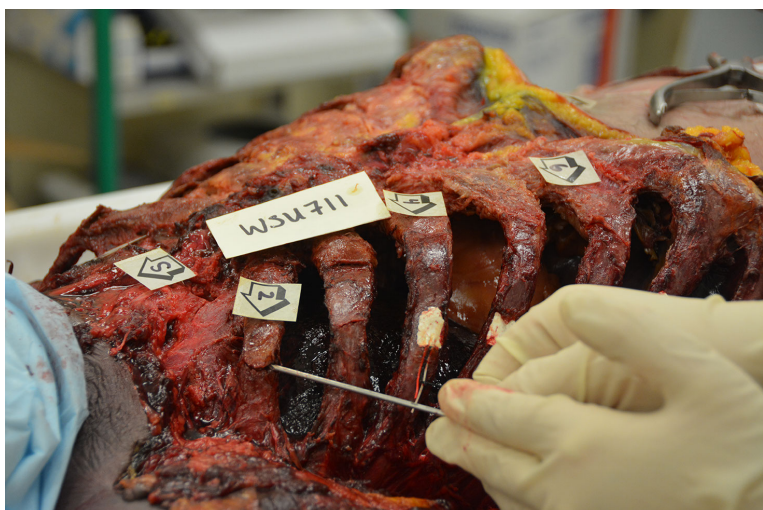
AV2105Autopsy_ManubriumFx2.JPG



AV2105Autopsy_RightRib1PostFx.JPG



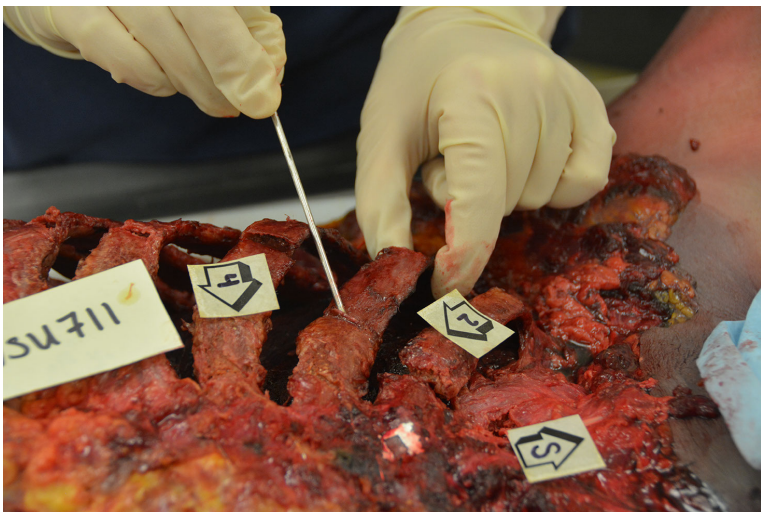
AV2105Autopsy_RightRib2AntFx.JPG



AV2105Autopsy_RightRib2AntLatFx.JPG



AV2105Autopsy_RightRib3AntFx.JPG



AV2105Autopsy_RightRib3AntLatFx.JPG



AV2105Autopsy_RightRib3AntLatFx2.JPG



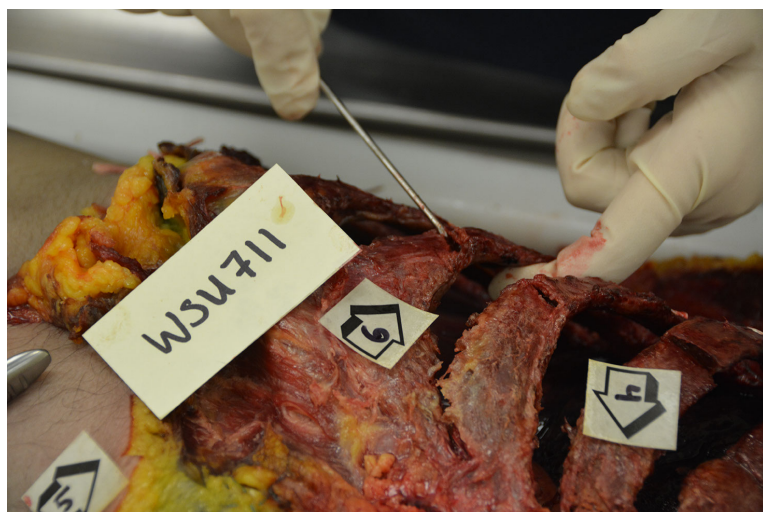
AV2105Autopsy_RightRib4AntFx.JPG



AV2105Autopsy_RightRib4AntLatFx.JPG



AV2105Autopsy_RightRib5AntLatFx.JPG



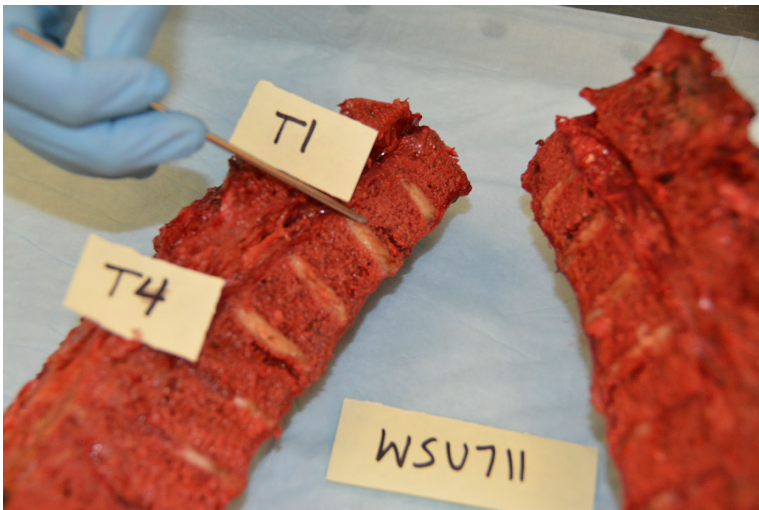
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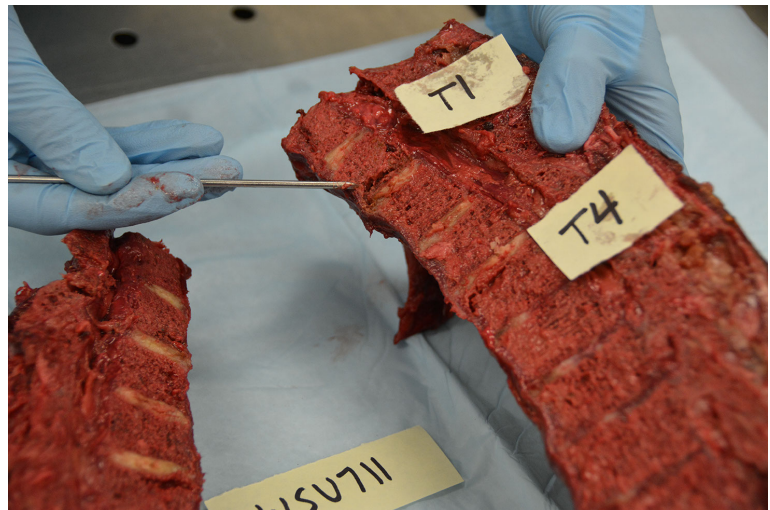
AV2105Autopsy_RightRib9PostFx.JPG



AV2105Autopsy_RightRibFx.JPG



AV2105Autopsy_T1AntInferiorFlexion.JPG



AV2105Autopsy_T1AntInferiorFlexion2.JPG



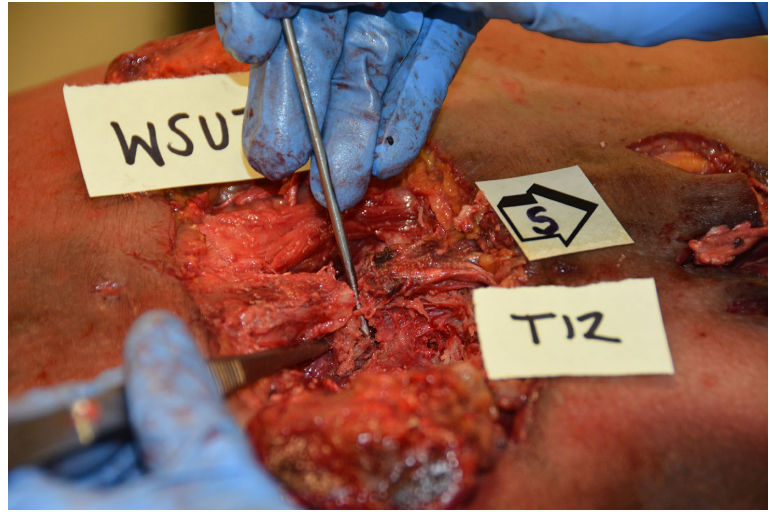
AV2105Autopsy_T4AntSuperiorFlexion.JPG



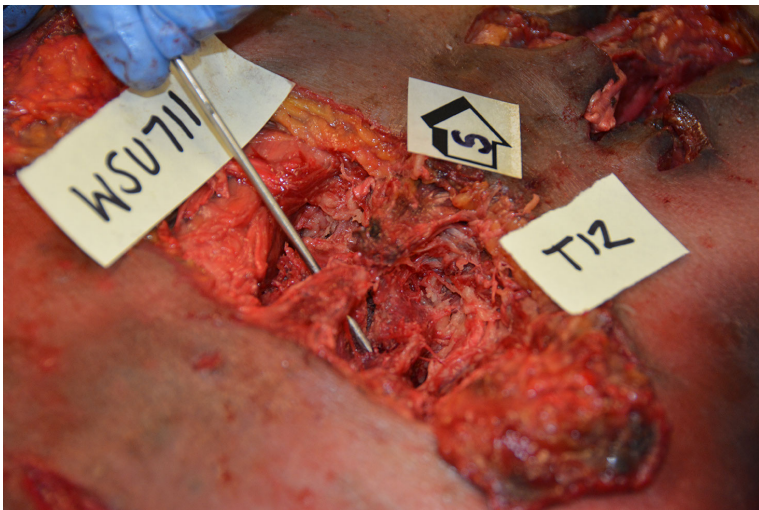
AV2105Autopsy_T4AntSuperiorFlexion2.JPG



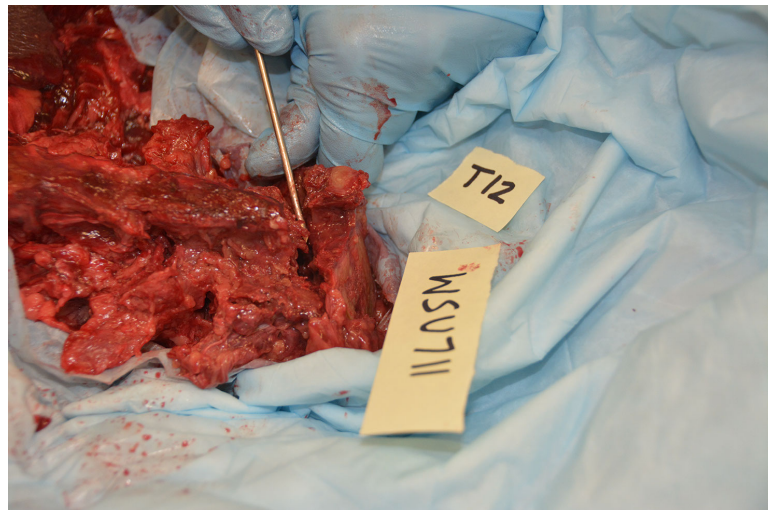
AV2105Autopsy_T10TransverseProcessFx.JPG



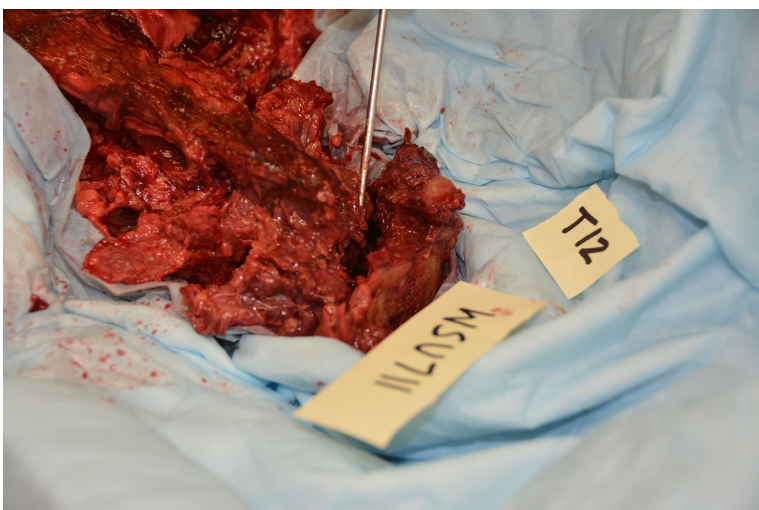
AV2105Autopsy_T11SpinousProcessFx.JPG



AV2105Autopsy_T11SpinuosProcessFx2.JPG



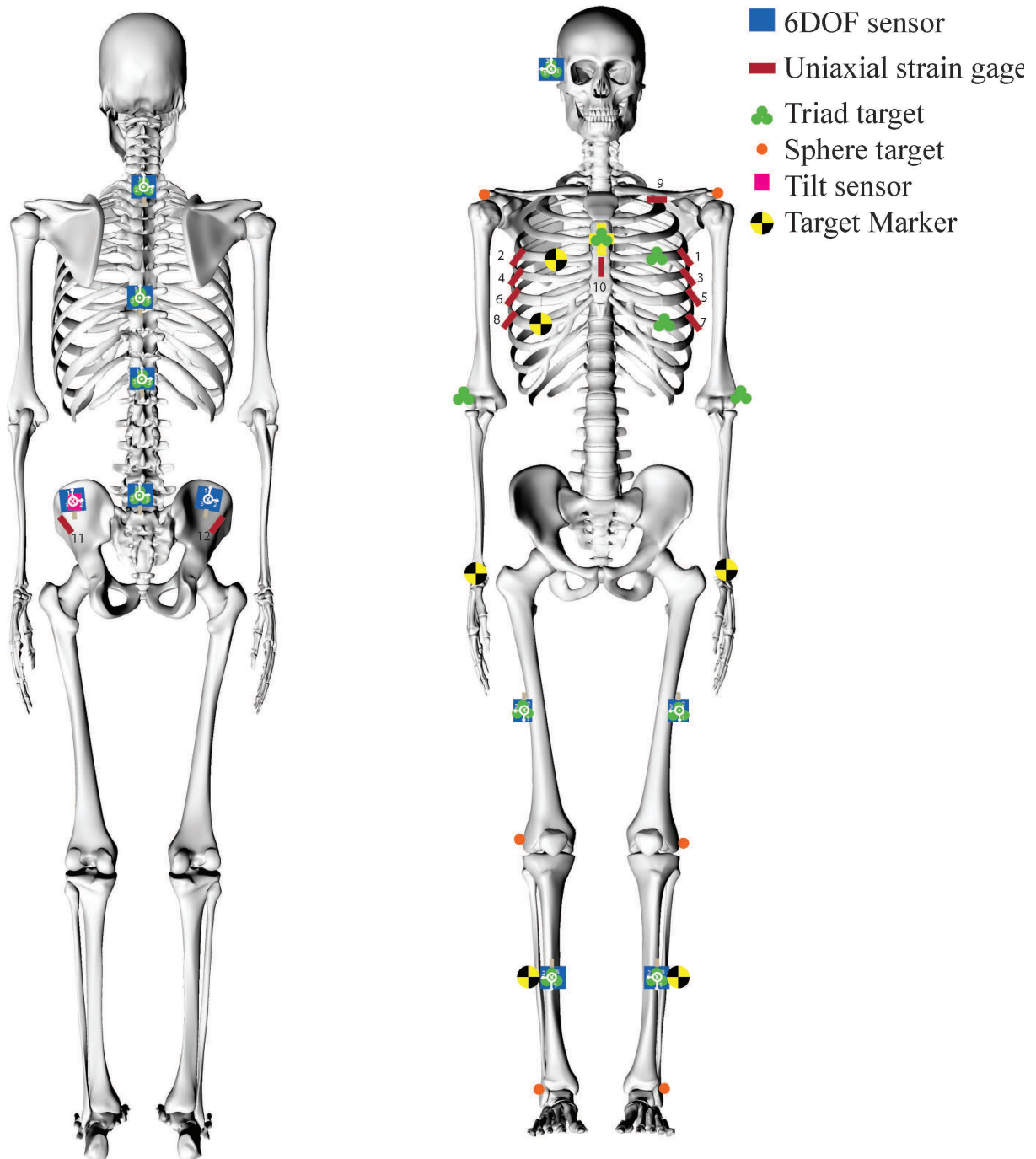
AV2105Autopsy_T12EndplateFx.JPG



AV2105Autopsy_T12ExtensionFx.JPG

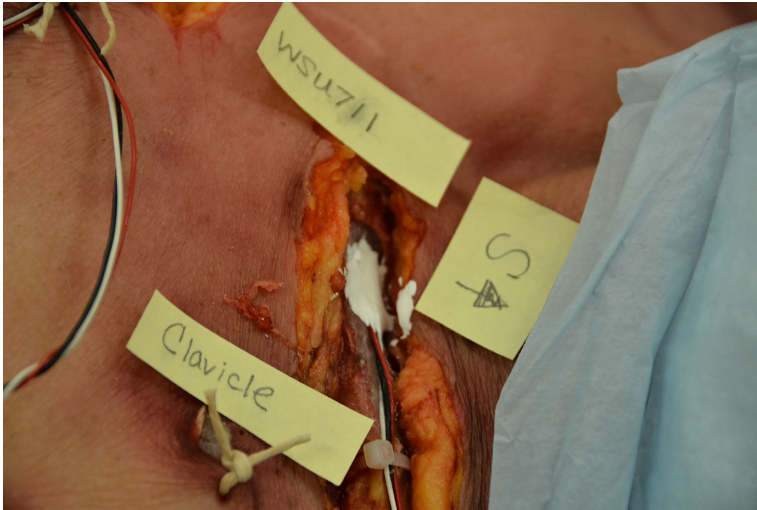
Subject Instrumentation

Due to the geometry of the PMHS spine, the T12 mount was installed midway between T11 and T12.

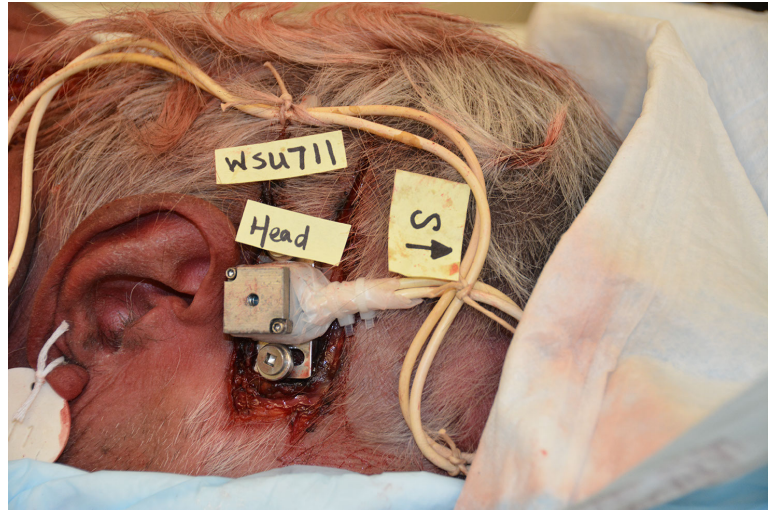


Instrumentation and tracker overview

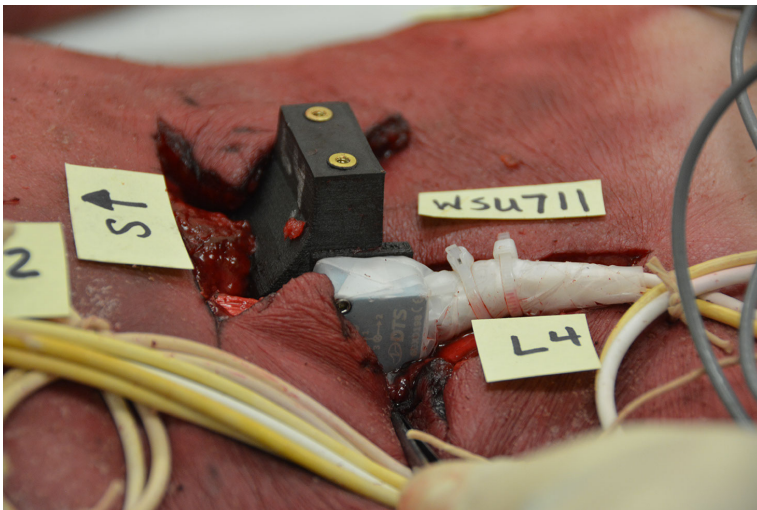
Instrumentation Pictures



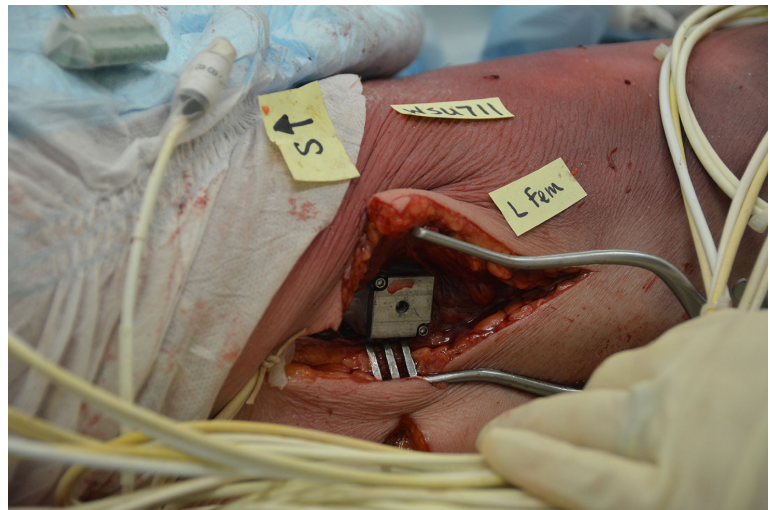
AV2105Instrumentation_ClavicleStrainGauge.JPG



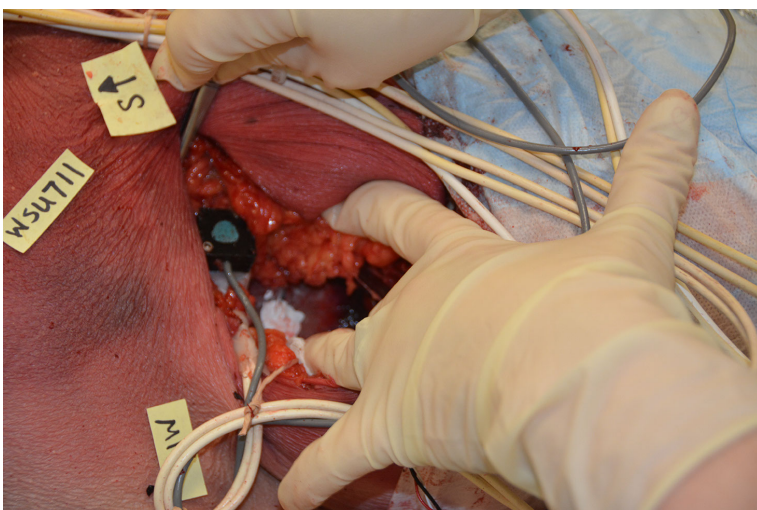
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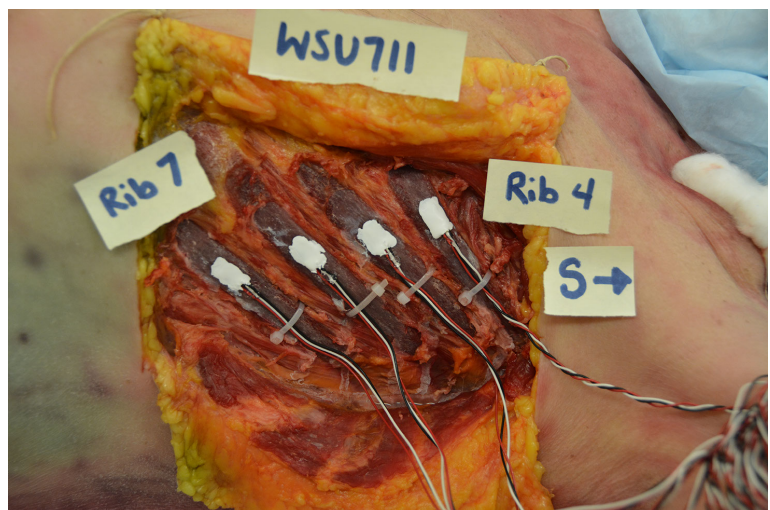
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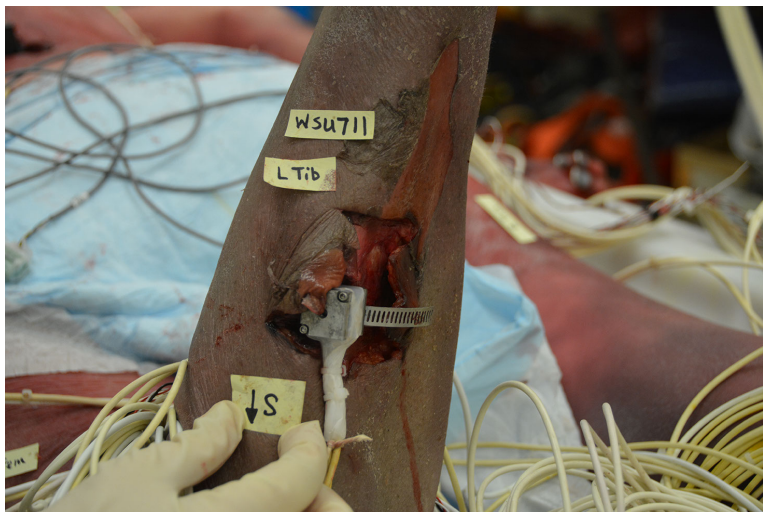
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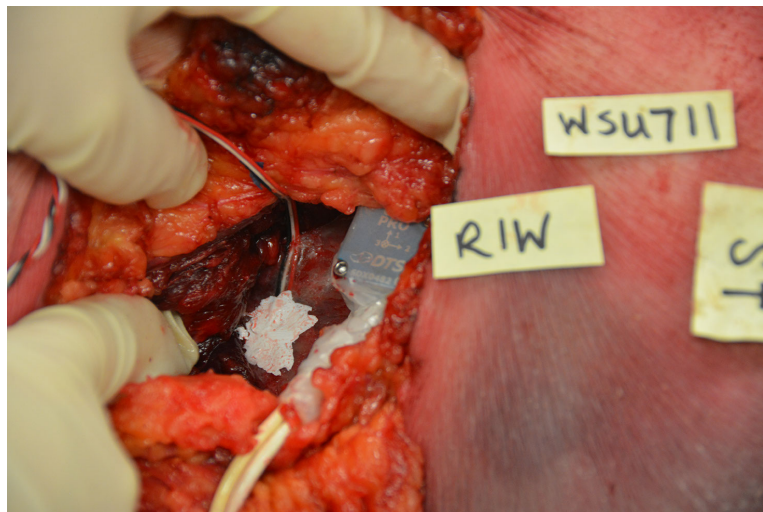
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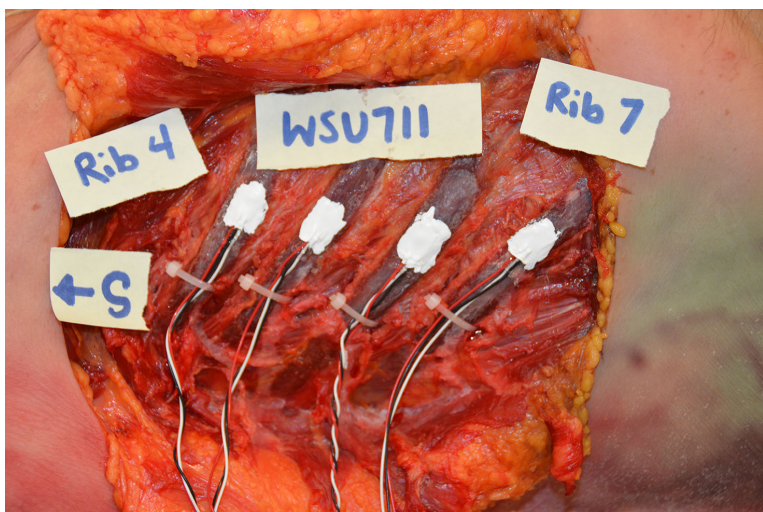
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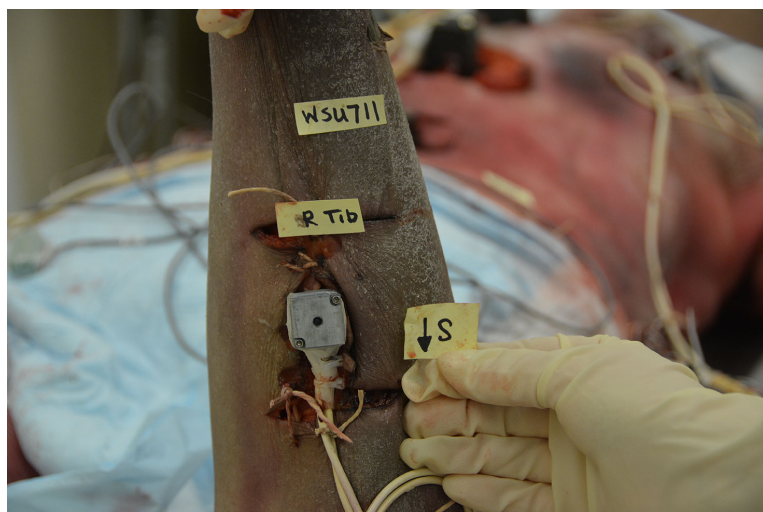
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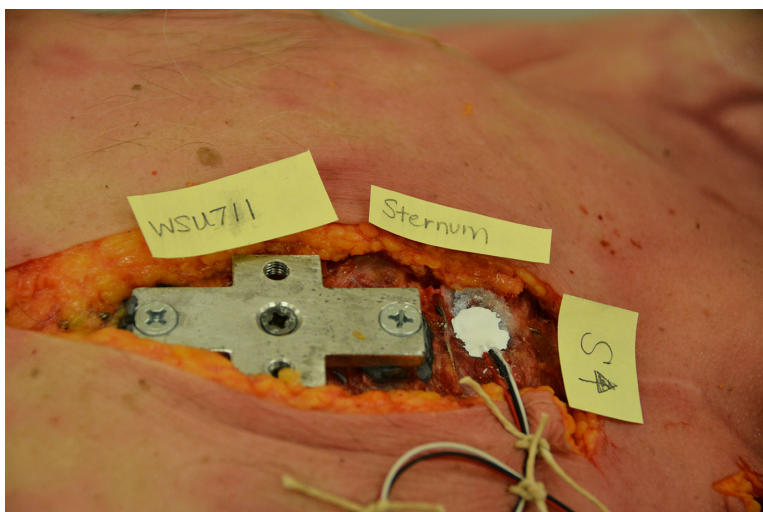
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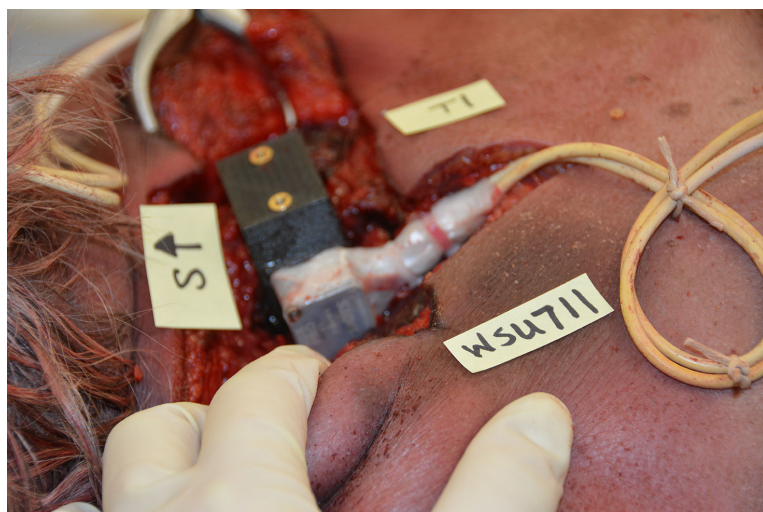
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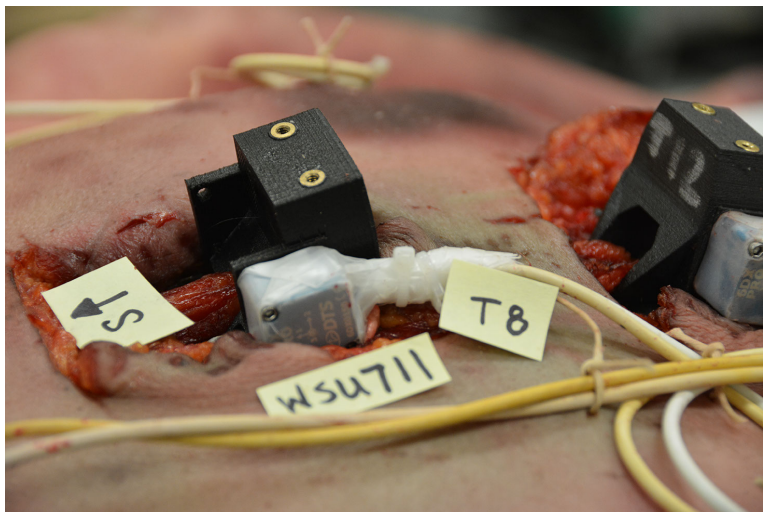
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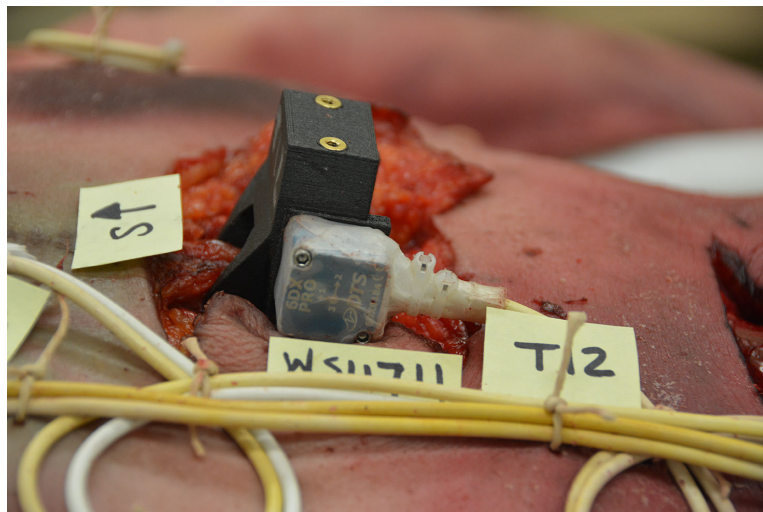
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AV2105Instrumentation_T1_6DOF.JPG



AV2105Instrumentation_T8_6DOF.JPG



AV2105Instrumentation_T12_6DOF.JPG

Pretest Positioning Pictures



AV2105Pre_HandTapeRightSide.JPG



AV2105Pre_HeadFront.JPG



AV2105Pre_HeadLeftSide.JPG



AV2105Pre_HeadRightFront.JPG



AV2105Pre_HeadRightSide.JPG



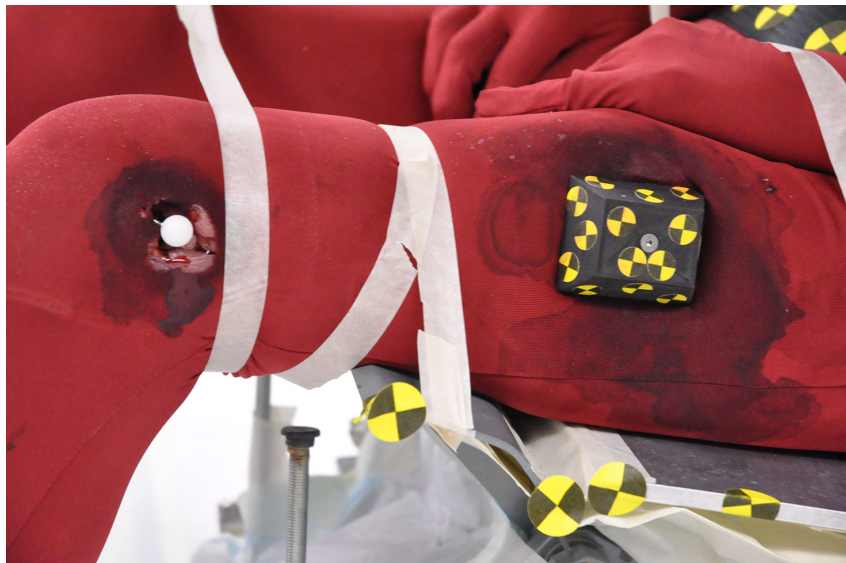
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AV2105Pre_HeadTapeRightSide.JPG



AV2105Pre_KneeTape.JPG



AV2105Pre_KneeTapeLeftSide.JPG



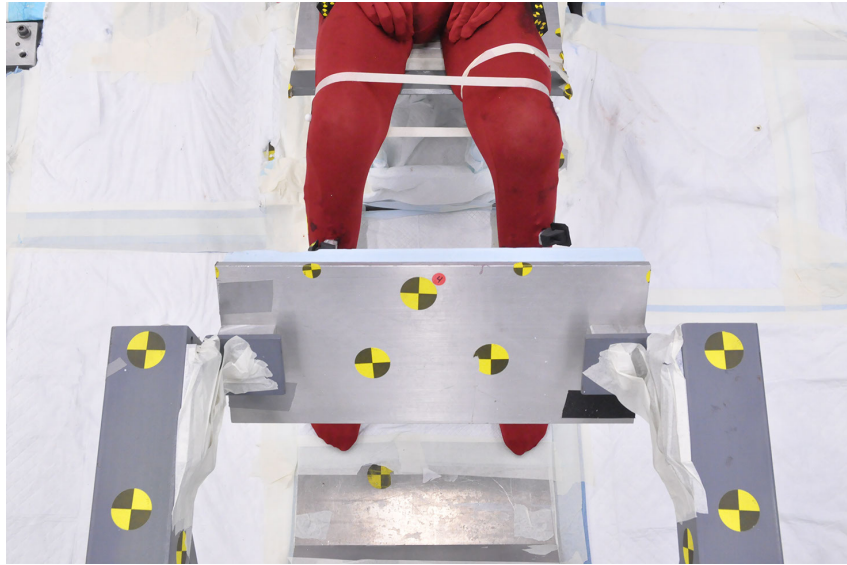
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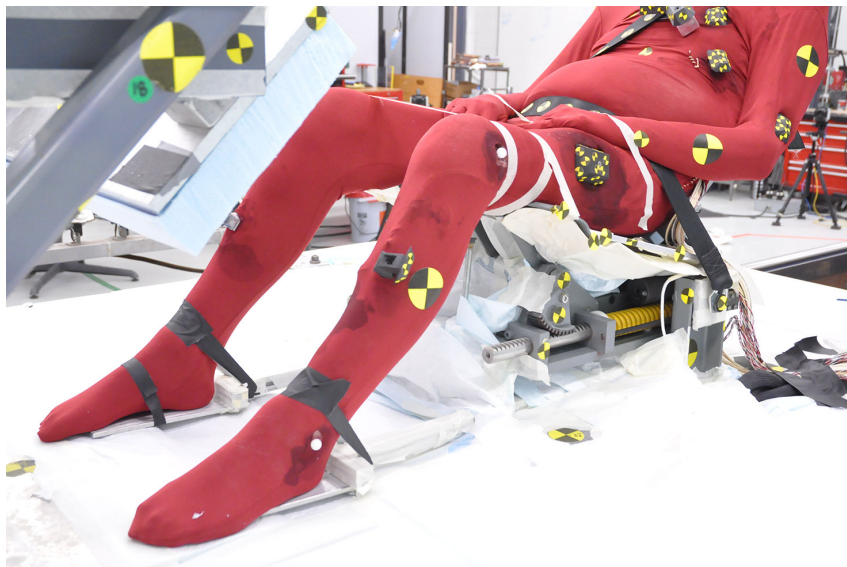
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AV2105Pre_LeftMedialAnkleTape.JPG



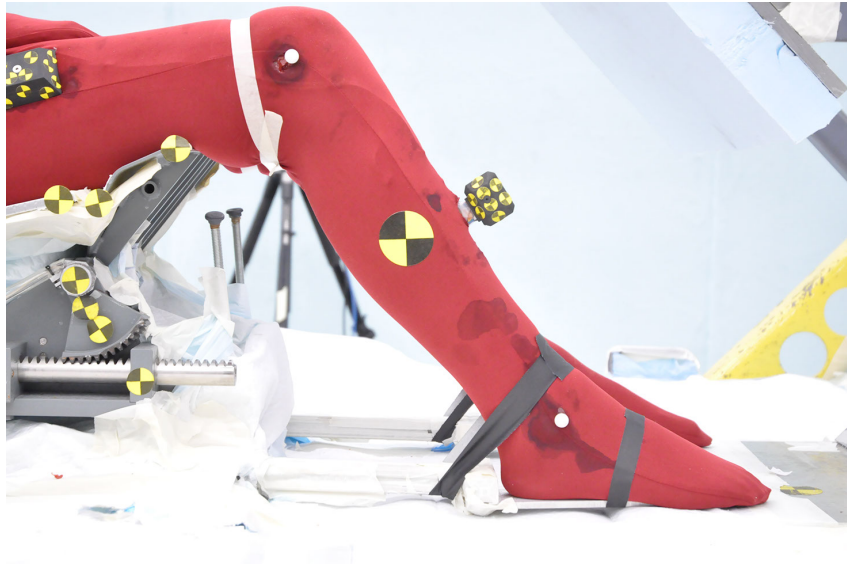
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AV2105Pre_LowerExtremLeftFront.JPG



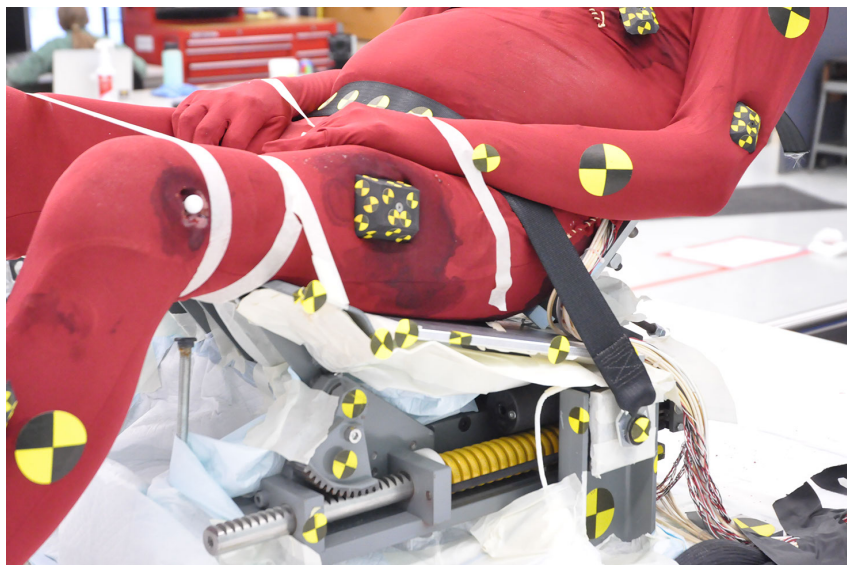
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AV2105Pre_LowerExtremRightSide.JPG



AV2105Pre_LowerTorsoFront.JPG



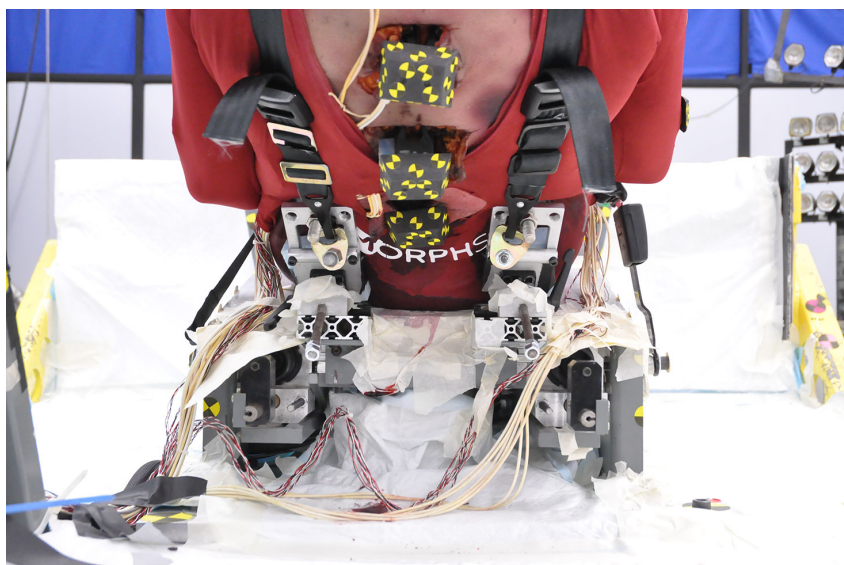
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AV2105Pre_LowerTorsoLeftRear.JPG



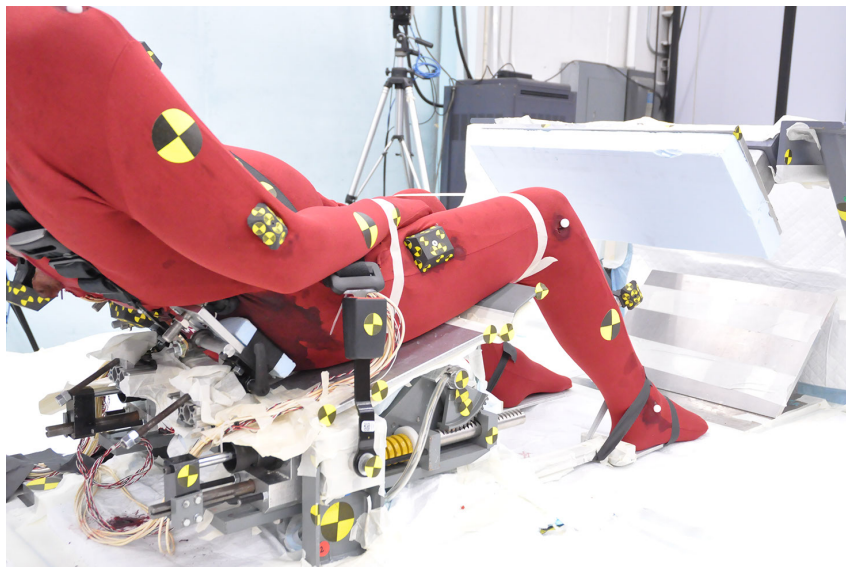
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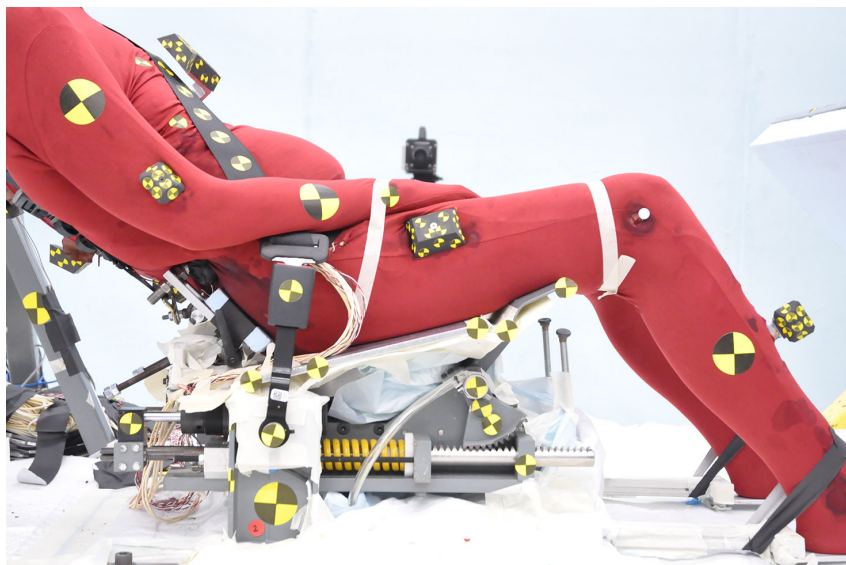
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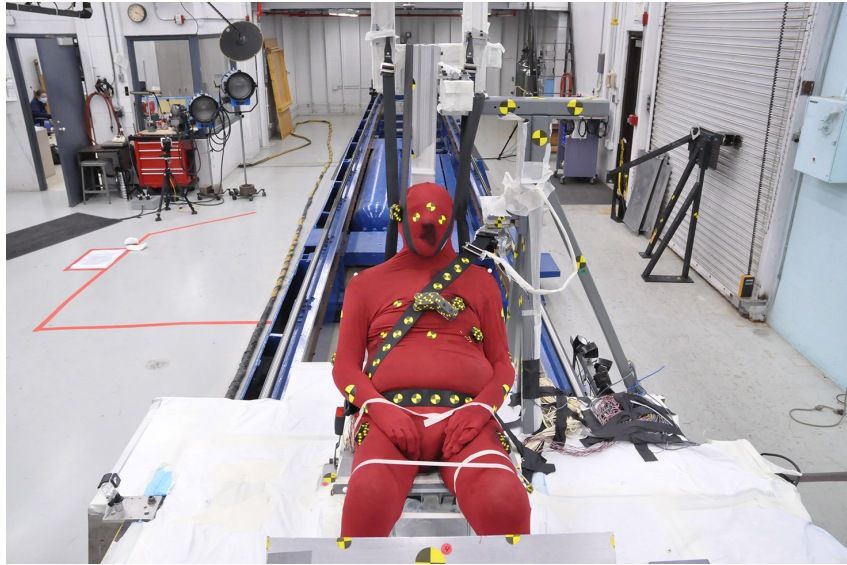
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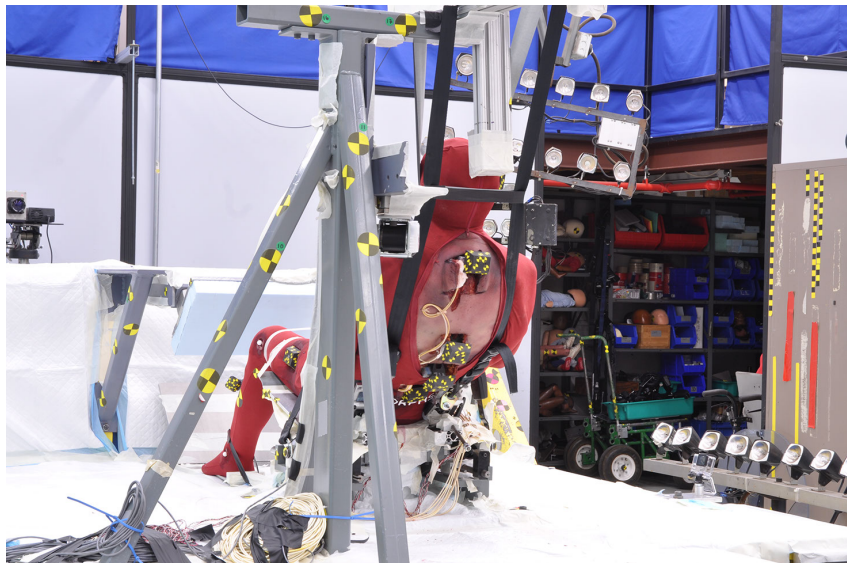
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AV2105Pre_OverallFront.JPG



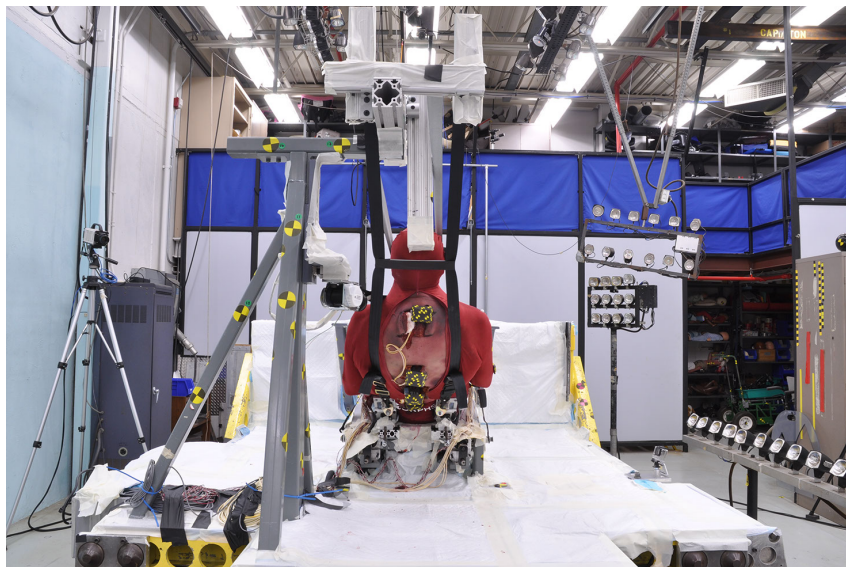
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AV2105Pre_OverallLeftRear.JPG



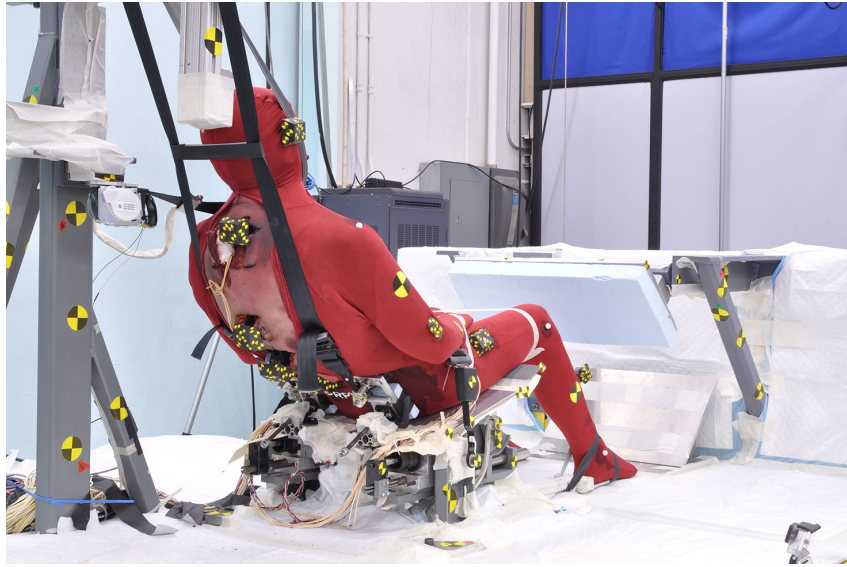
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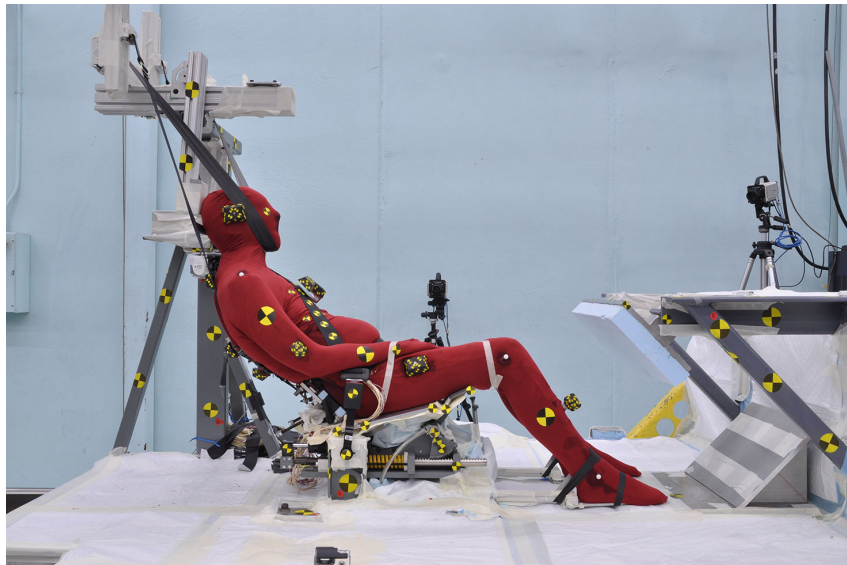
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AV2105Pre_OverallRightFront.JPG



AV2105Pre_OverallRightRear.JPG



AV2105Pre_OverallRightSide.JPG



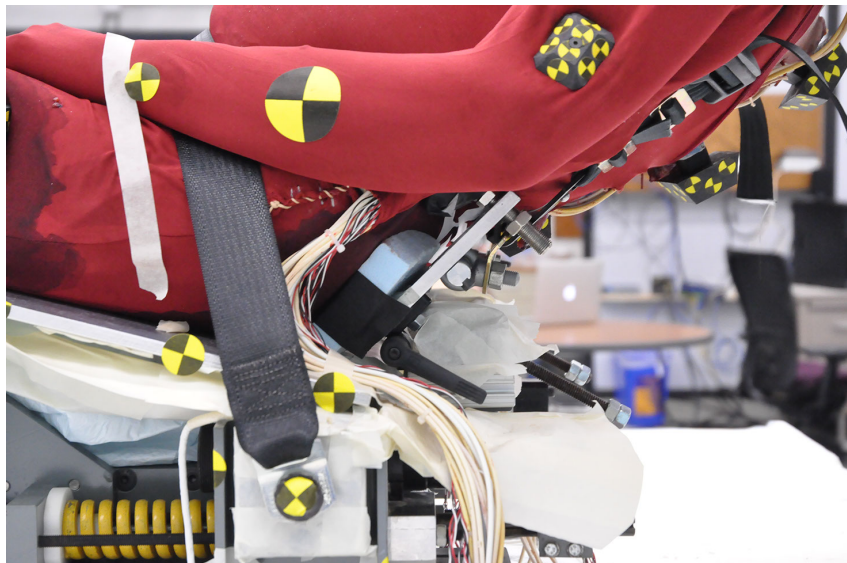
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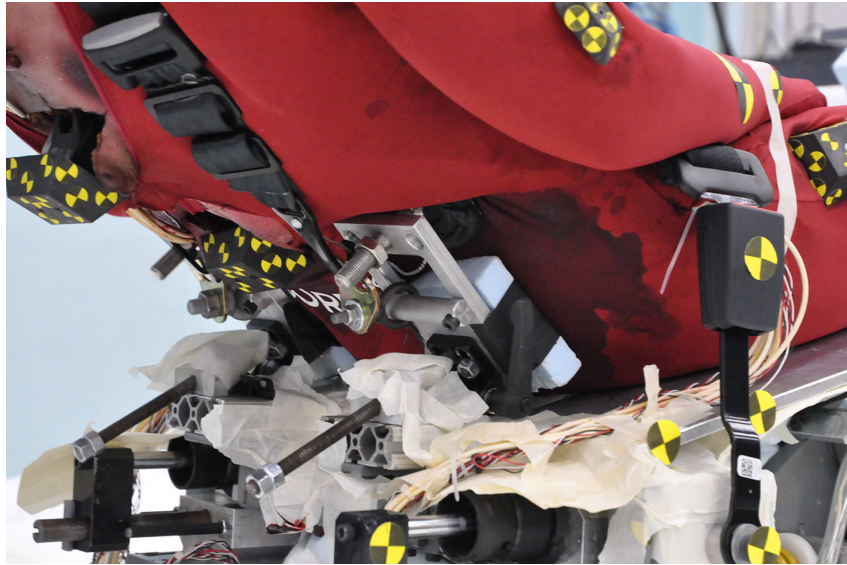
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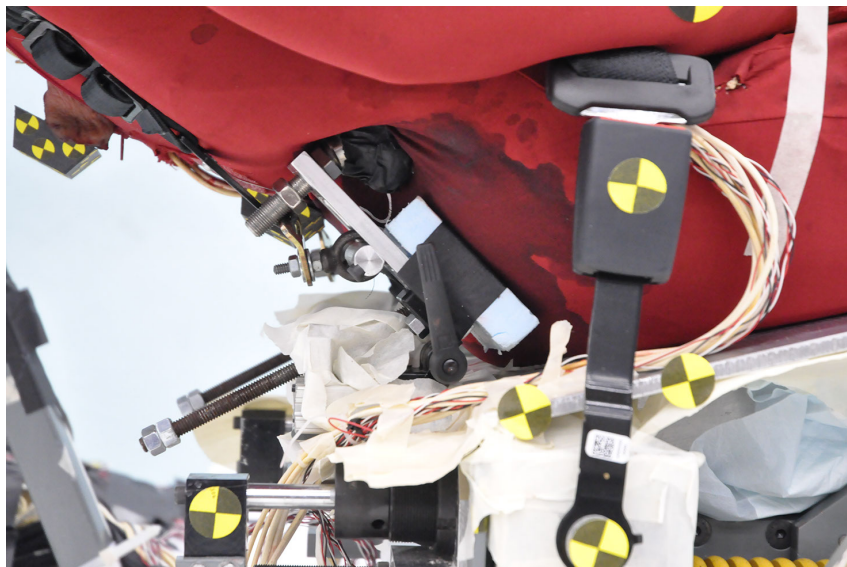
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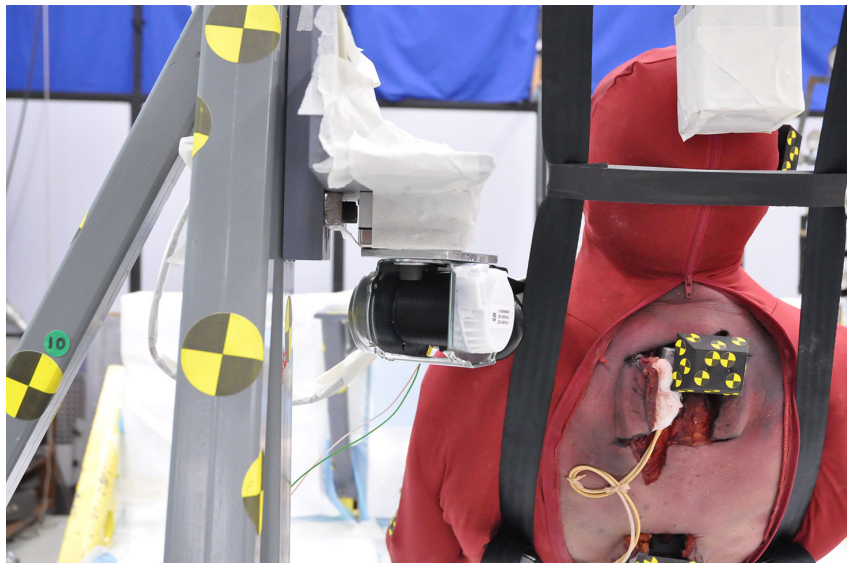
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AV2105Pre_PelvisBlocksRightRear.JPG



AV2105Pre_PelvisBlocksRightSide.JPG



AV2105Pre_RetractorRear.JPG



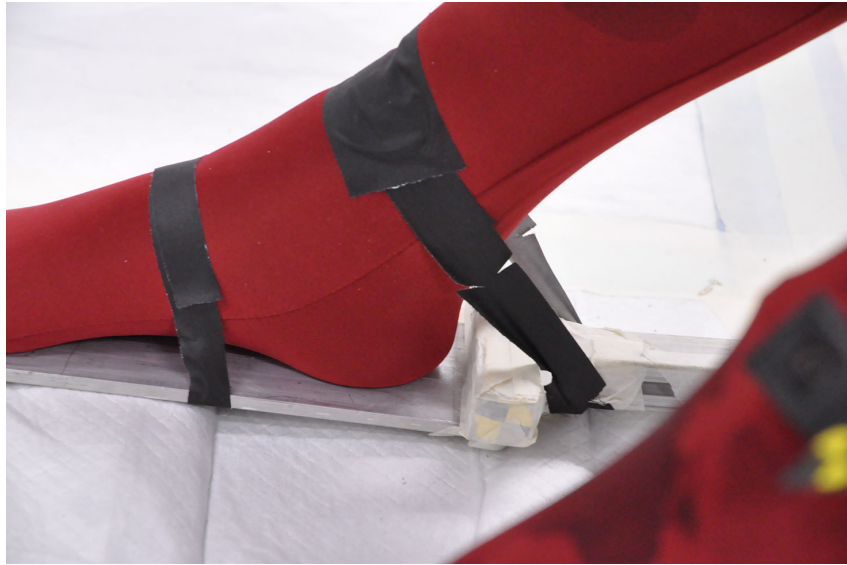
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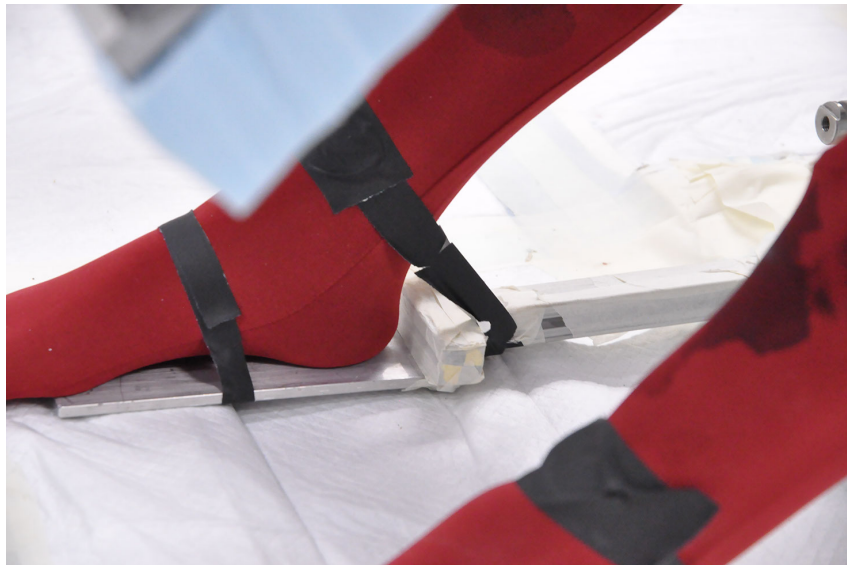
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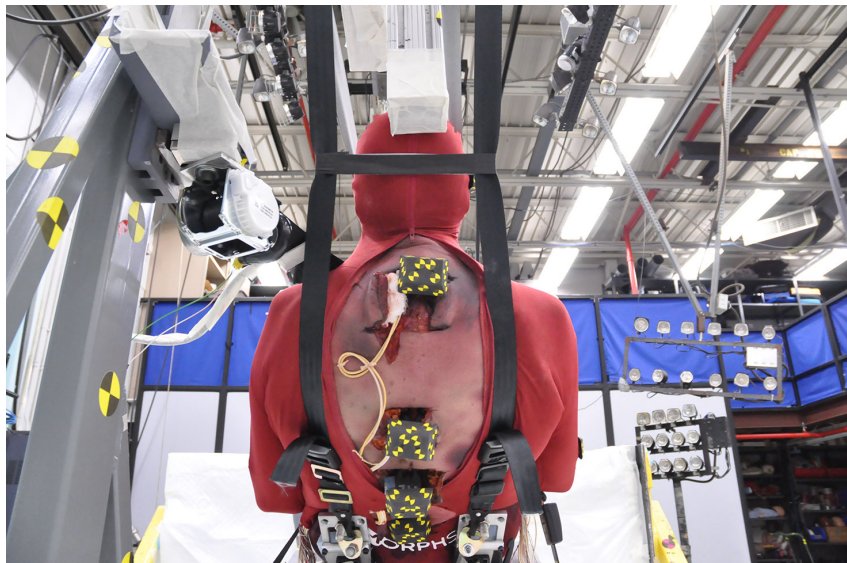
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AV2105Pre_RightMedialAnkleTape.JPG



AV2105Pre_RightMedialFootTape.JPG



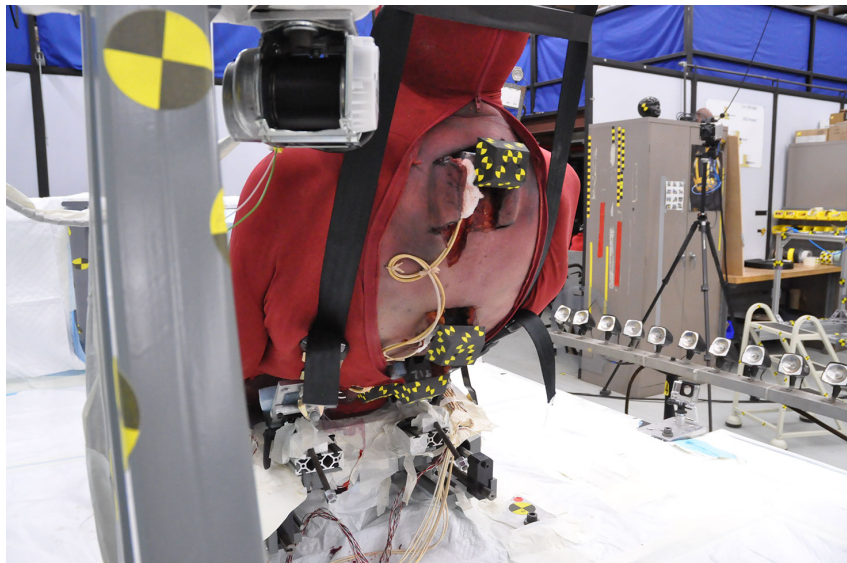
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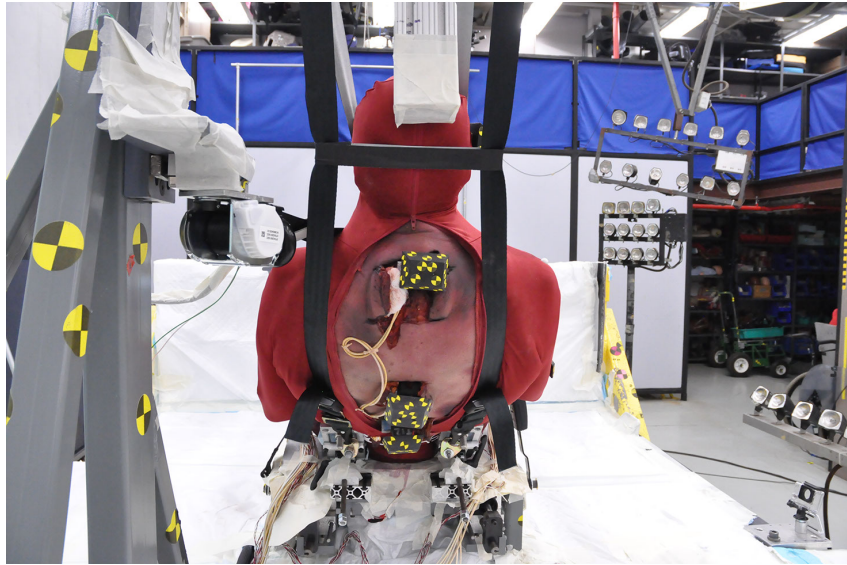
AV2105Pre_UpperTorsoFront.JPG



AV2105Pre_UpperTorsoLeftFront.JPG



AV2105Pre_UpperTorsoLeftRear.JPG



AV2105Pre_UpperTorsoRear.JPG

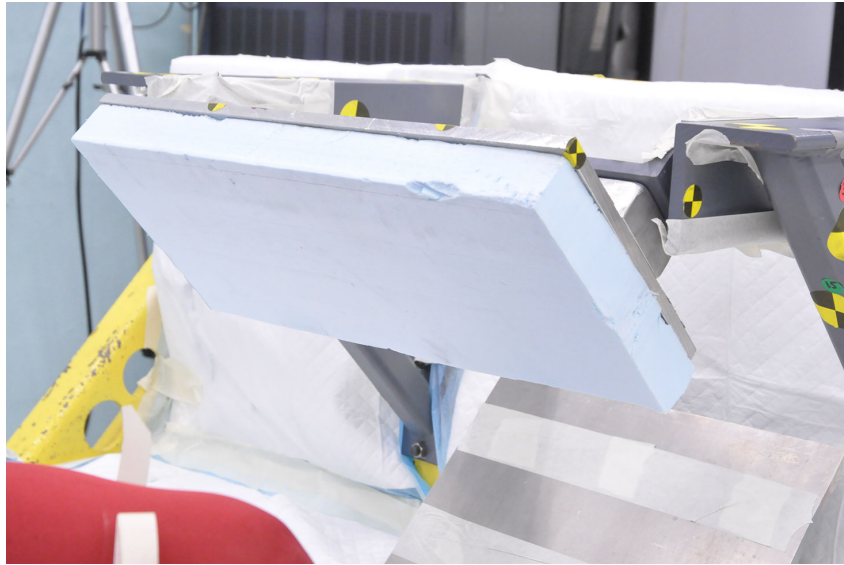


AV2105Pre_UpperTorsoRightFront.JPG



AV2105Pre_UpperTorsoRightRear.JPG

Post Test Positioning Pictures



AV2105Post_KneeBolster.JPG



AV2105Post_LowerExtremFront.JPG



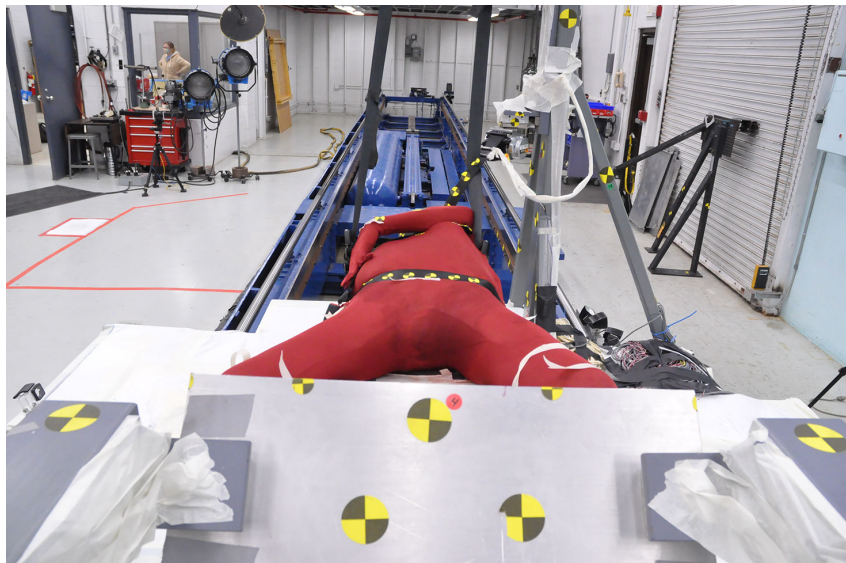
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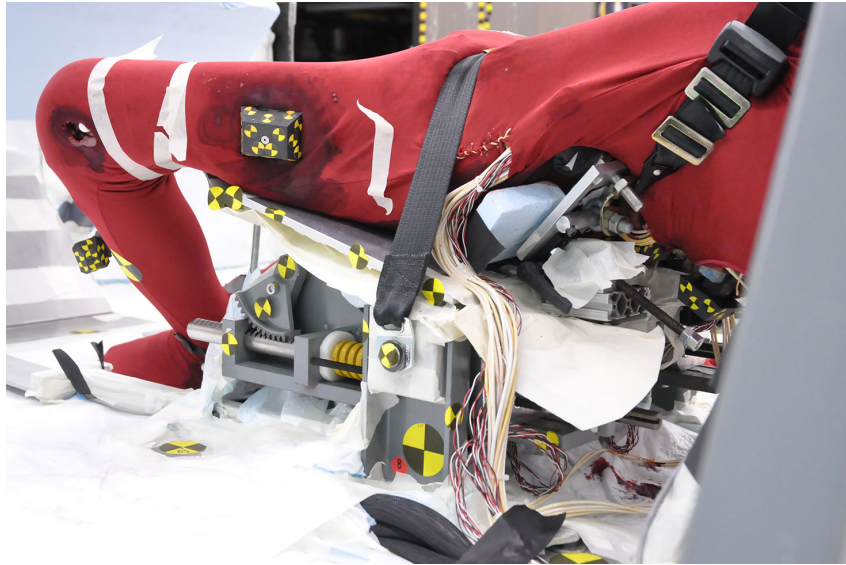
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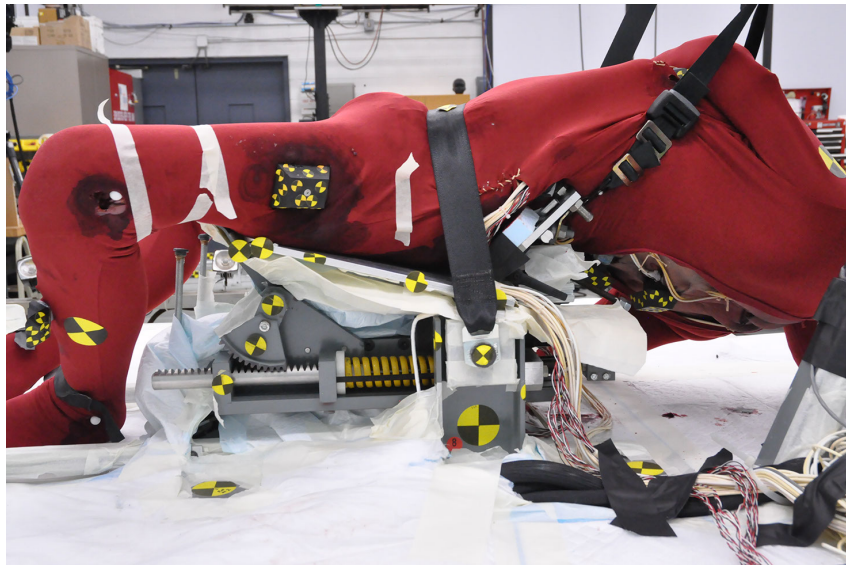
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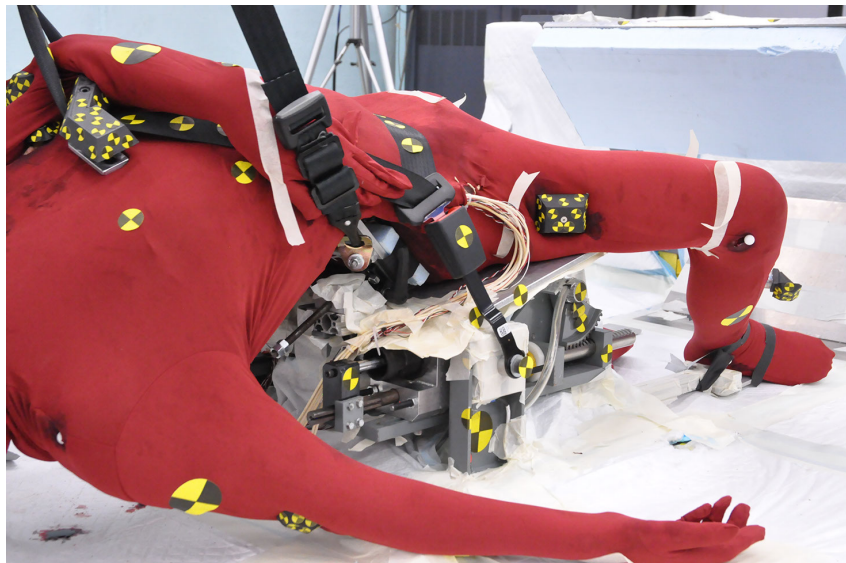
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AV2105Post_LowerTorsoLeftRear.JPG



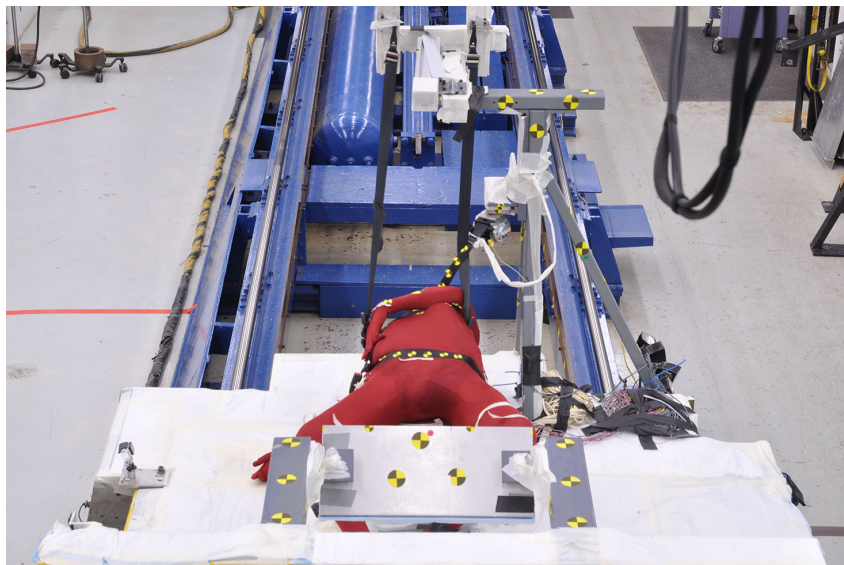
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AV2105Post_LowerTorsoRightRear.JPG



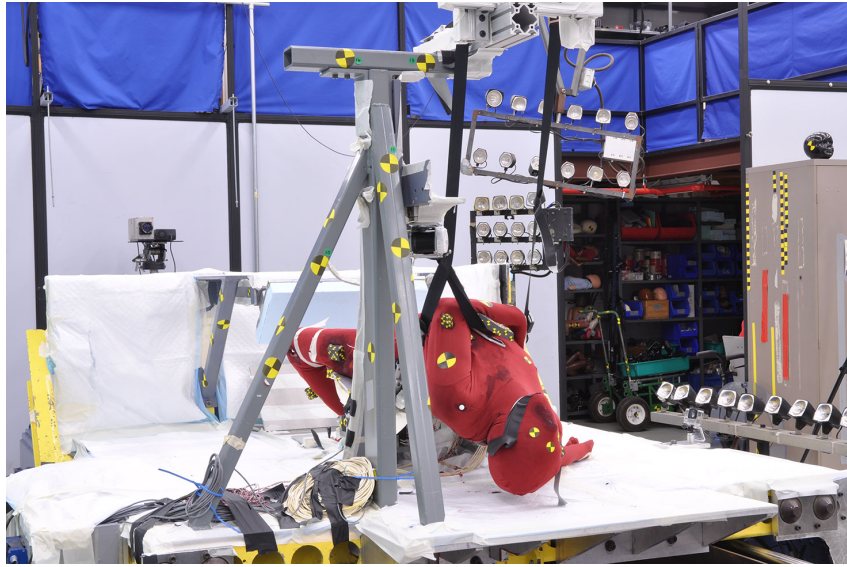
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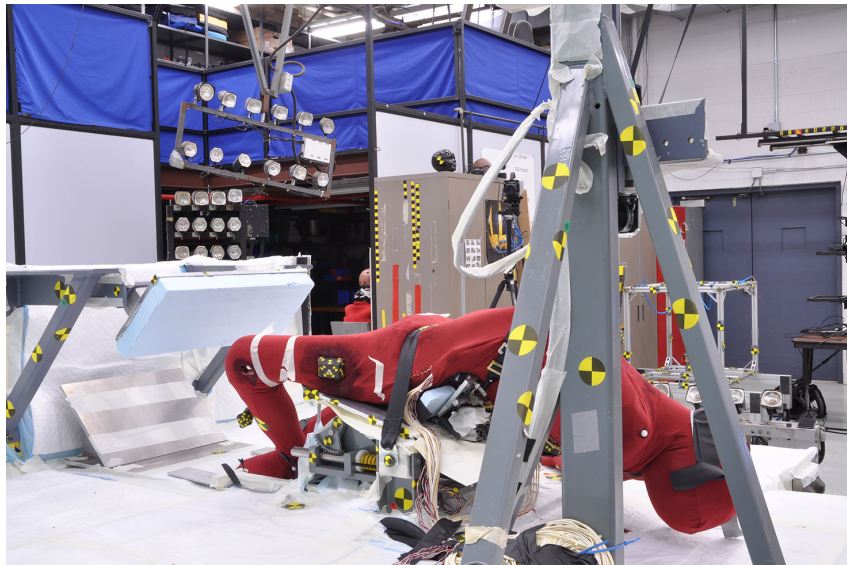
AV2105Post_OverallFront.JPG



AV2105Post_OverallLeftFront.JPG



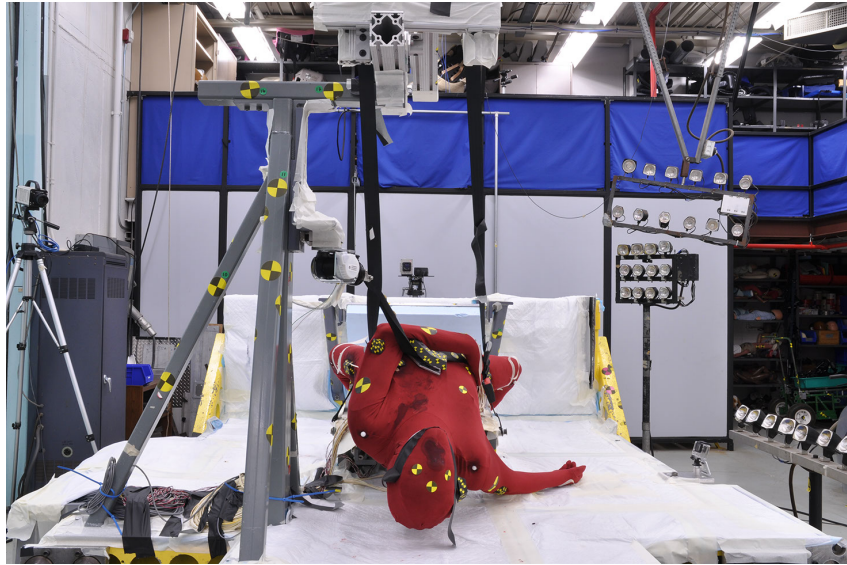
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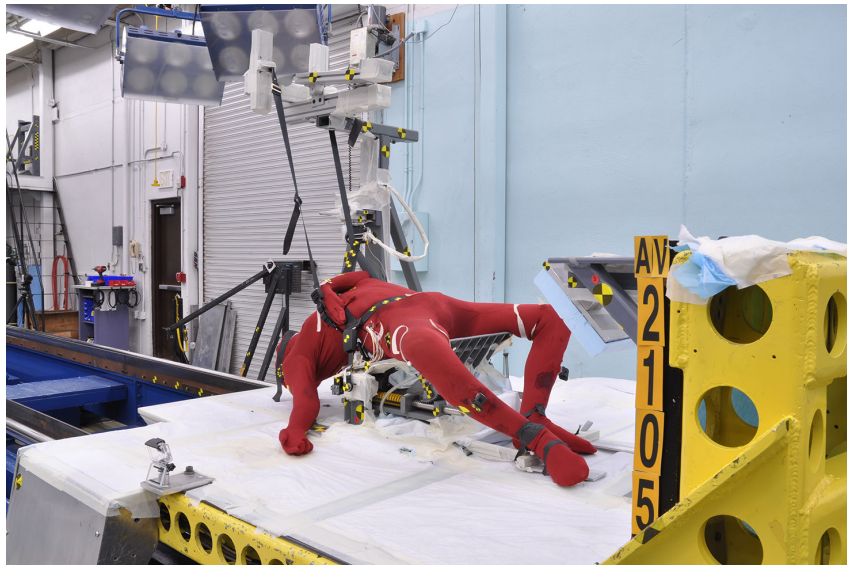
AV2105Post_OverallLeftRear2.JPG



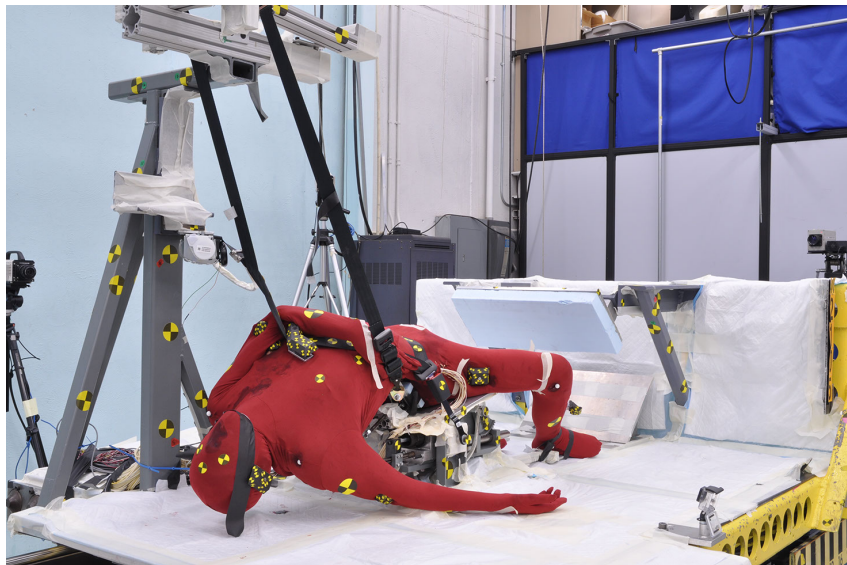
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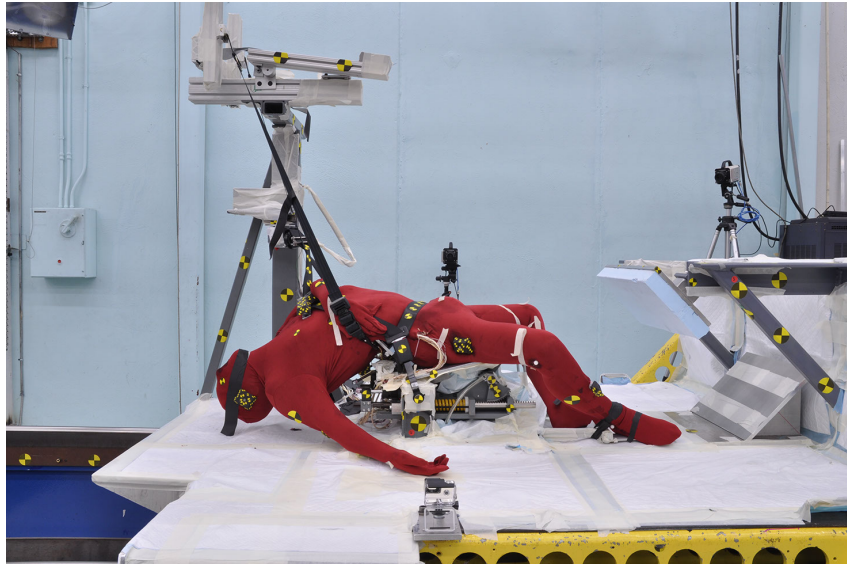
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AV2105Post_OverallRightFront.JPG



AV2105Post_OverallRightRear.JPG



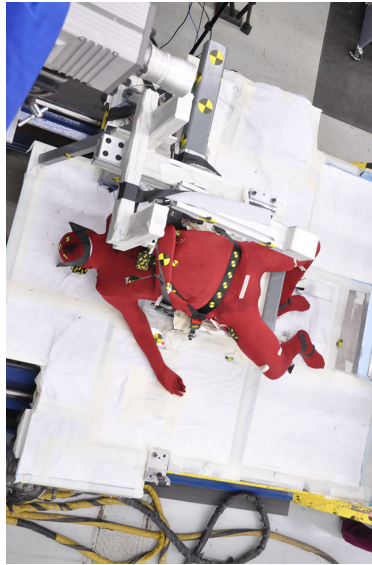
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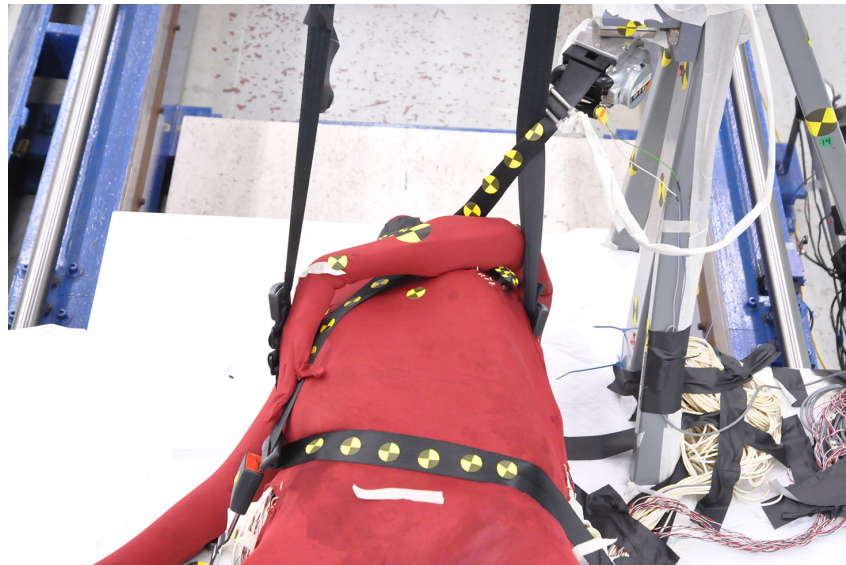
AV2105Post_OverheadFront.JPG



AV2105Post_OverheadRear.JPG



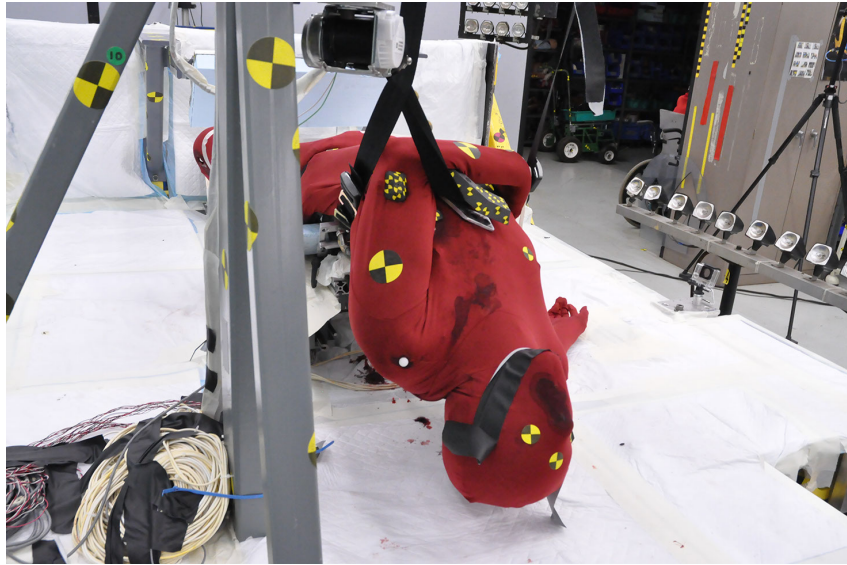
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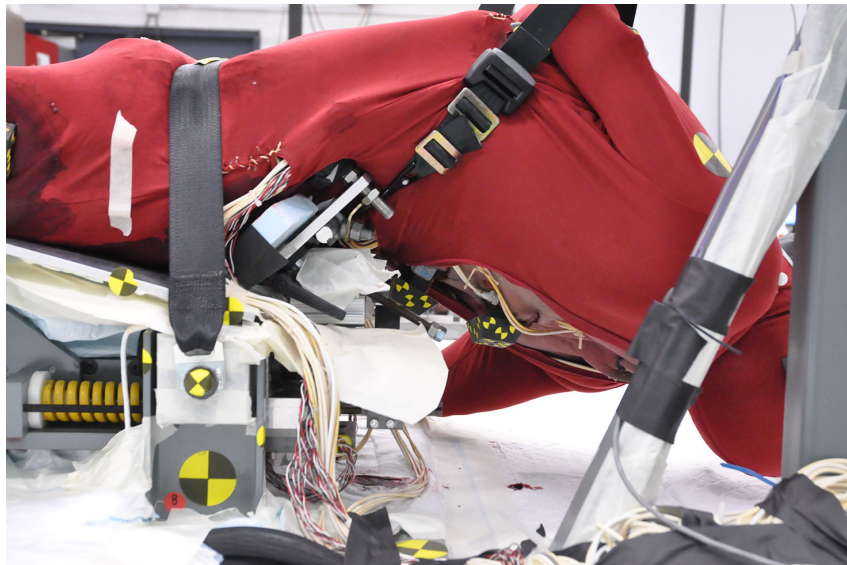
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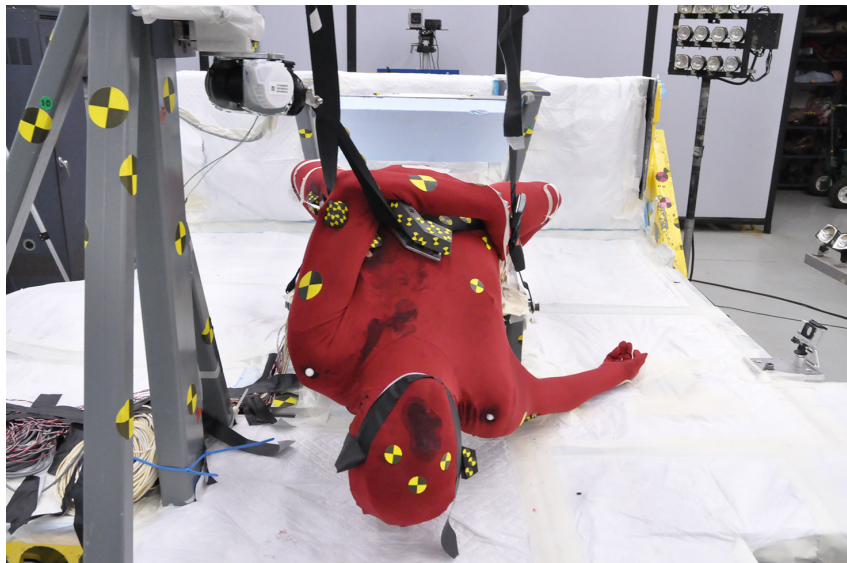
AV2105Post_UpperTorsoLeftFront.JPG



AV2105Post_UpperTorsoLeftRear.JPG



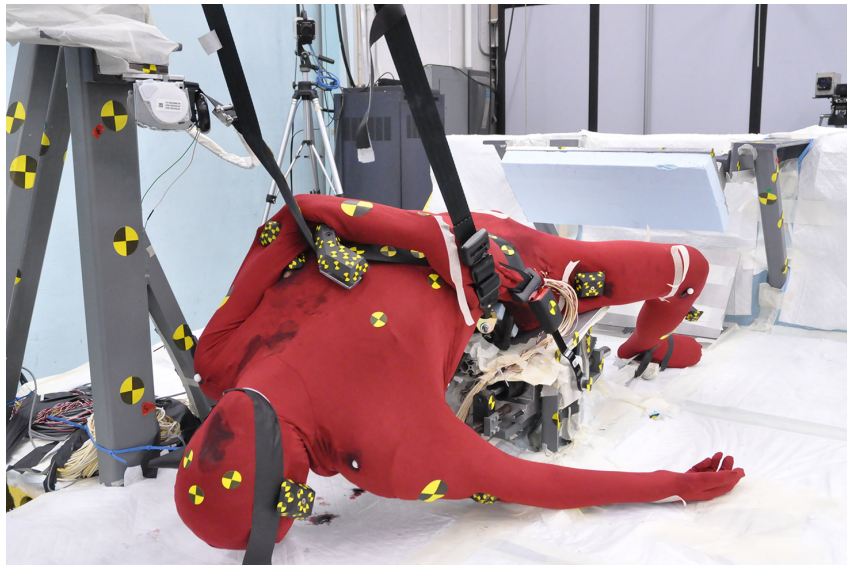
AV2105Post_UpperTorsoLeftSide.JPG



AV2105Post_UpperTorsoRear.JPG



AV2105Post_UpperTorsoRightFront.JPG

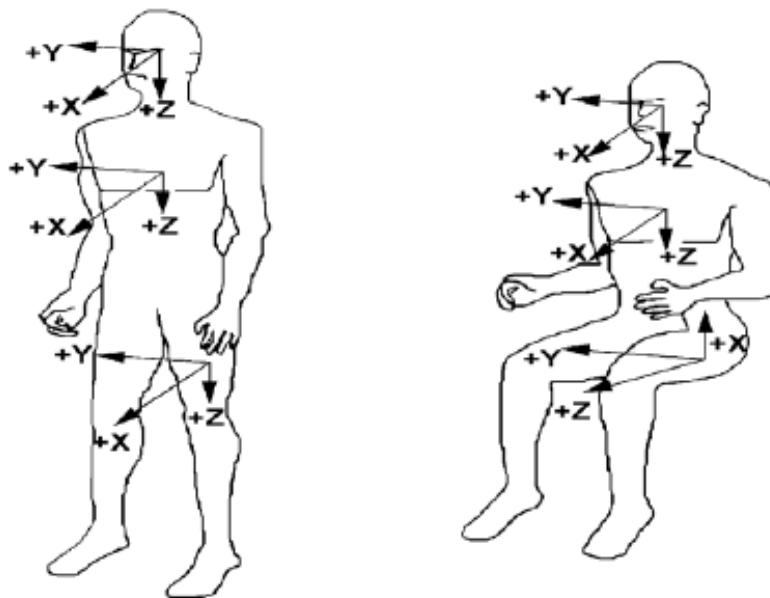
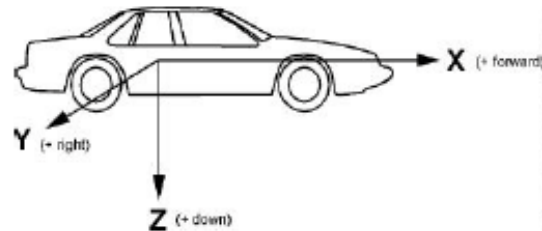


AV2105Post_UpperTorsoRightRear.JPG

Appendix A

Coordinate Measurement and Definitions:

Global Coordinate System



Figures obtained from NHSTA Test Reference Guide Version 5, Volume II:
Biomechanical Tests

Local Coordinate System

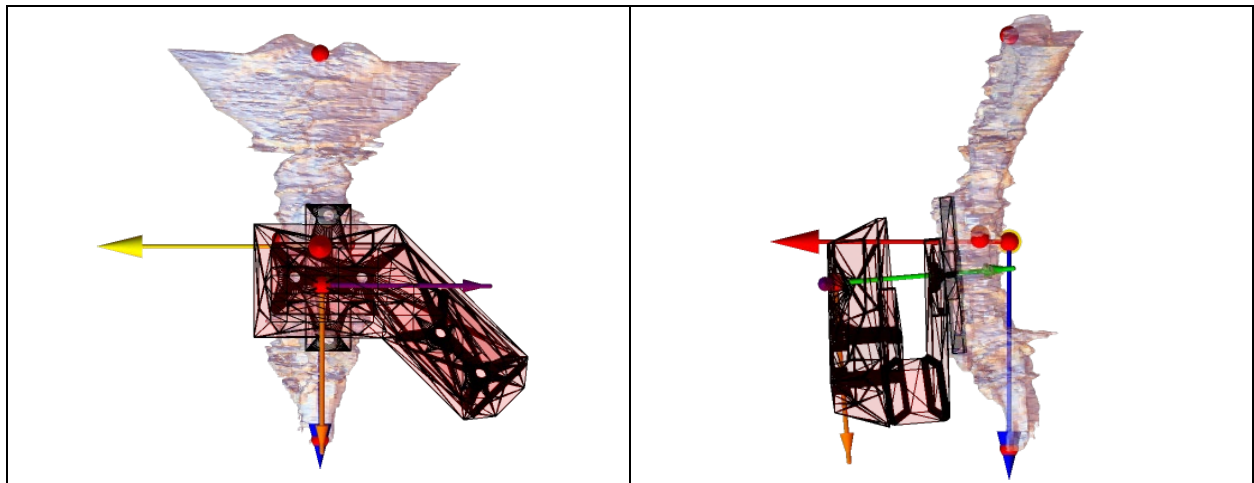
Using landmark data obtained from CT scans, a set of unit vectors \mathbf{i} , \mathbf{j} , and \mathbf{k} describing the X, Y, and Z components of the bone coordinate system in the global coordinate system and \mathbf{u} , \mathbf{v} , and \mathbf{w} describing the X, Y, and Z components of the sensor coordinate system in the global coordinate system were calculated as described by Rudd et al (2006) and Kerrigan et al (2008)

Head



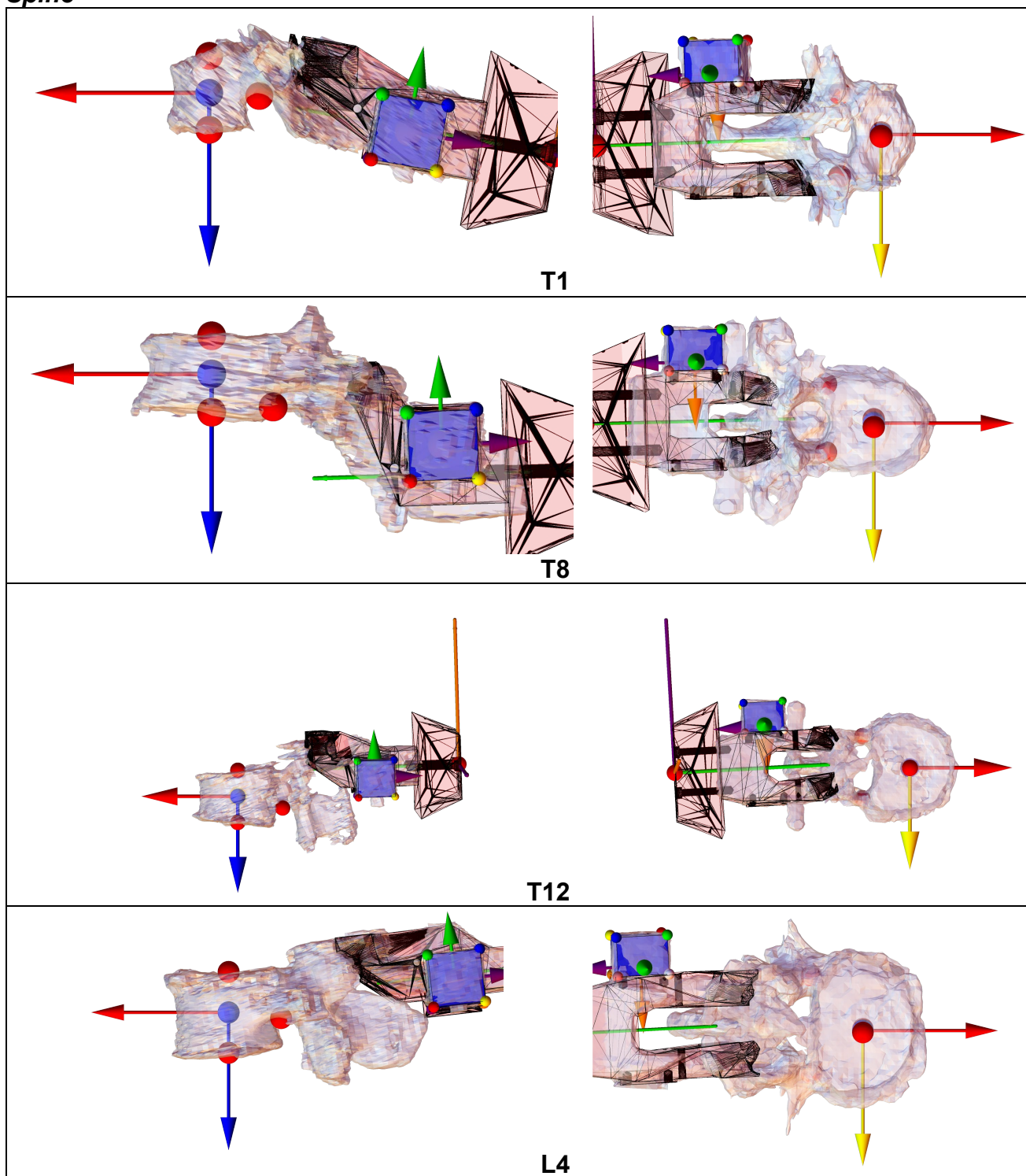
Head sensor (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Sternum



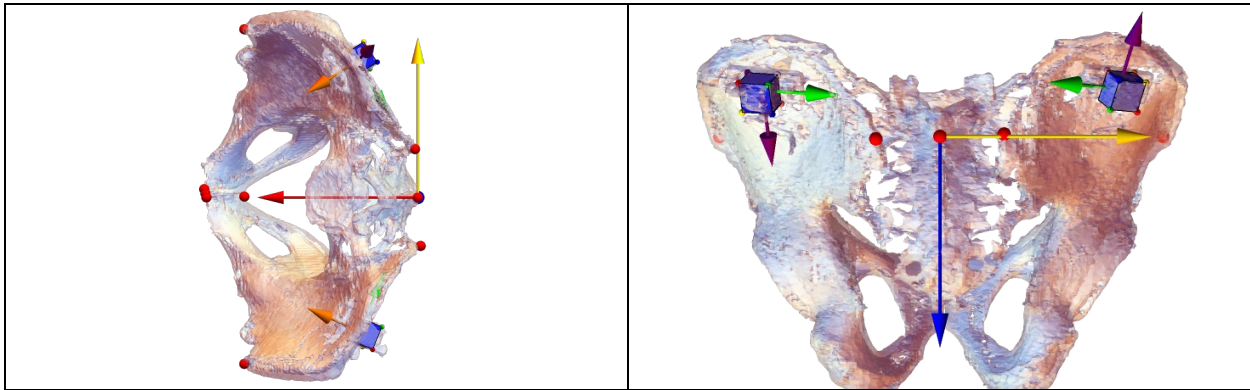
Sternum sensor (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Spine



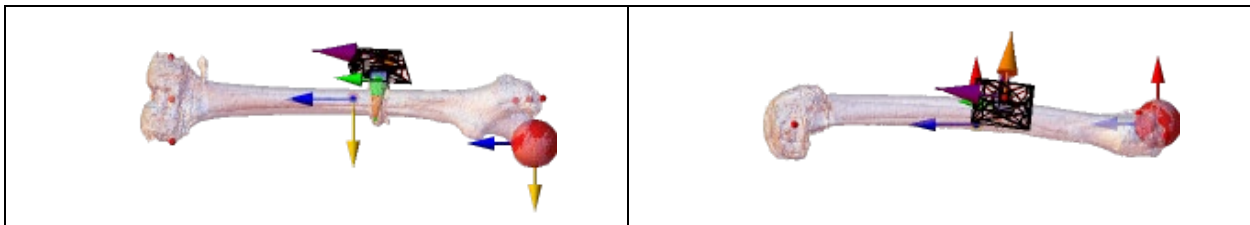
Spine sensors (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Pelvis



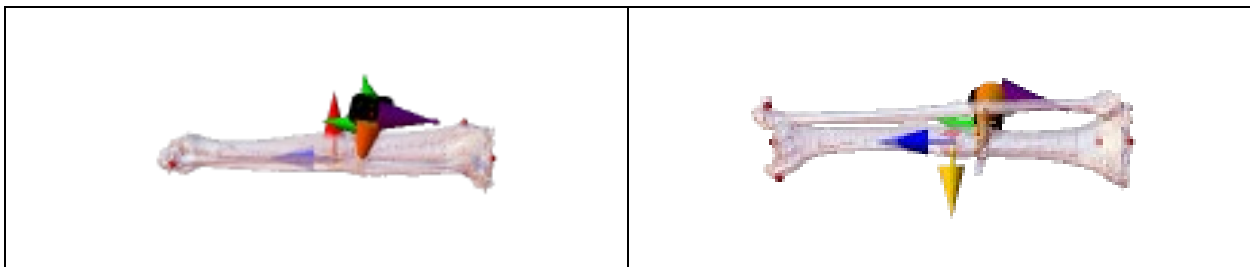
Iliac wing sensors (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Left Femur



Left femur sensor (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Left Tibia



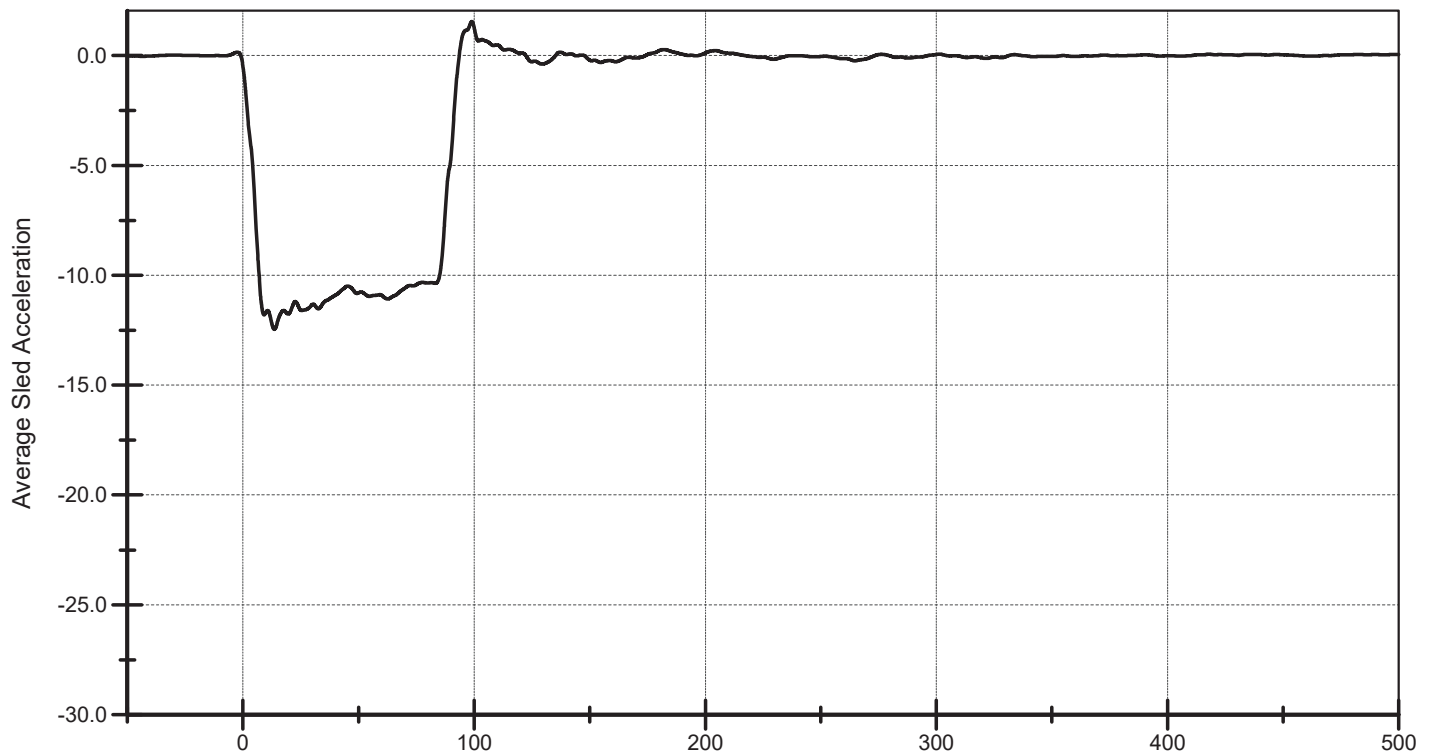
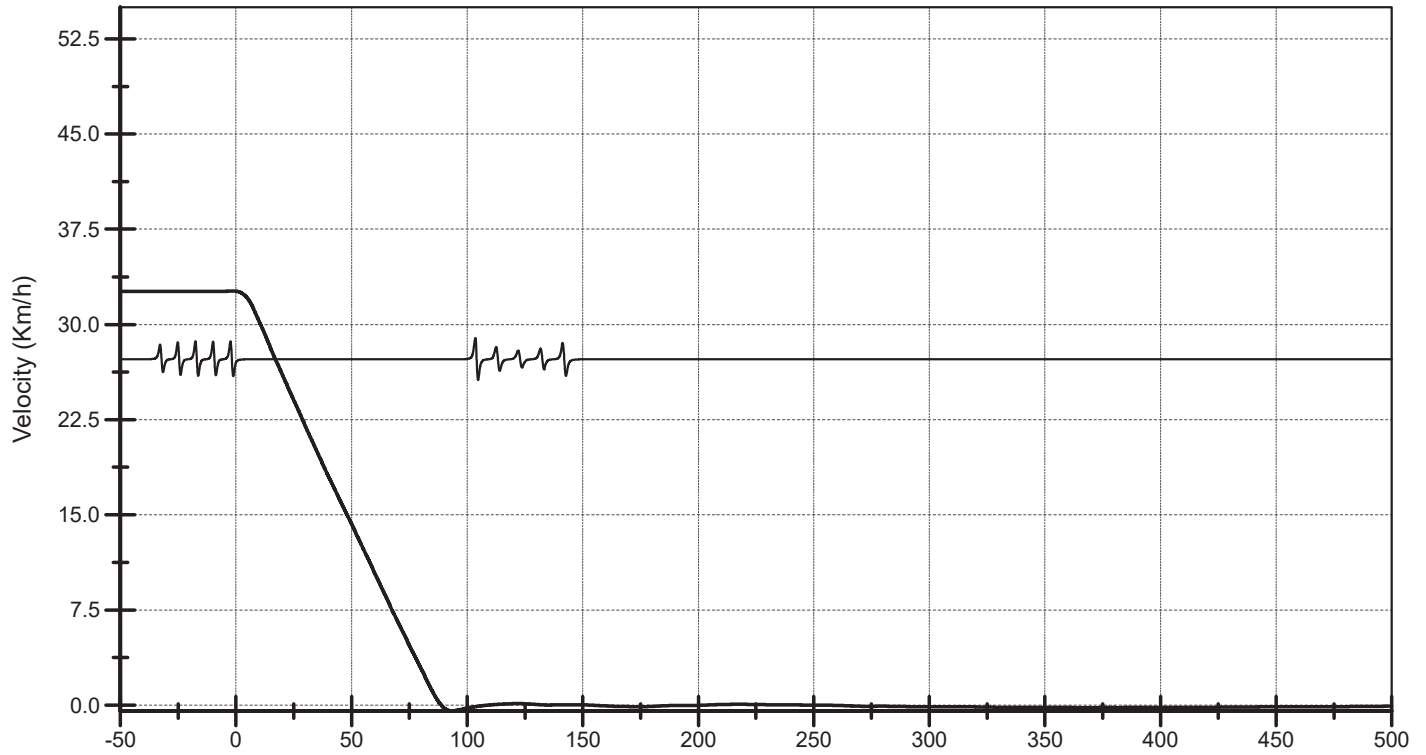
Left tibia sensor (x: green, y: purple, z: orange) and local (x: red, y: yellow, z: blue) coordinate systems

Manipulations for checking recorded load cell polarity relative to sign convention

Load Cell	Measure	Manipulations	Polarity
Upper and lower necks loads	Fx	Head rearward, chest forward	+
	Fy	Head leftward, chest rightward	+
	Fz	Head upward, chest downward	+
	Mx	Left ear toward left shoulder	+
	My	Chin toward sternum	+
	Mz	Chin toward left shoulder	+
Left shoulder loads	Fx	Left shoulder forward, chest rearward	+
	Fy	Left shoulder rightward, chest leftward	+
	Fz	Left shoulder downward, chest upward	+
Right shoulder loads	Fx	Right shoulder forward, chest rearward	+
	Fy	Right shoulder downward, chest upward	+
	Fz	Shoulder downward, chest rearward	+
Clavicle	Fx	Shoulder forward, chest rearward	+
	Fz	Shoulder downward, chest upward	+
Upper and lower lumbar spine	Fx	Chest rearward, pelvis forward	+
	Fy	Chest leftward, pelvis rightward	+
	Fz	Chest upward, pelvis downward	+
	Mx	Left shoulder toward left hip	+
	My	Sternum toward front legs	+
	Mz	Right shoulder forward, left shoulder rearward	+
Sacrum load	Fy	Left H-point pad leftward, chest rightward	+
Left iliac load	Fy	Left iliac rightward, chest leftward	+
Right iliac load	Fy	Right iliac rightward, chest leftward	+
Iliac lap belt load	Fx	Upper iliac spine rearward, chest forward	(-)
	My	Upper iliac spine rearward, chest forward	(-)
Femur loads	Fx	Knee upward, upper femur downward	+
	Fy	Knee rightward, upper femur leftward	+
	Fz	Knee forward, pelvis rearward	+
	Mx	Knee leftward, hold upper femur in place	+
	My	Knee upward, hold upper femur in place	+
	Mz	Tibia leftward, hold pelvis in place	+
Knee clevis	Fz	Tibia downward, femur upward	+
Upper tibia loads	Fz	Tibia downward, femur upward	+
	Mx	Ankle leftward, hold knee in place	+
	My	Ankle forward, bottom of knee clevis rearward	+
Lower tibia loads	Fx	Ankle forward, knee rearward	+
	Fy	Ankle rightward, knee leftward	+
	Mx	Ankle leftward, hold knee in place	+
	My	Ankle forward, bottom of knee clevis rearward	+

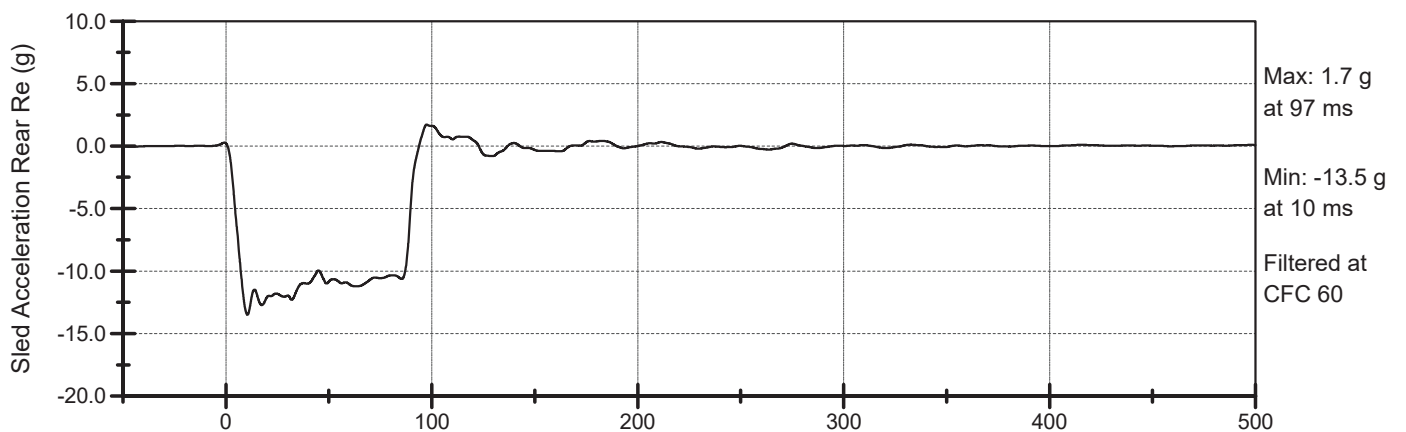
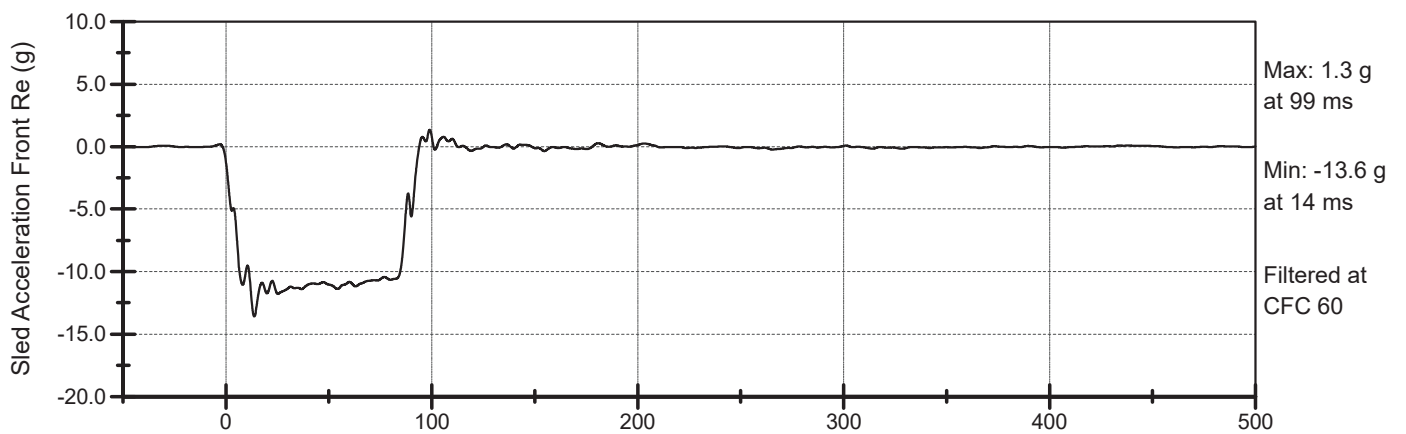
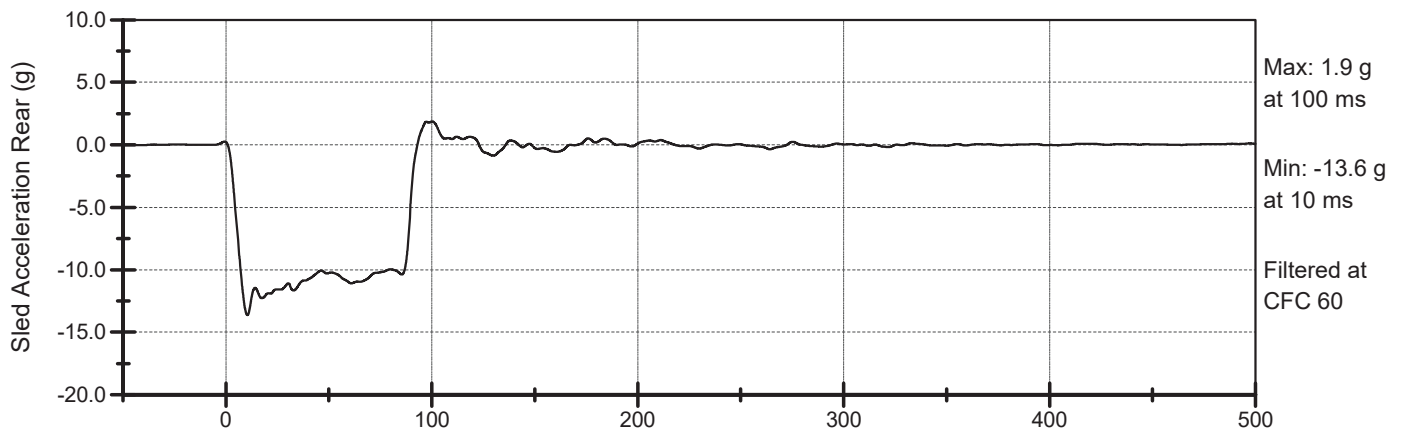
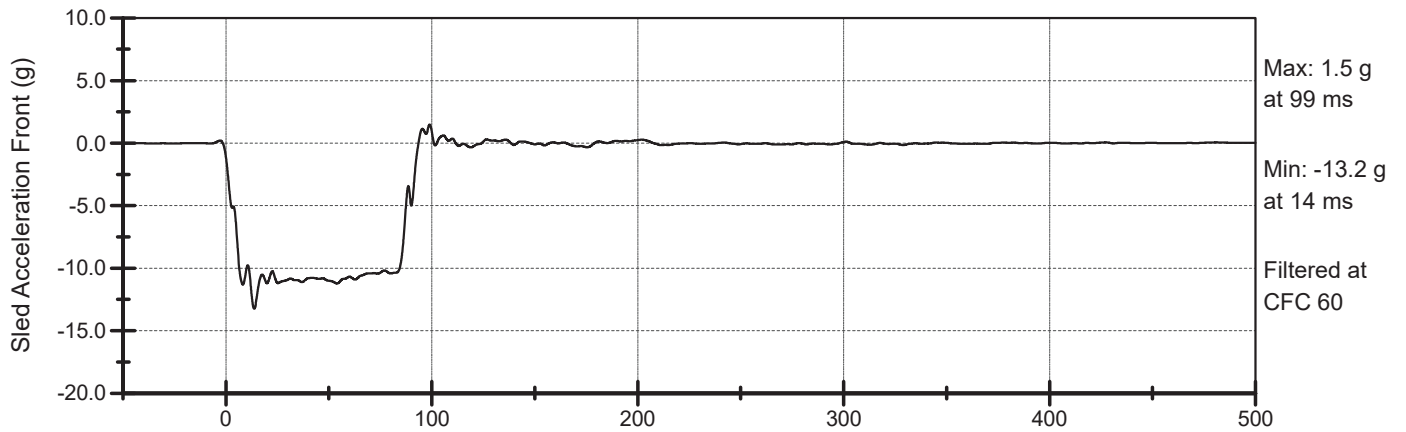
Appendix B

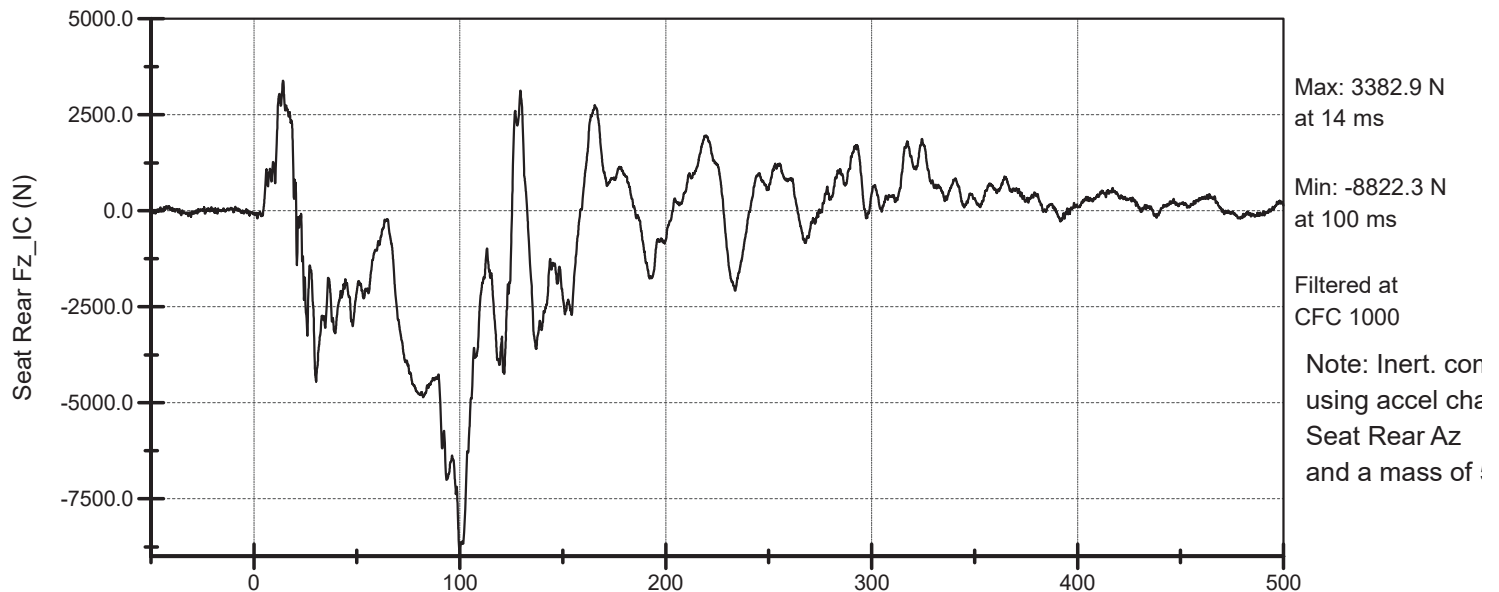
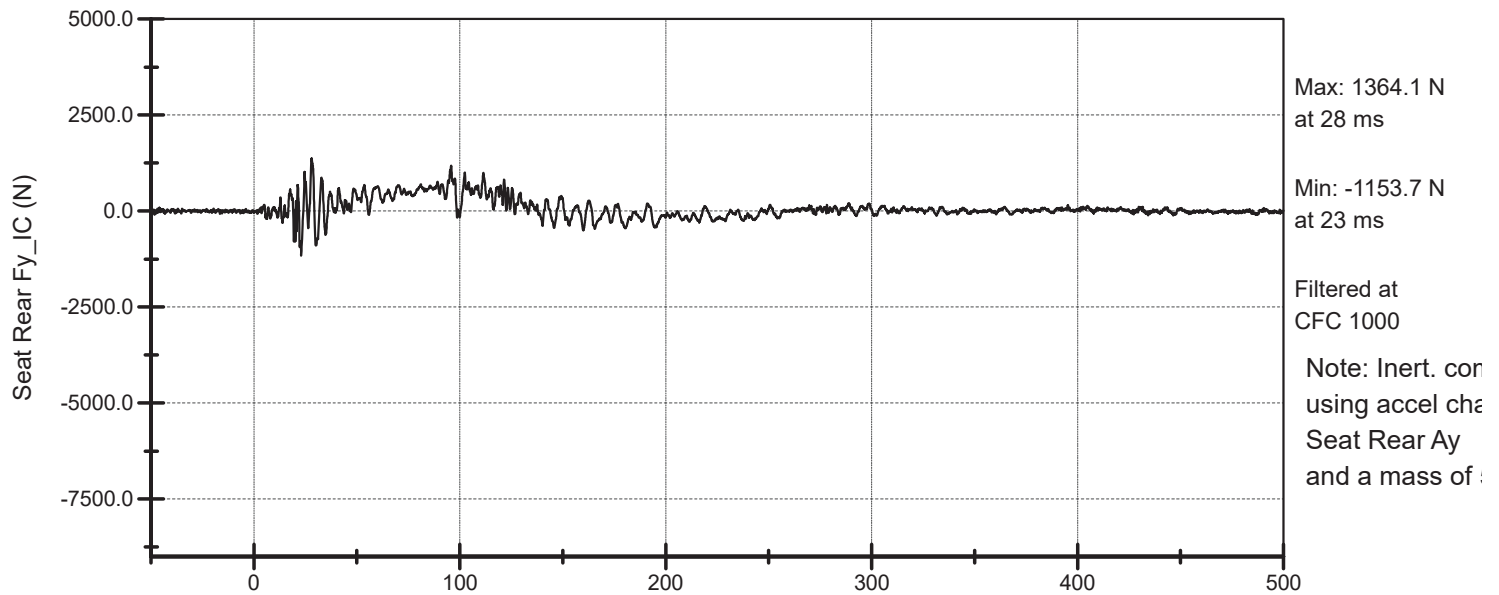
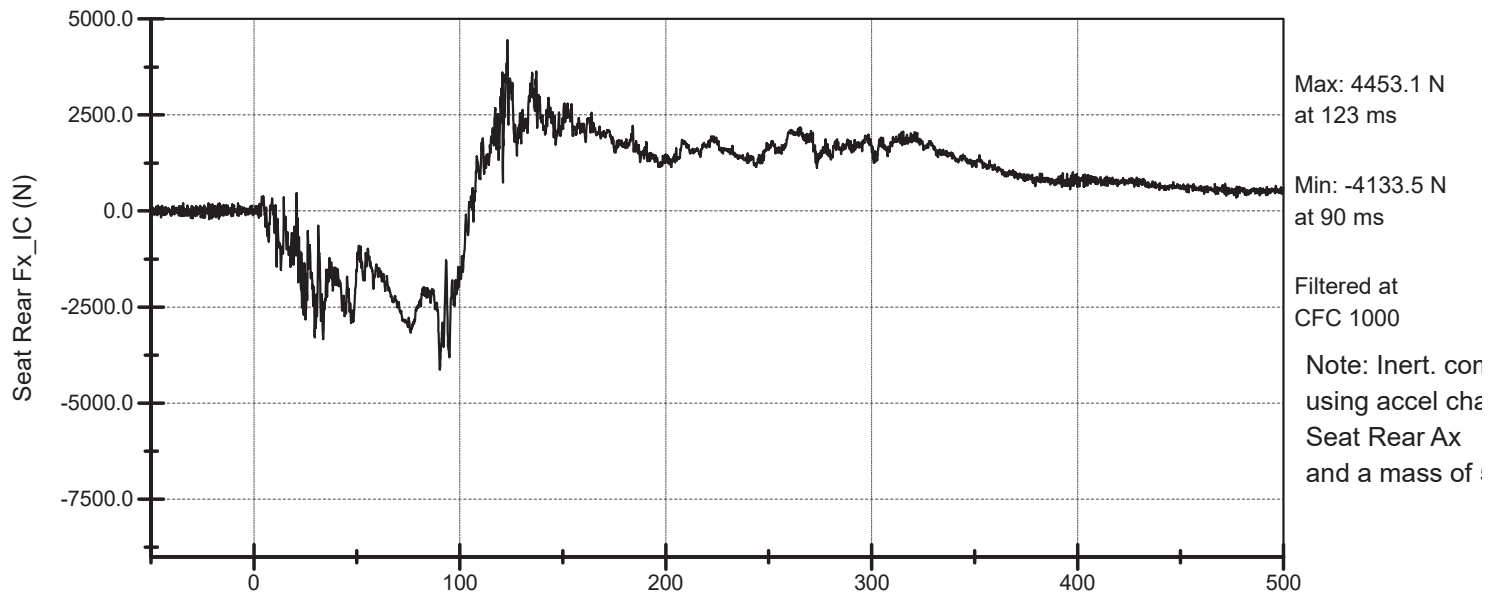
Test Signals

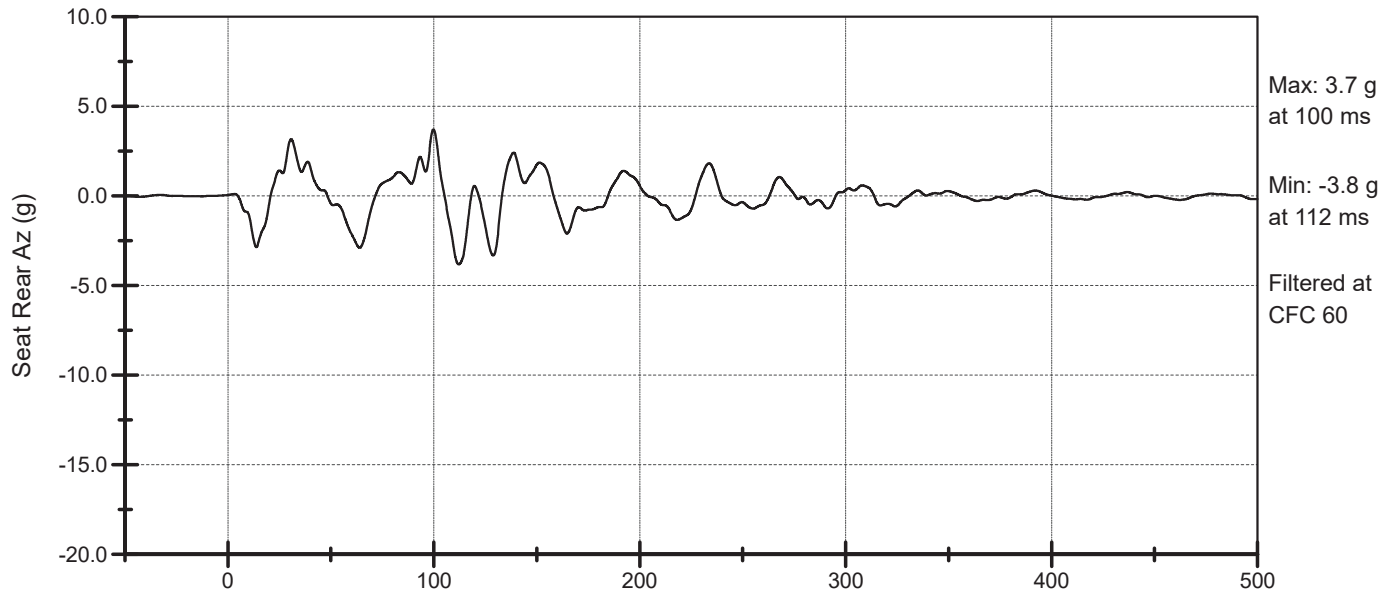
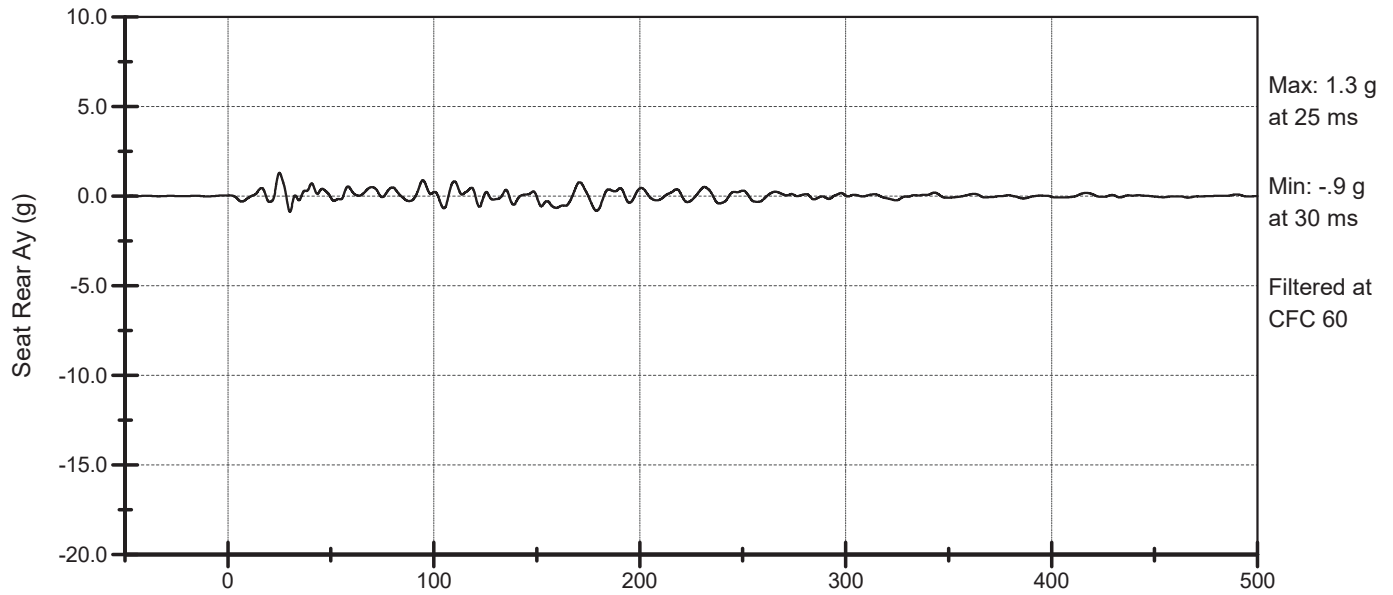
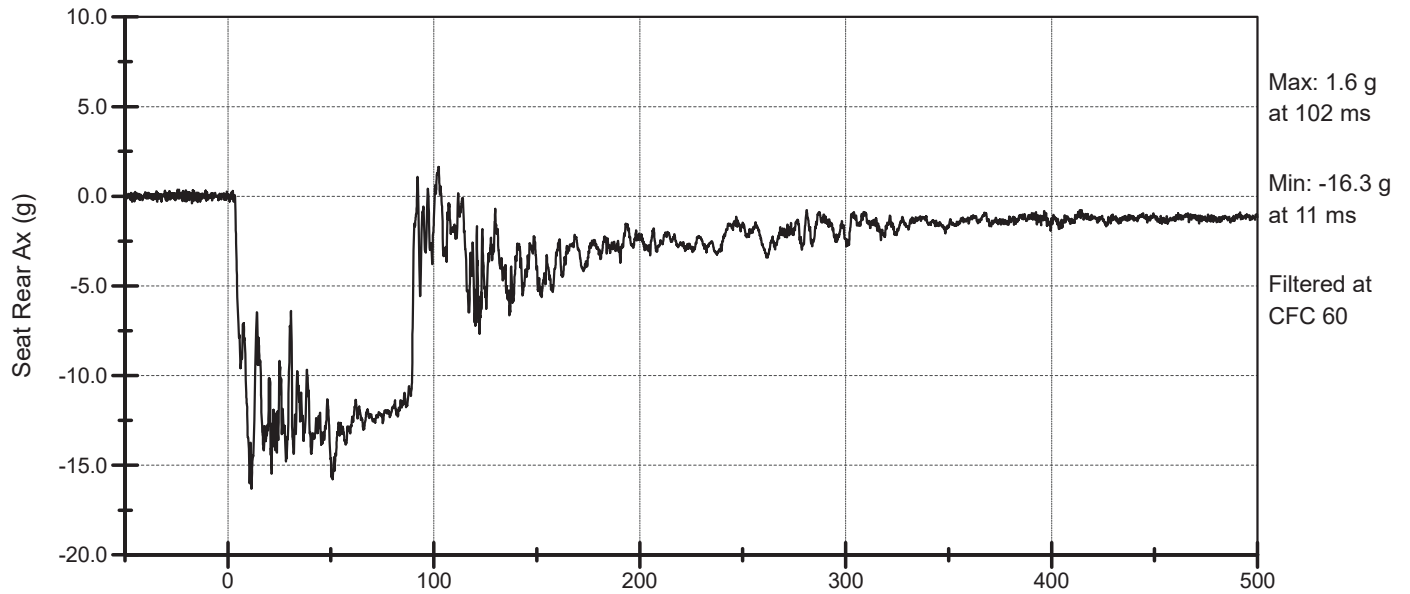


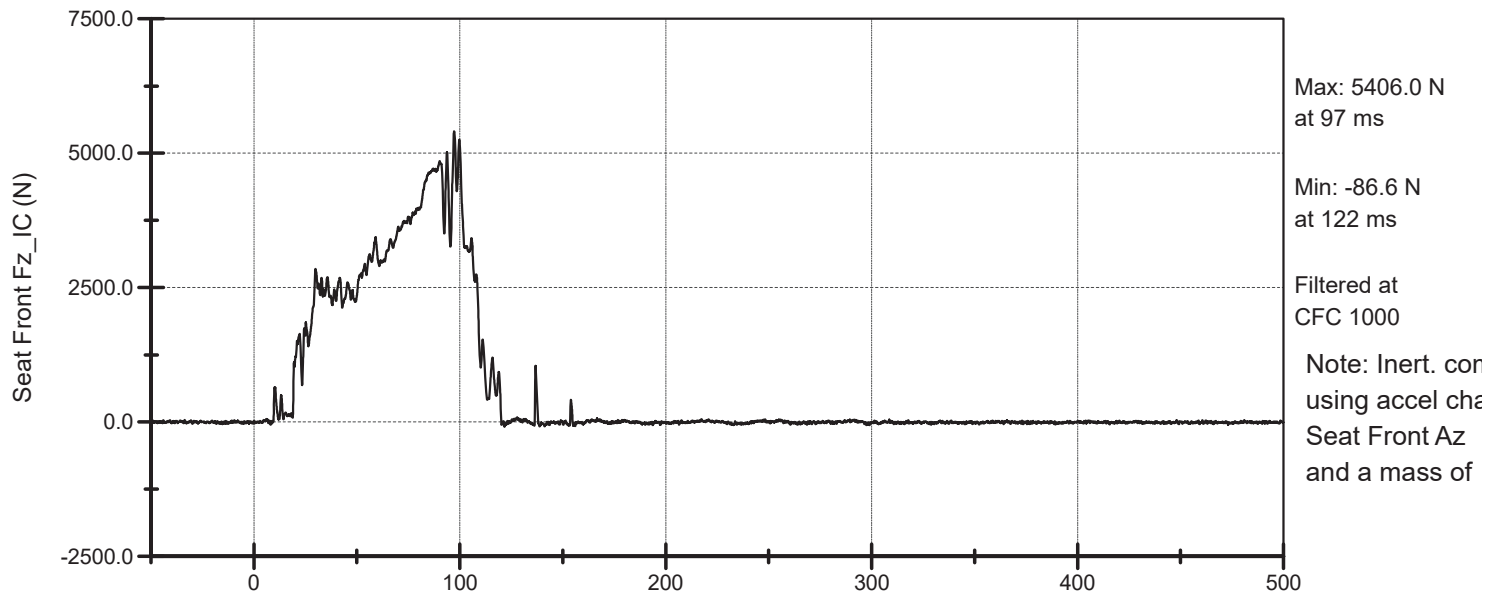
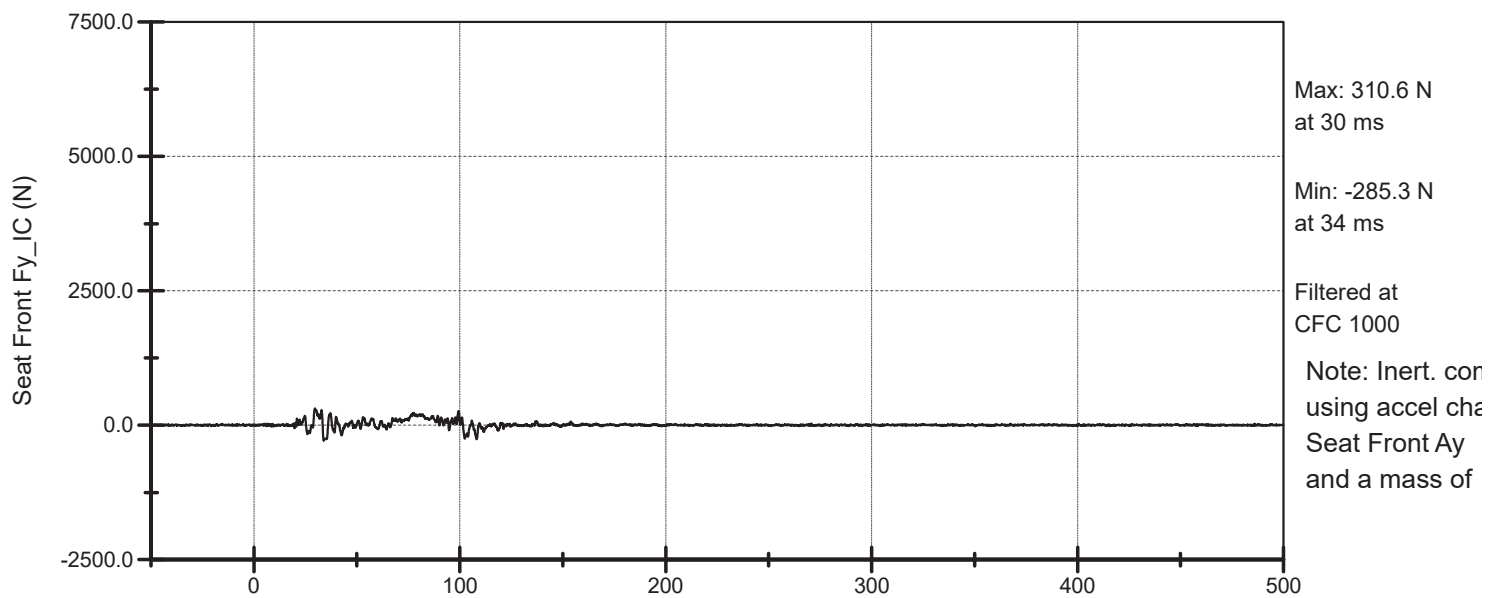
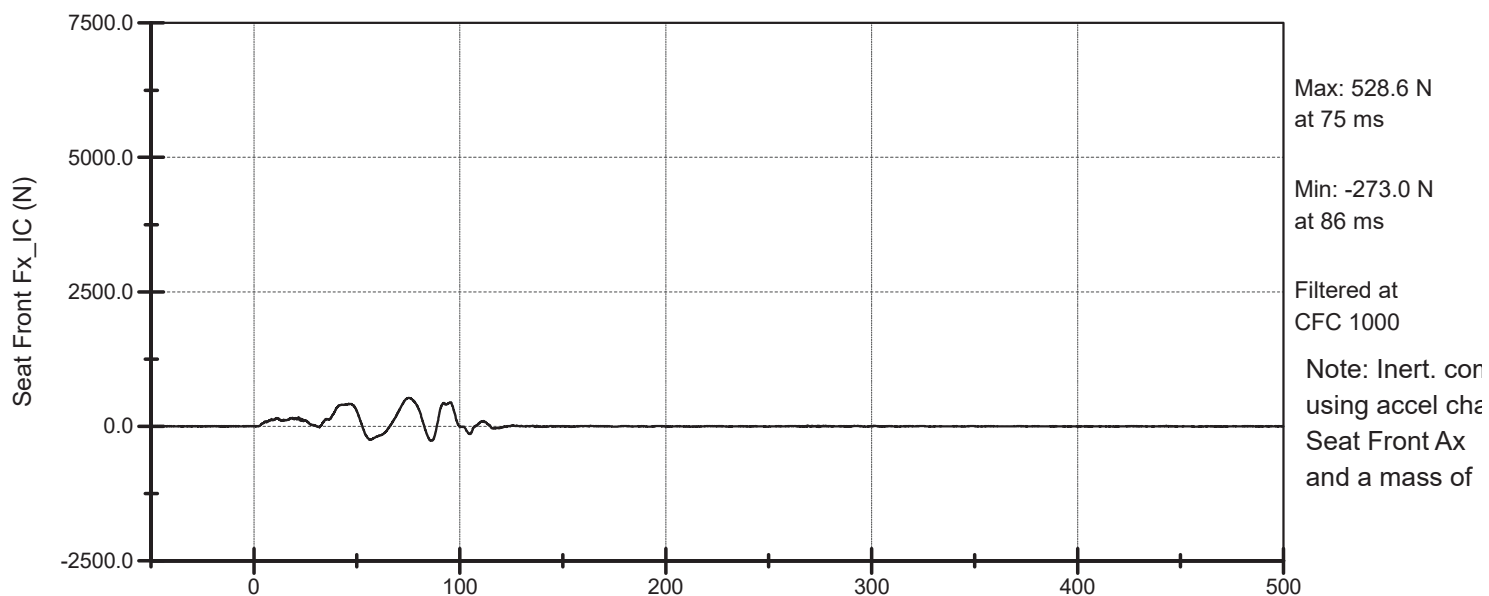
Sled Decel Peak = -12.5 G
 Sled Plateau Average Level = -11.1 G
 Sled Pulse Duration = 93.6 ms

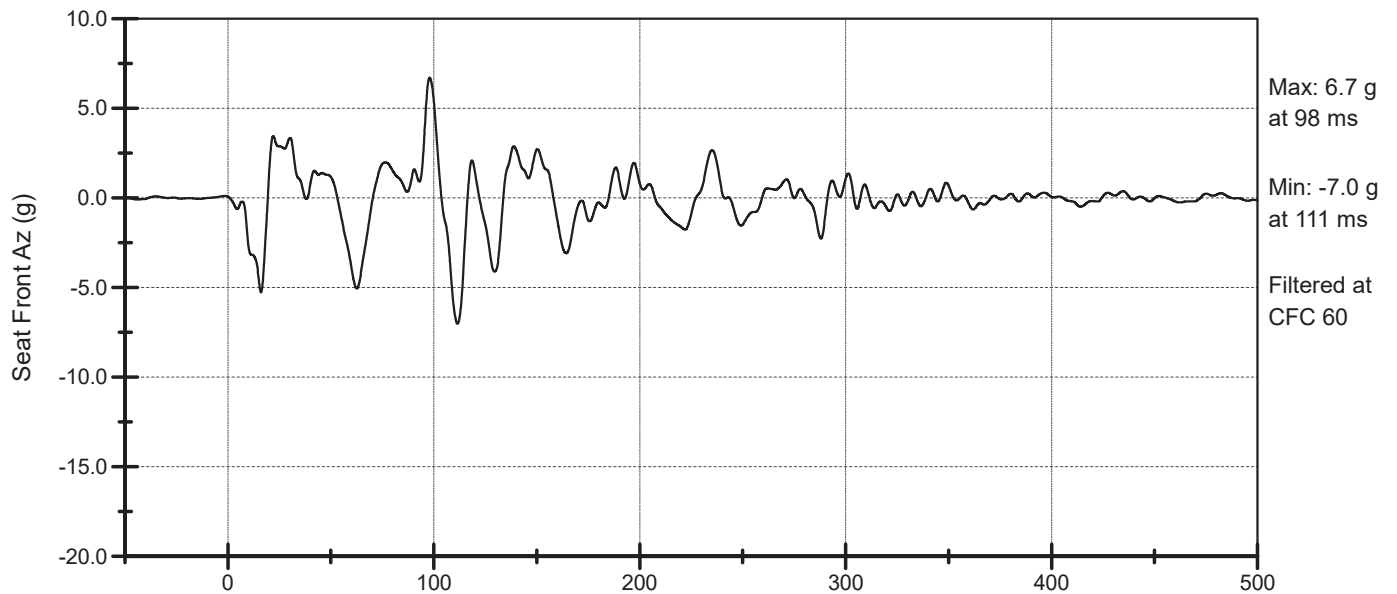
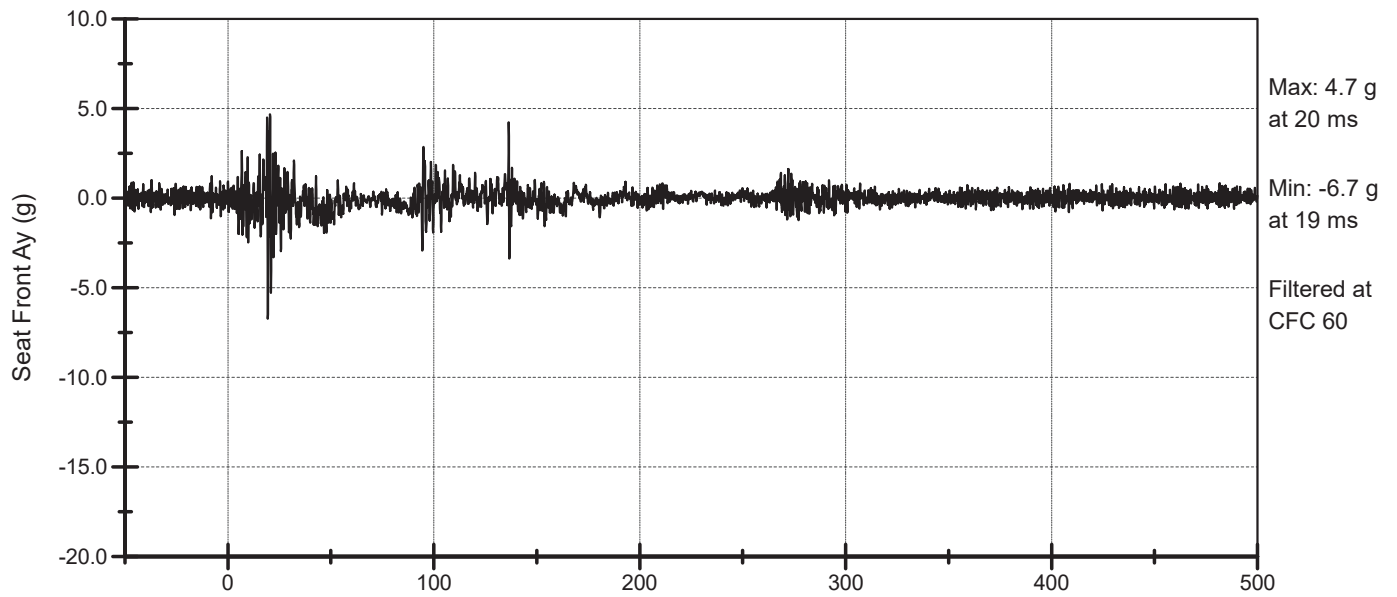
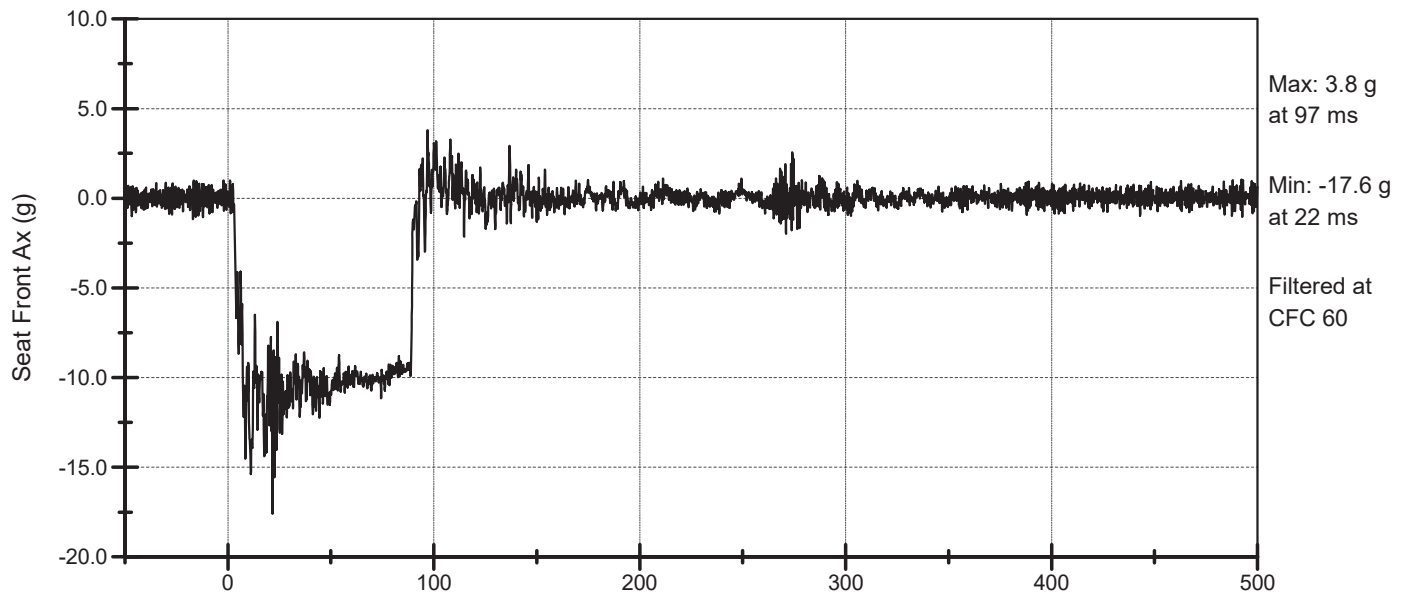
Stopping Dist. (est) = .440 m
 Sled Delta V = 32.6 kph (20.3 mph)
 Efficiency = $V_{out} / V_{in} = 14.6 / 18.0 = 81.1\%$

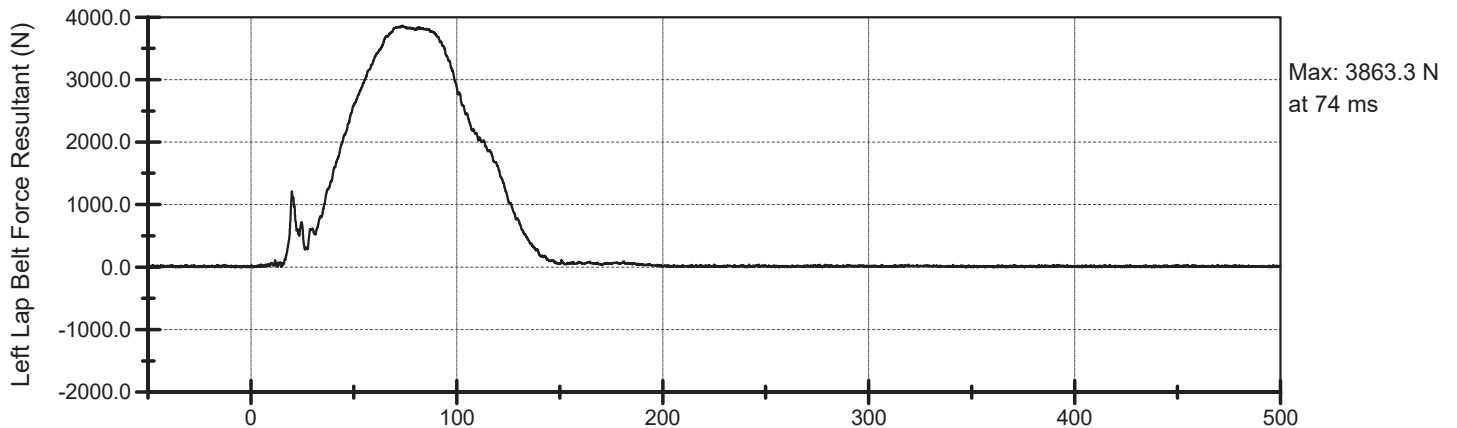
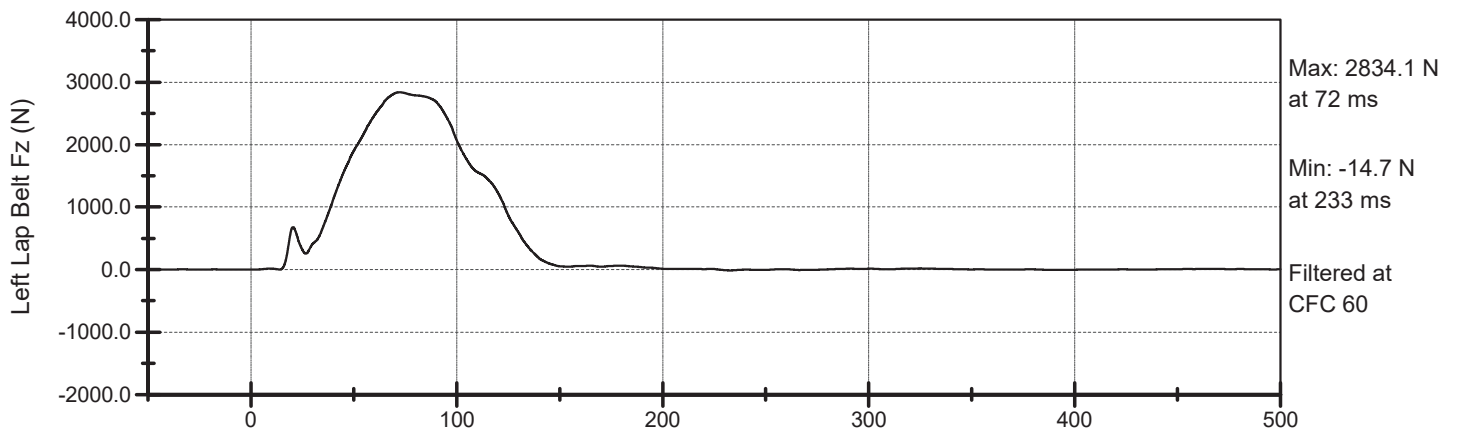
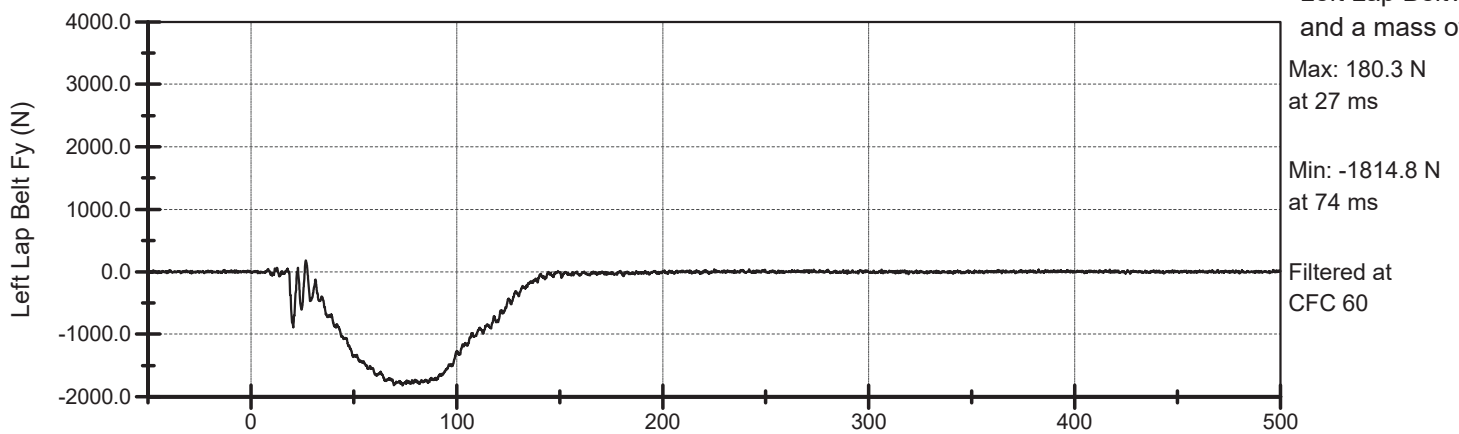
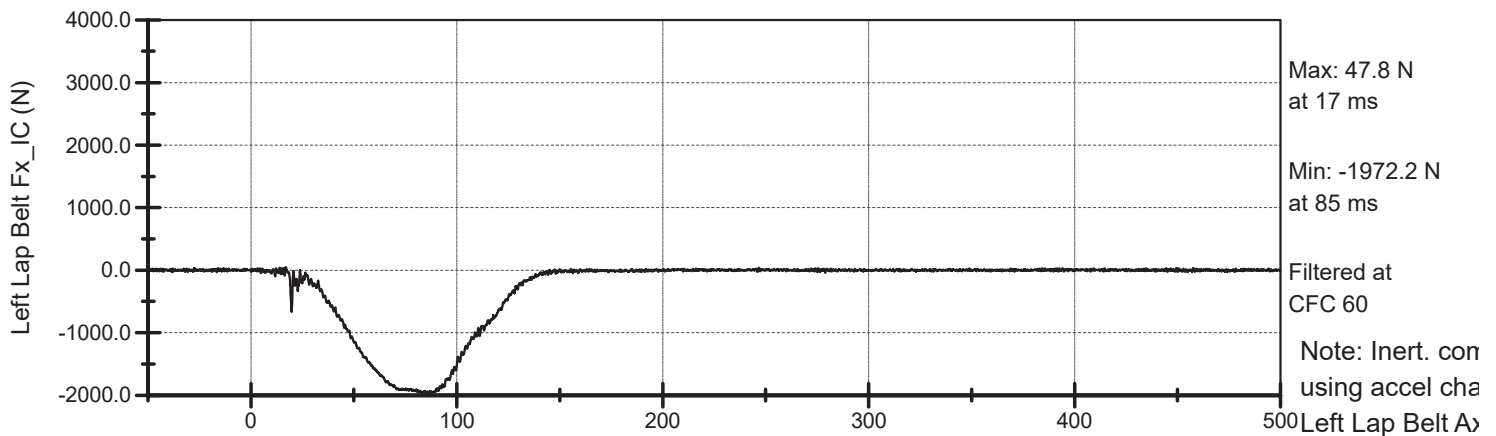


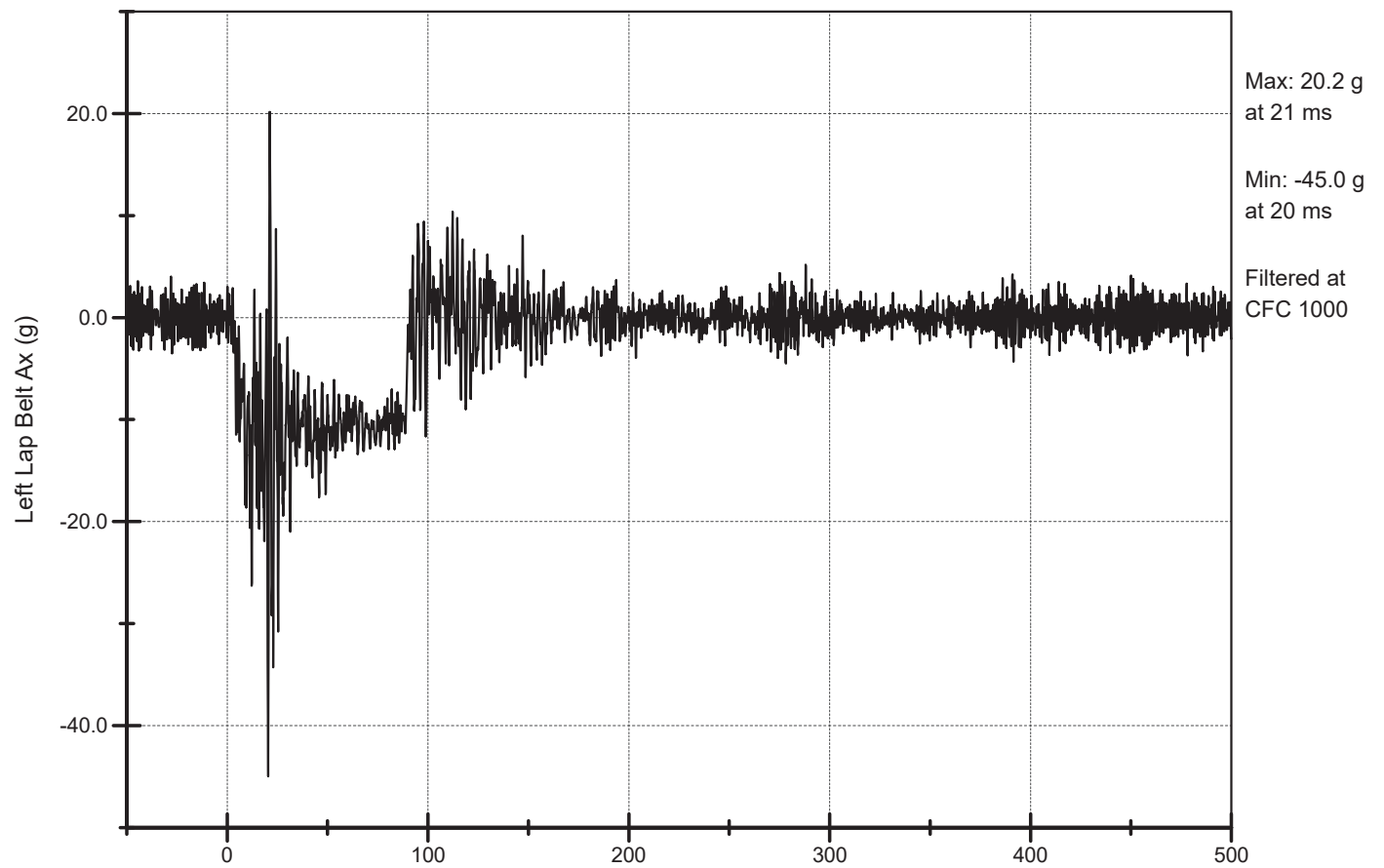


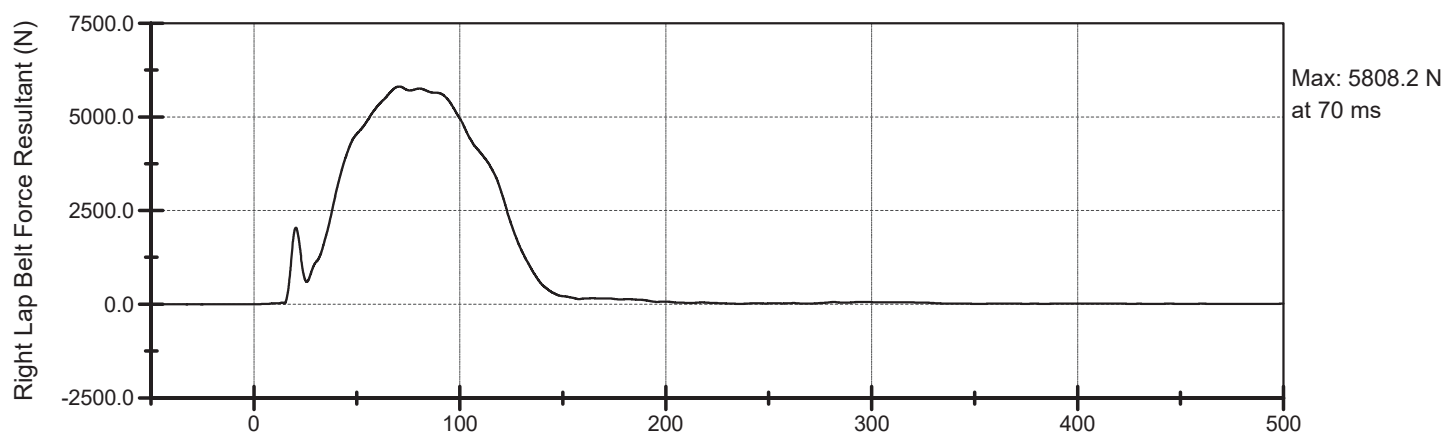
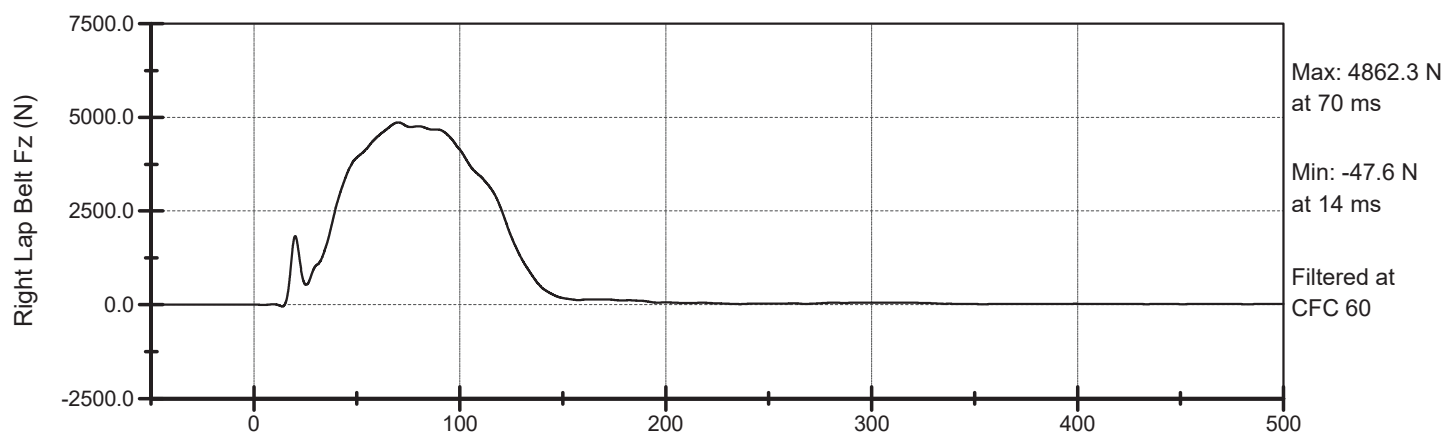
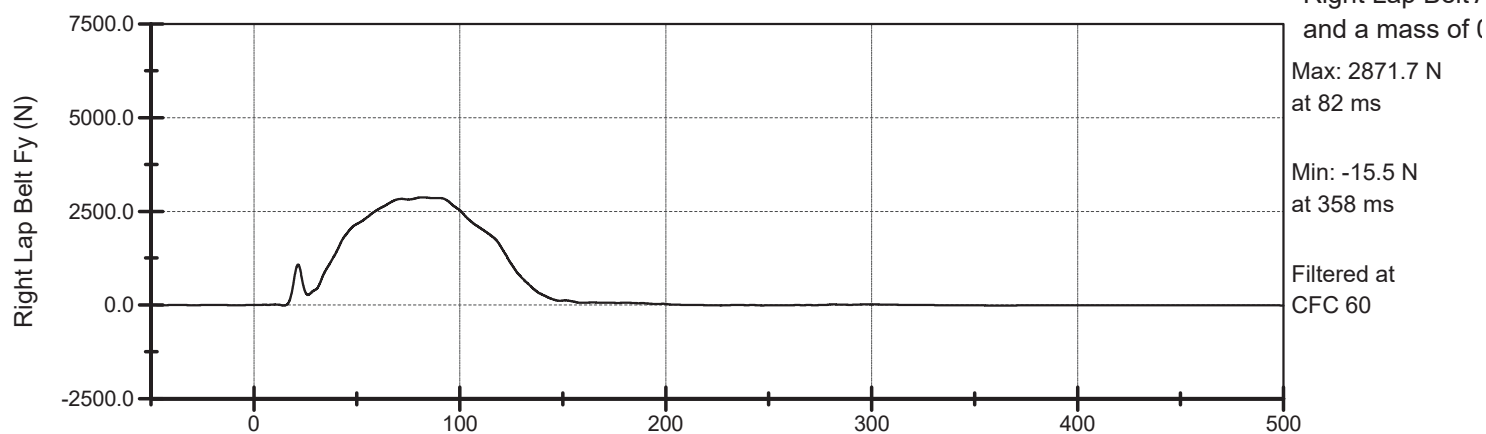
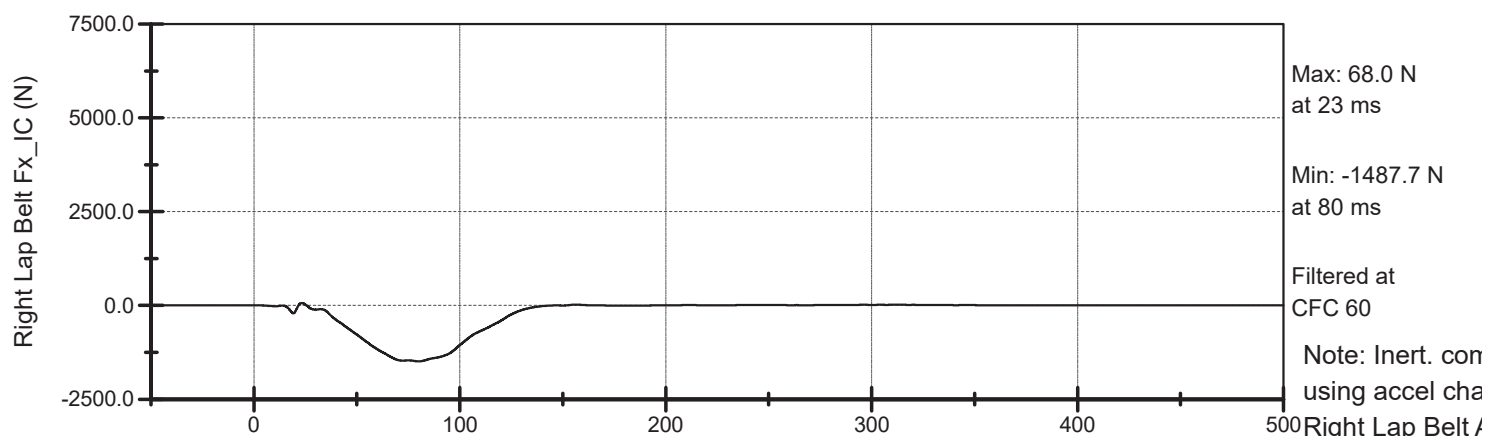


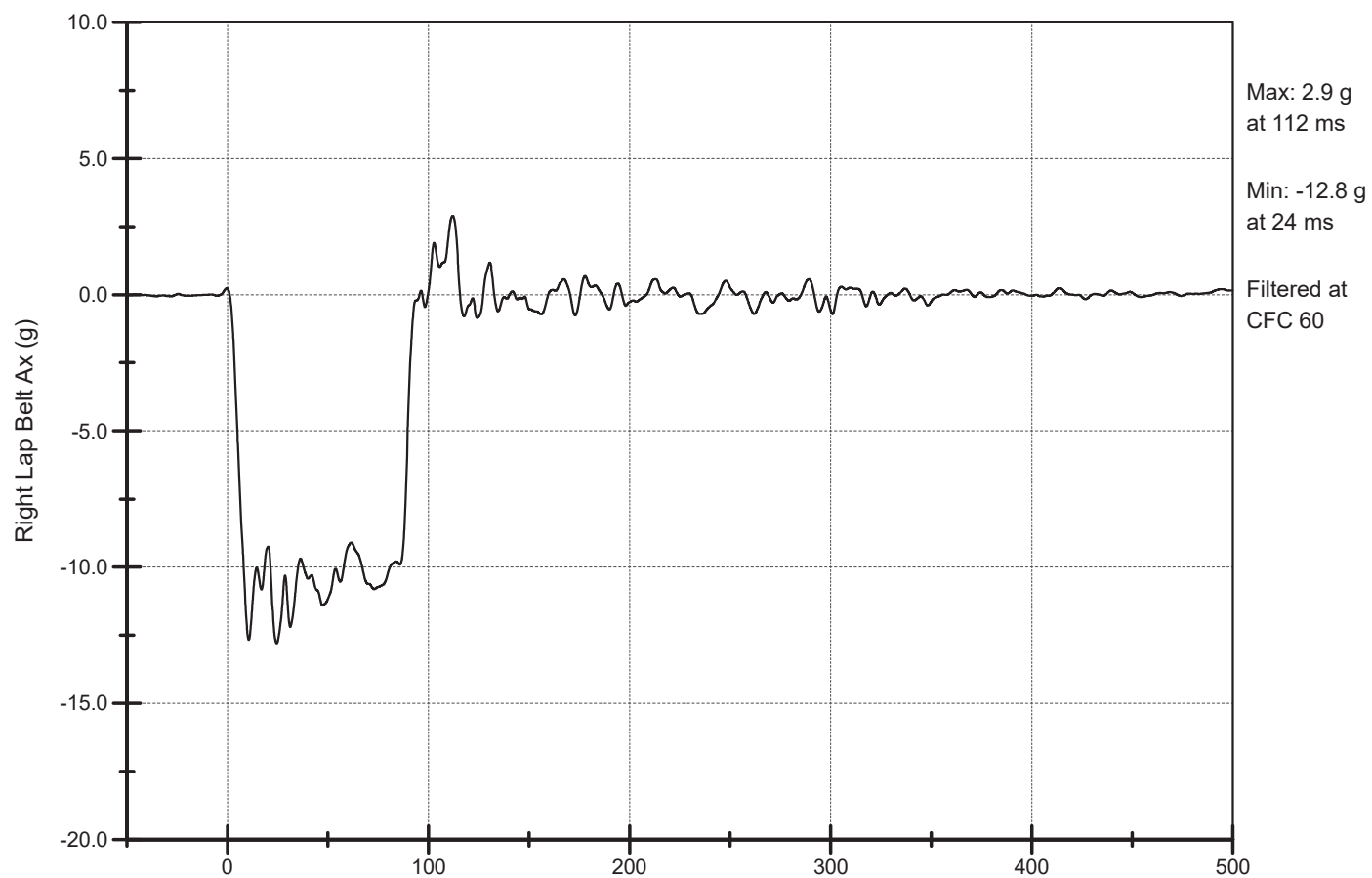


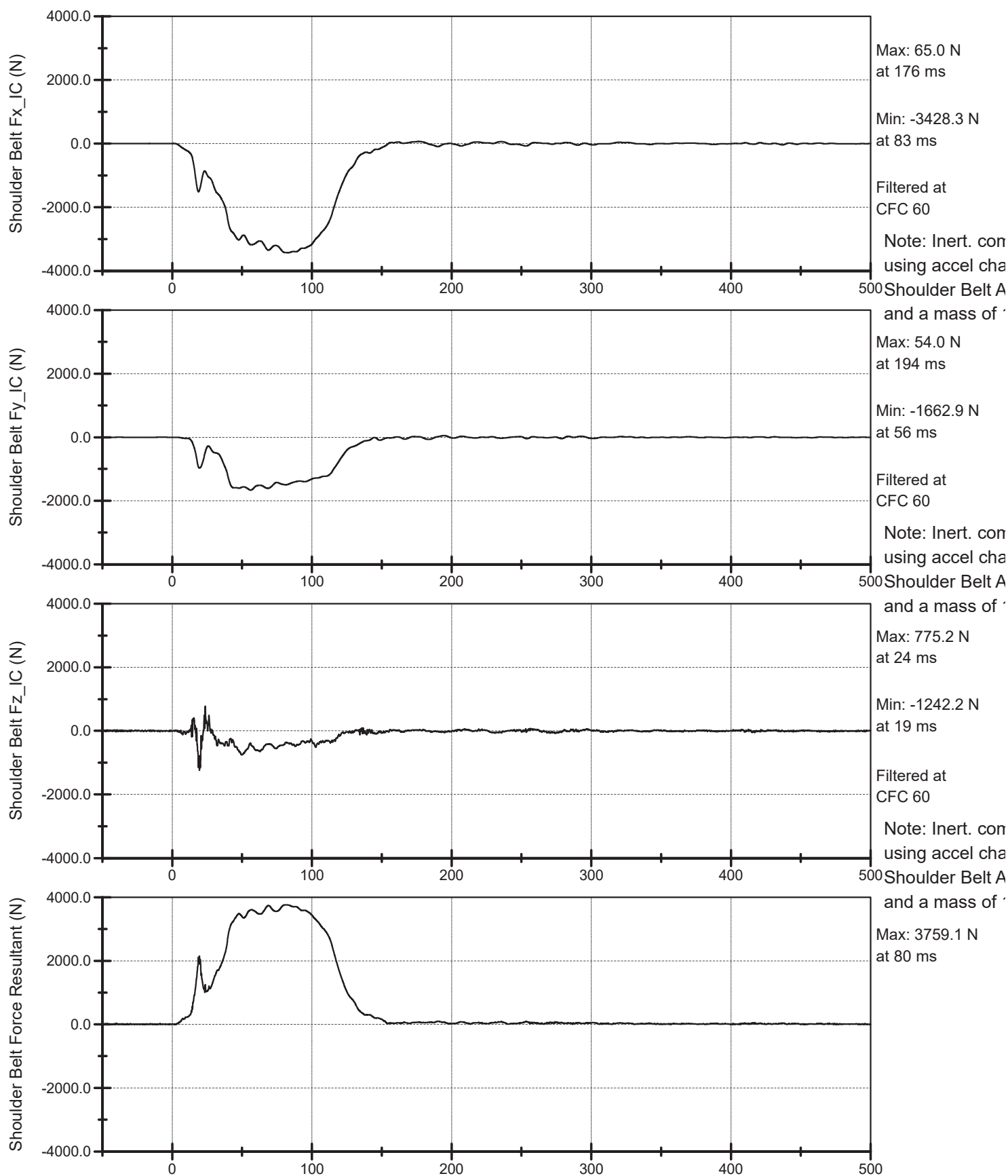


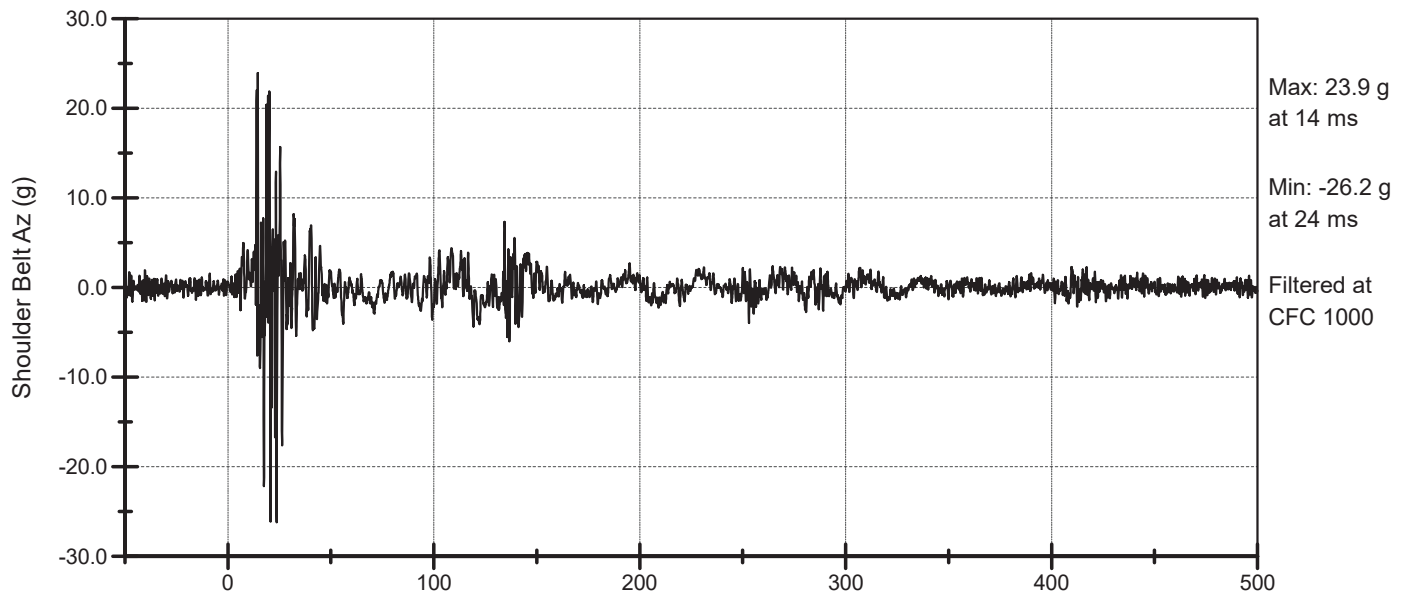
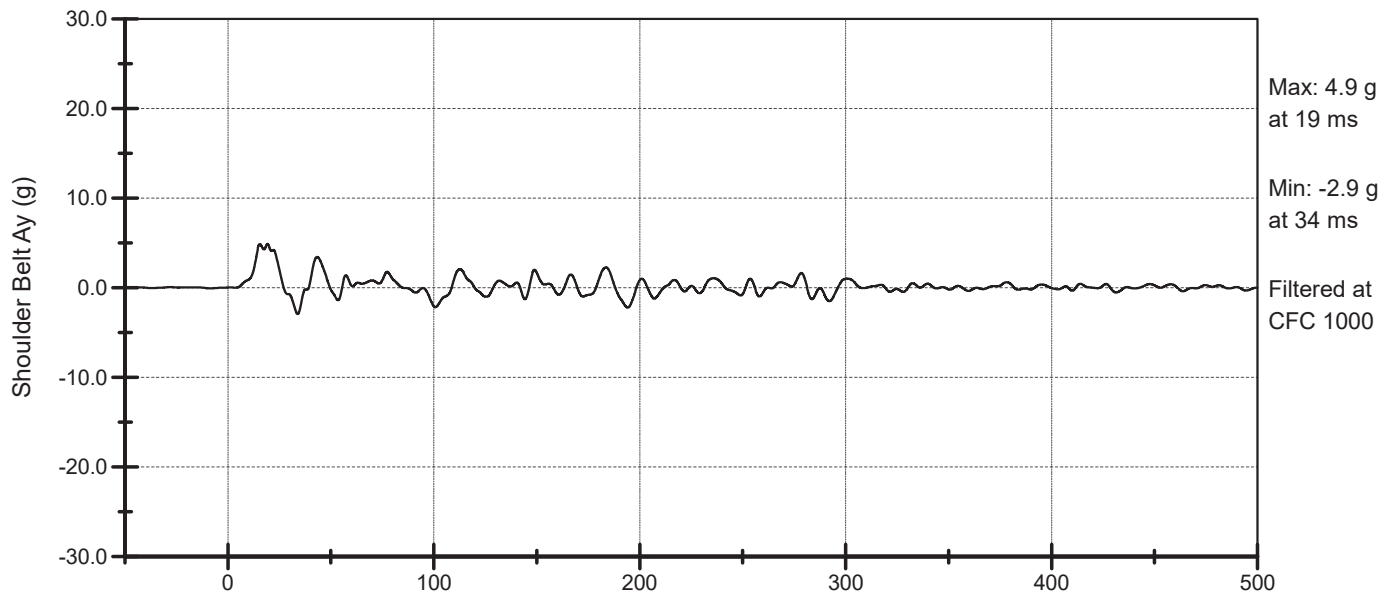
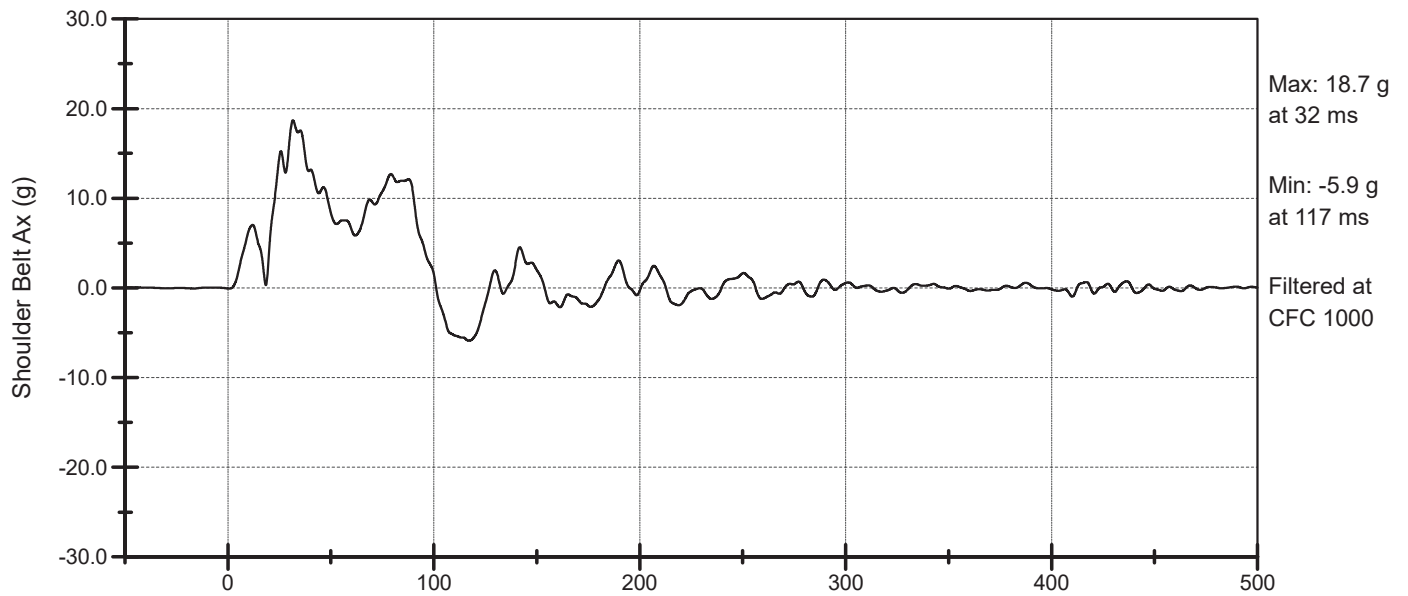


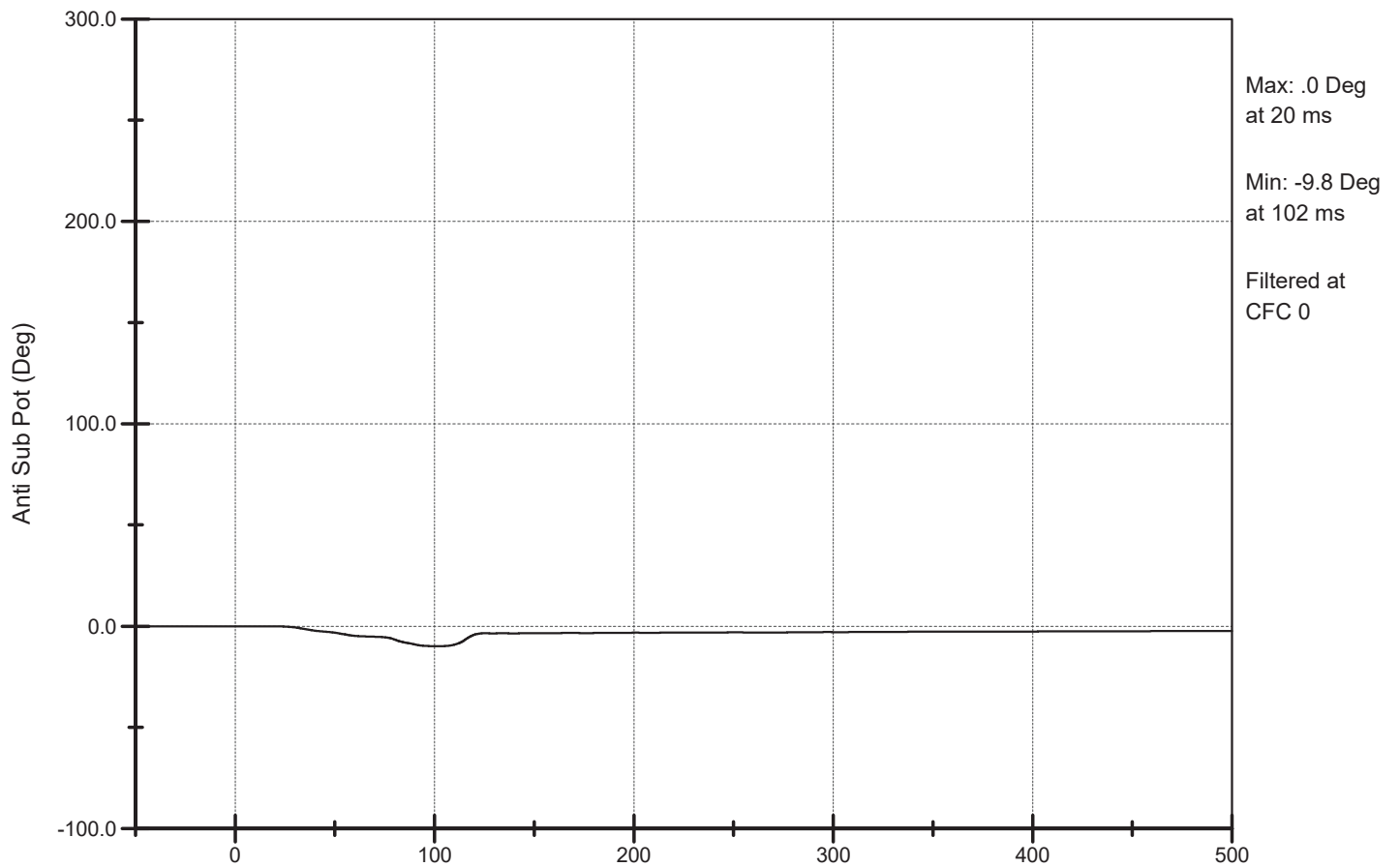
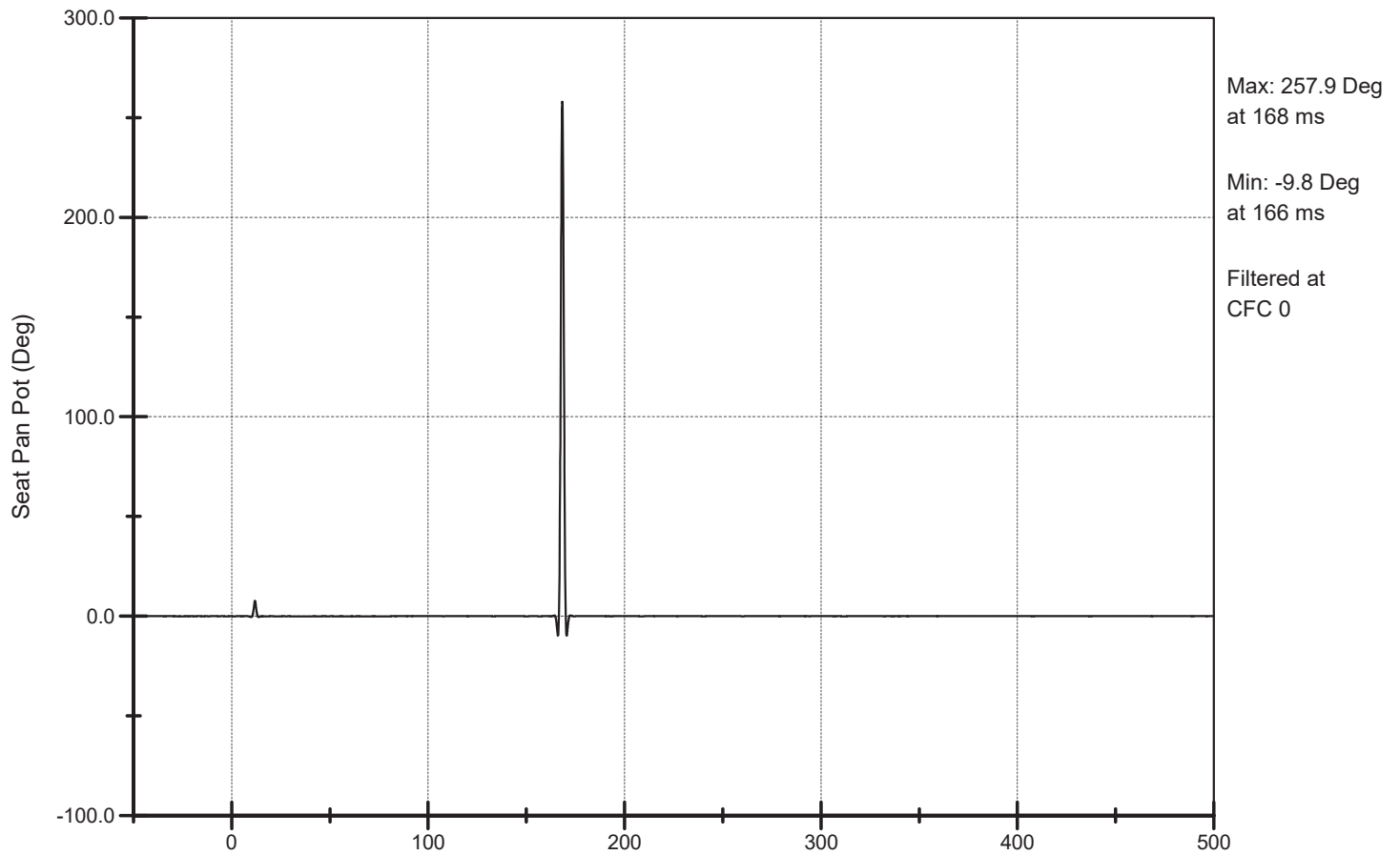








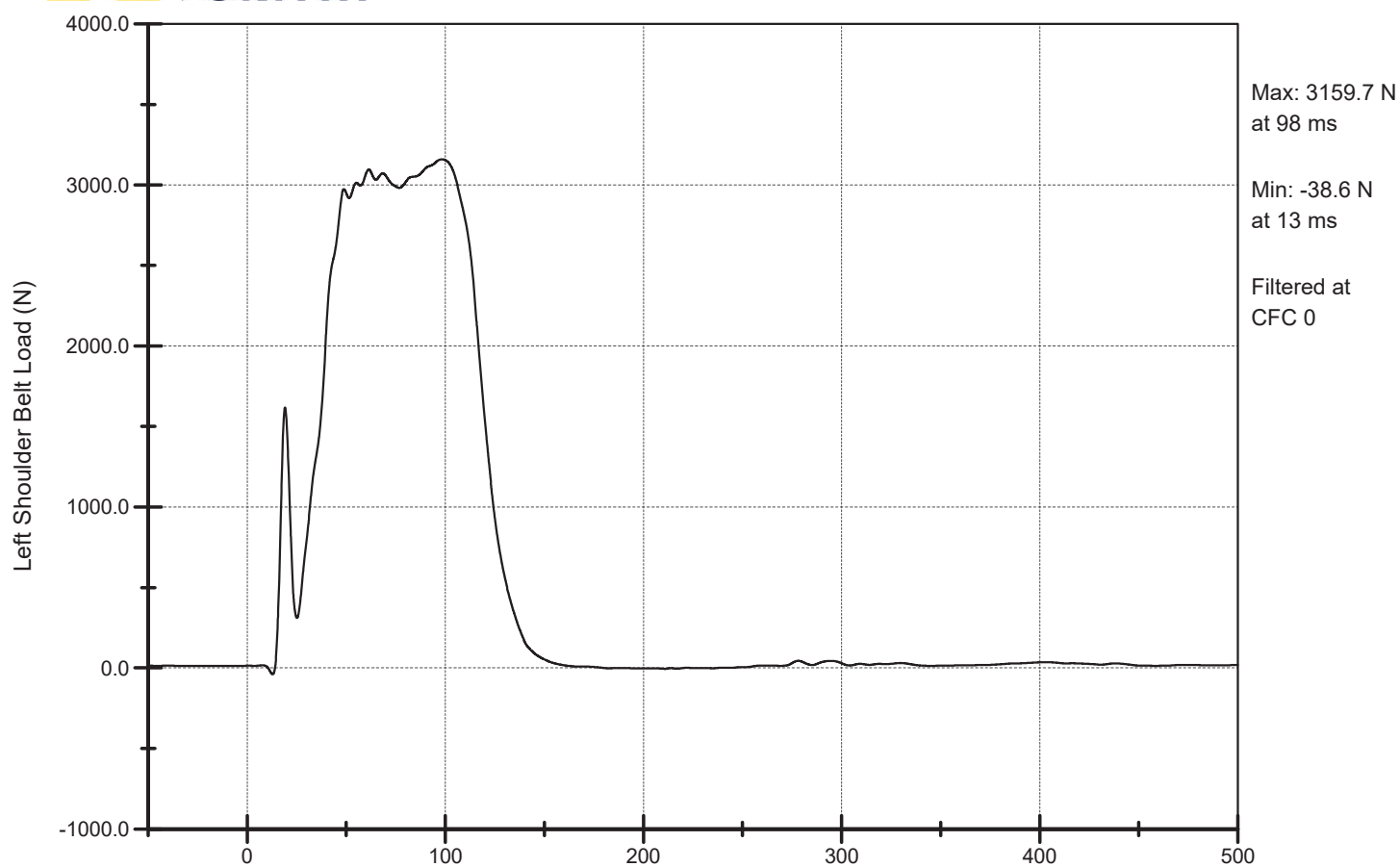


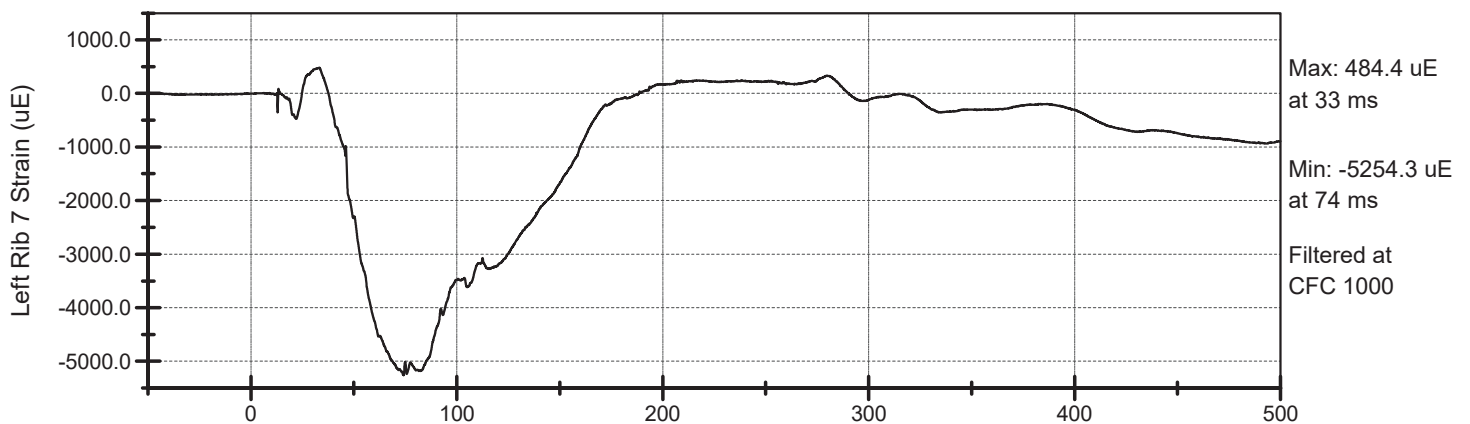
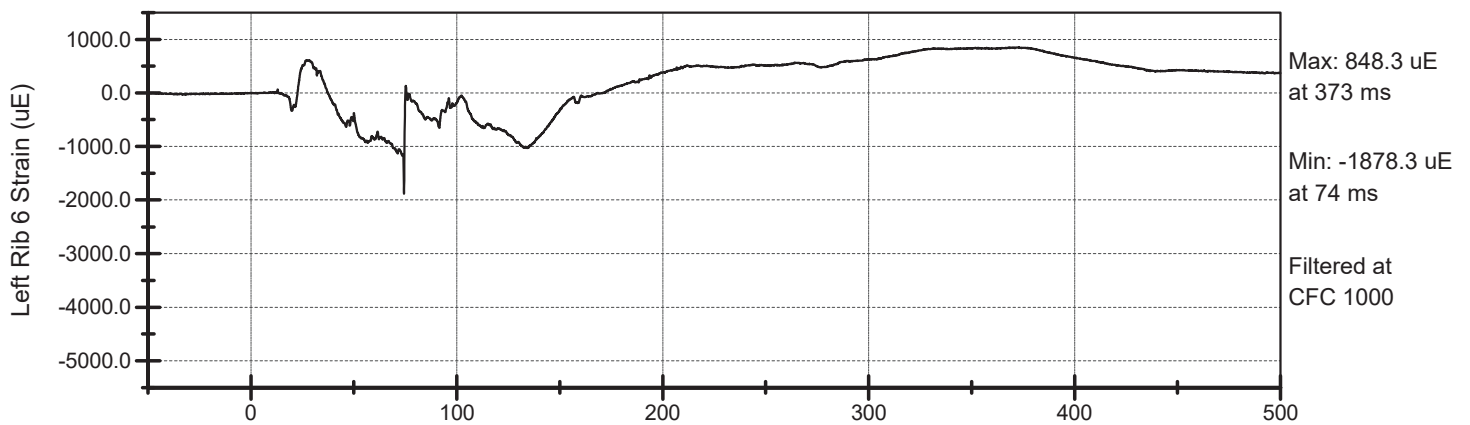
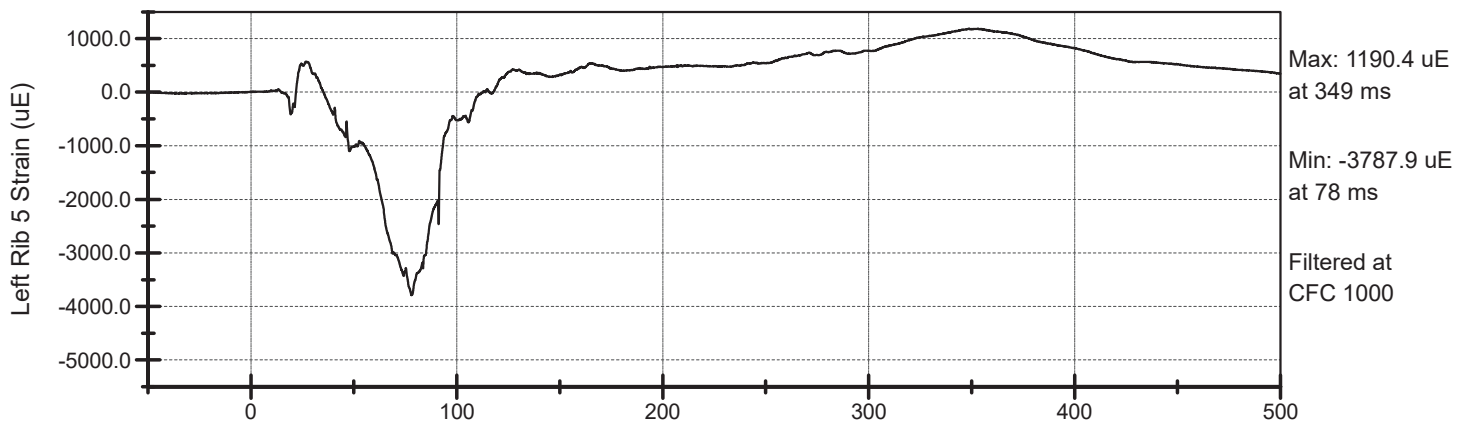
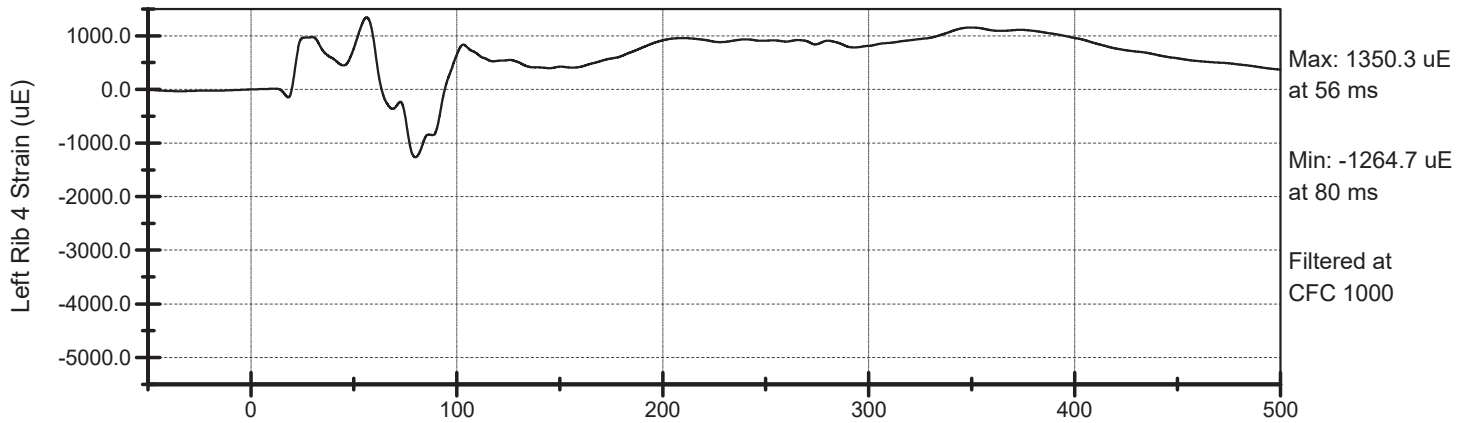


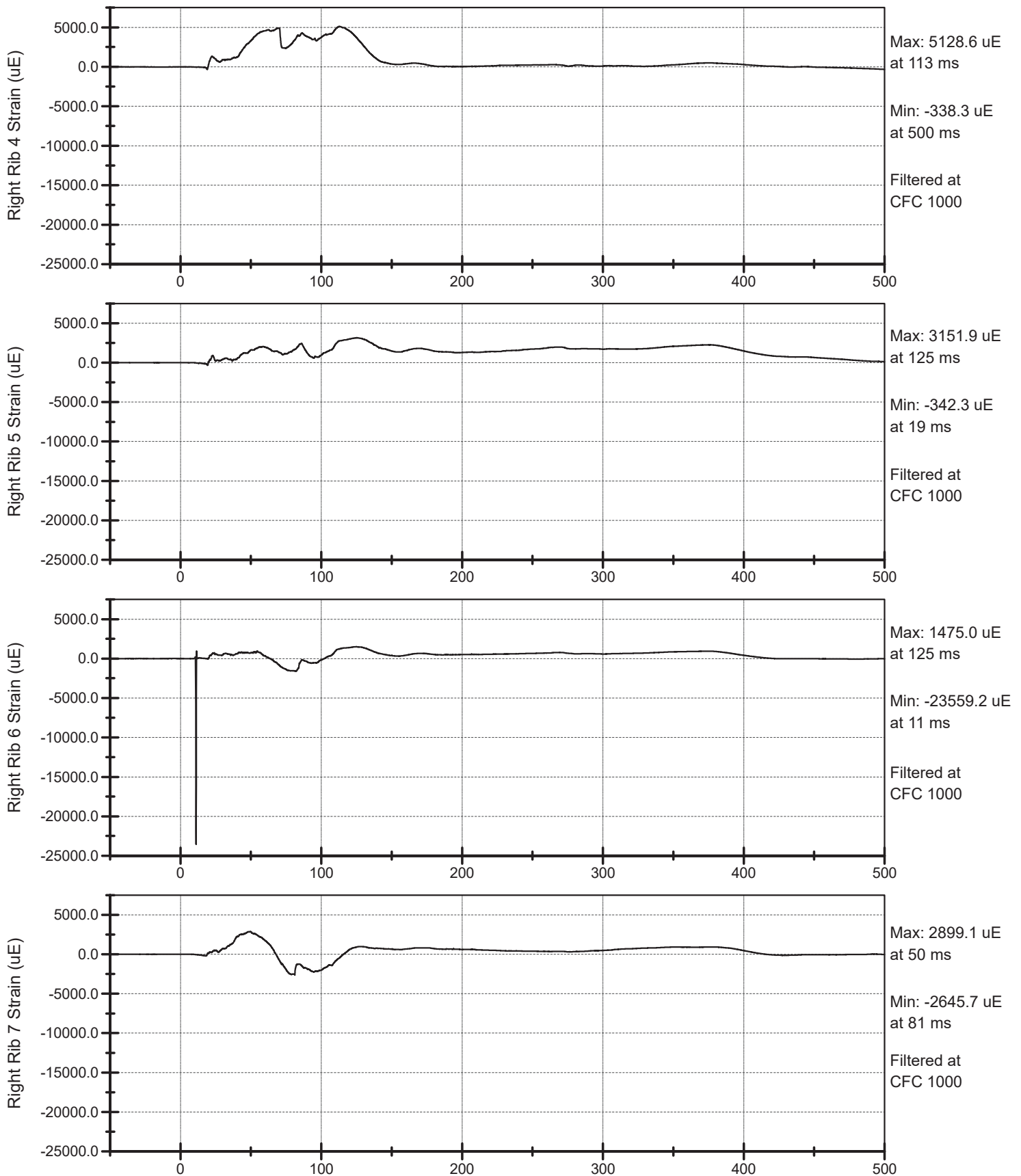


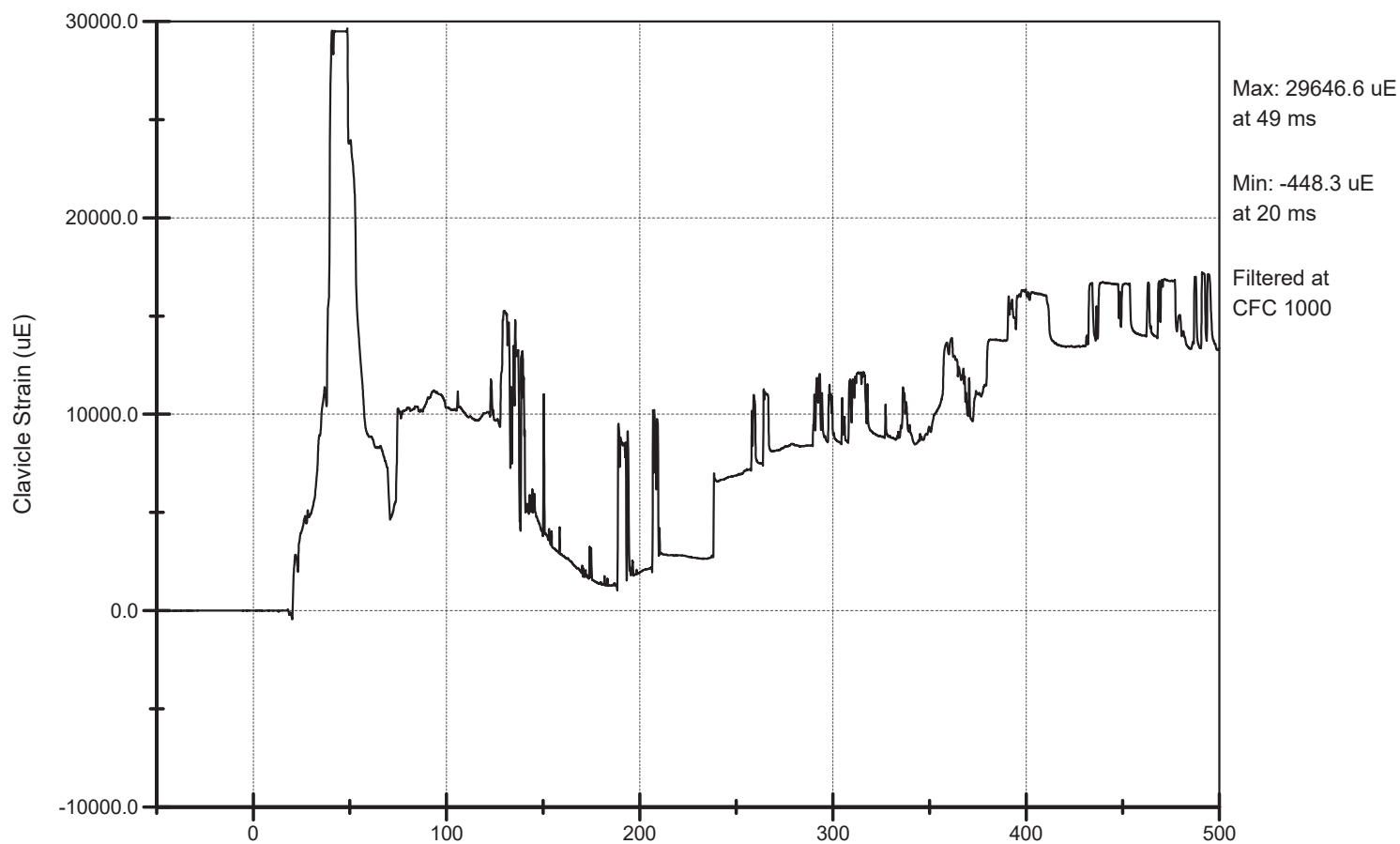
UMTRI

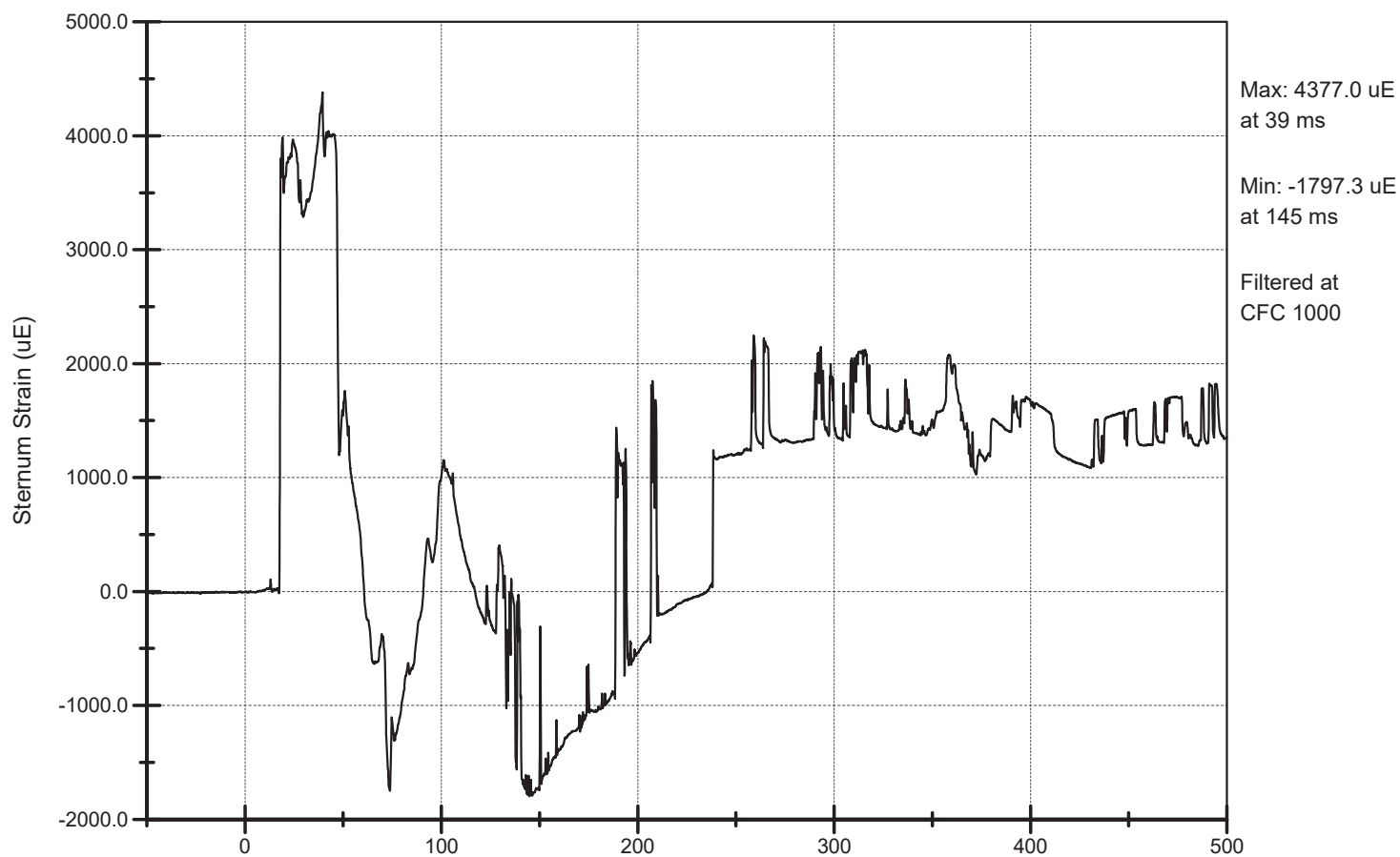
Shoulder Belt Load Cell AV2105 001

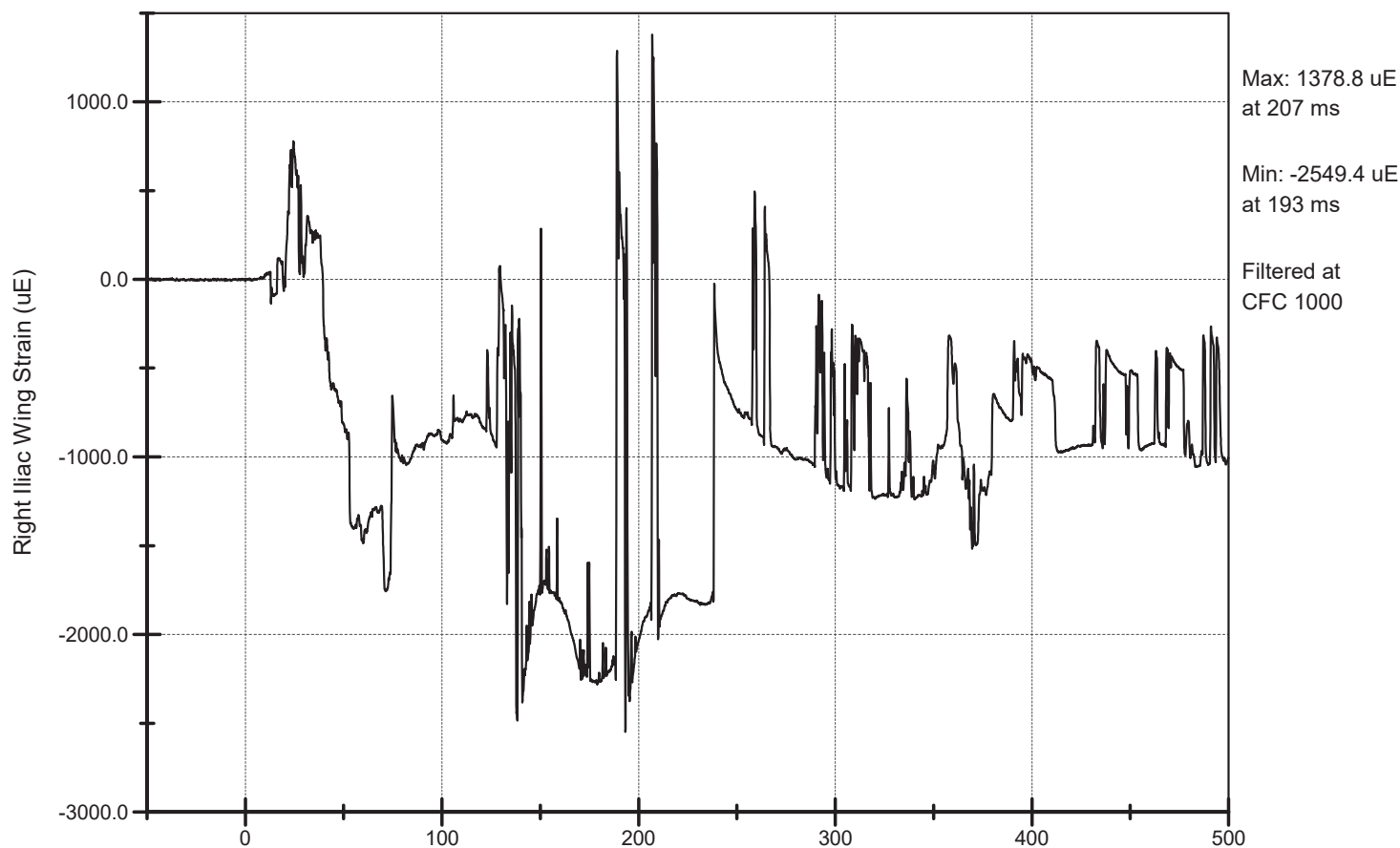
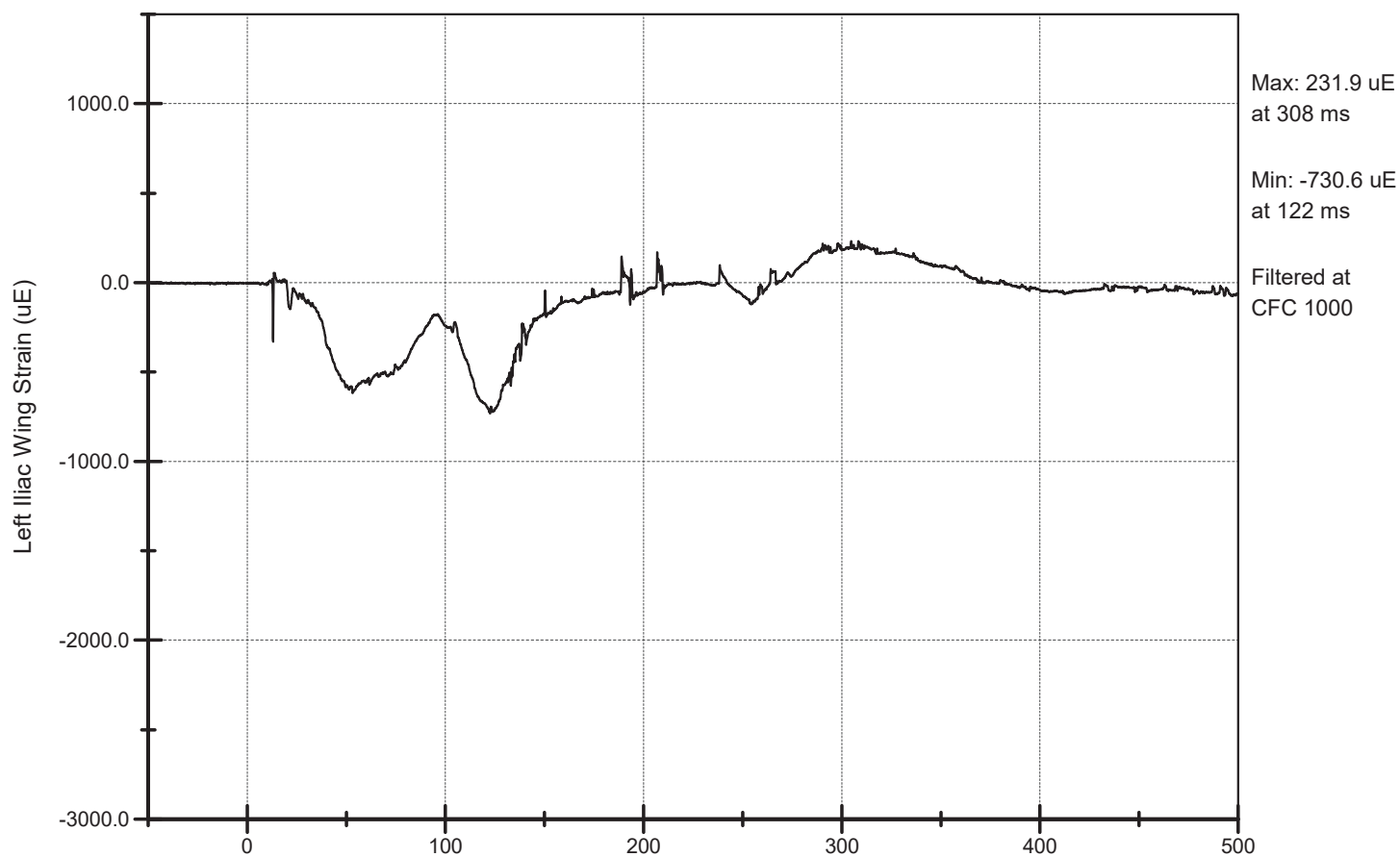


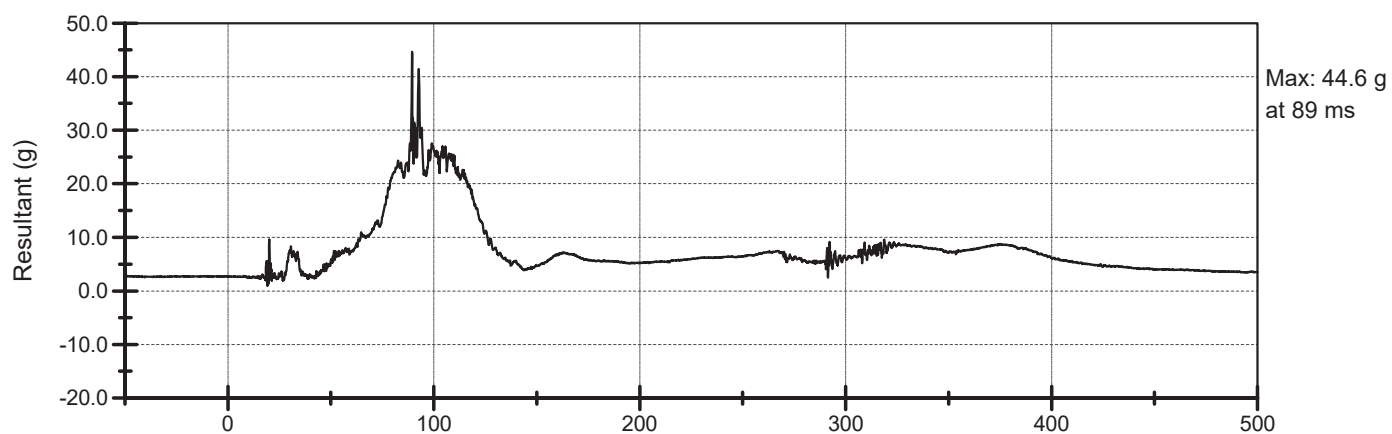
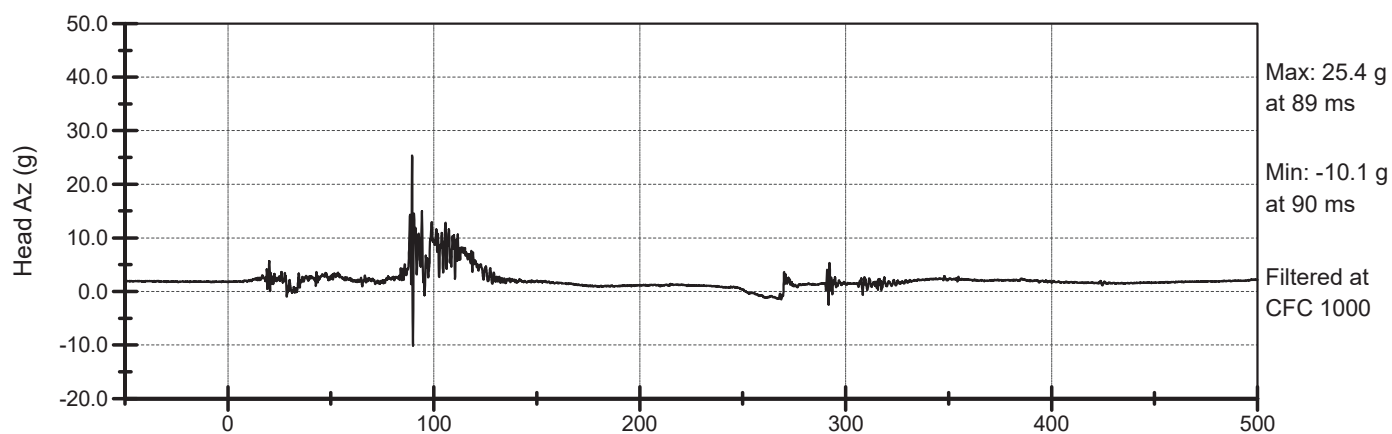
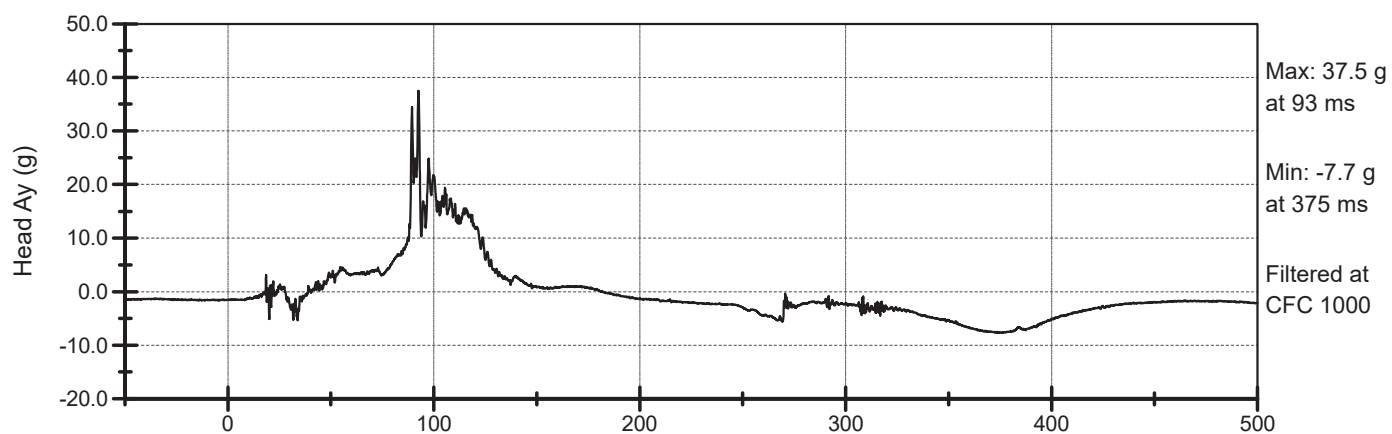
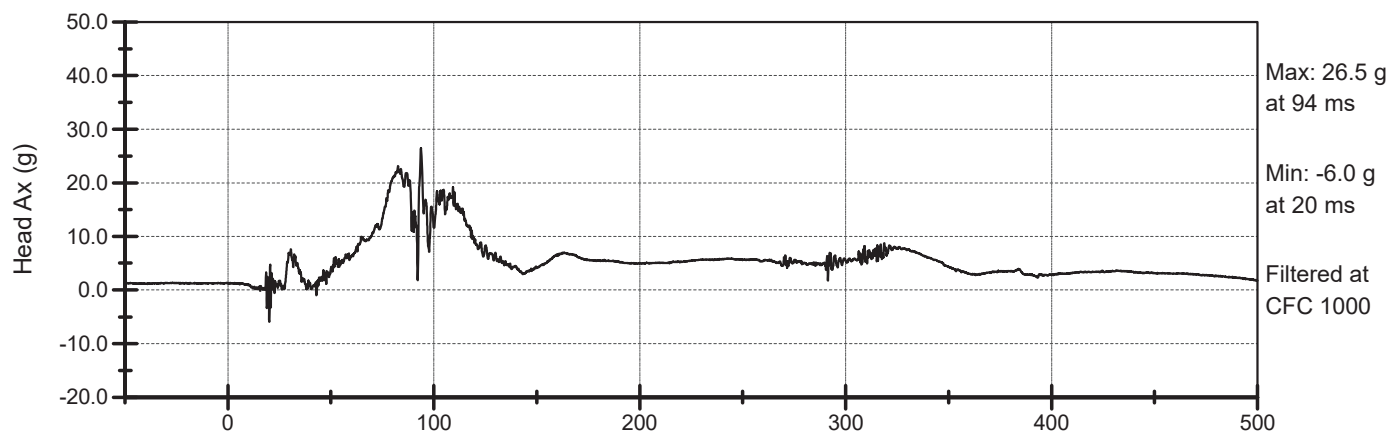


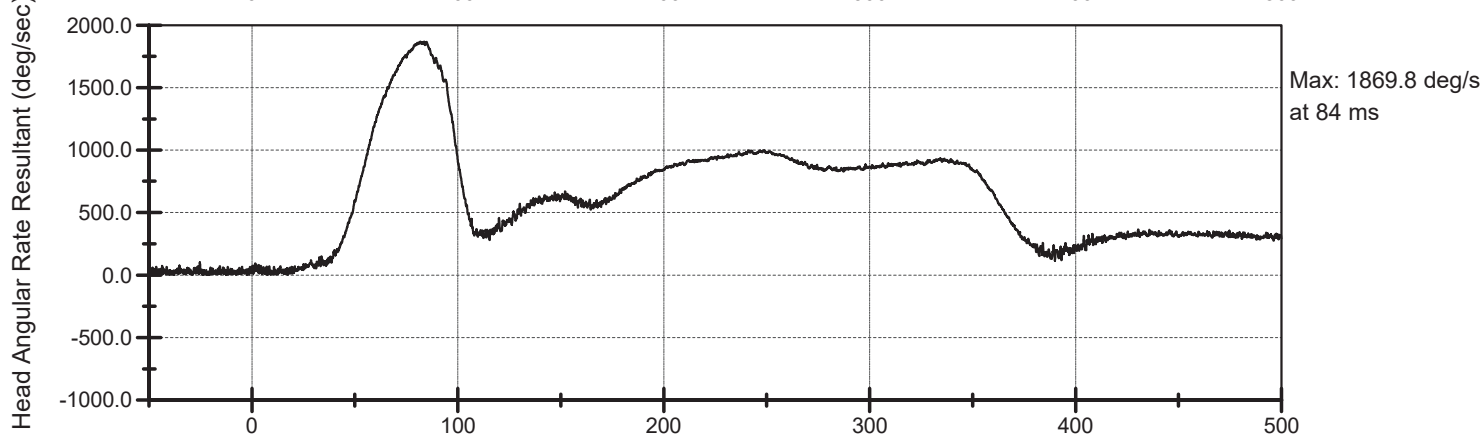
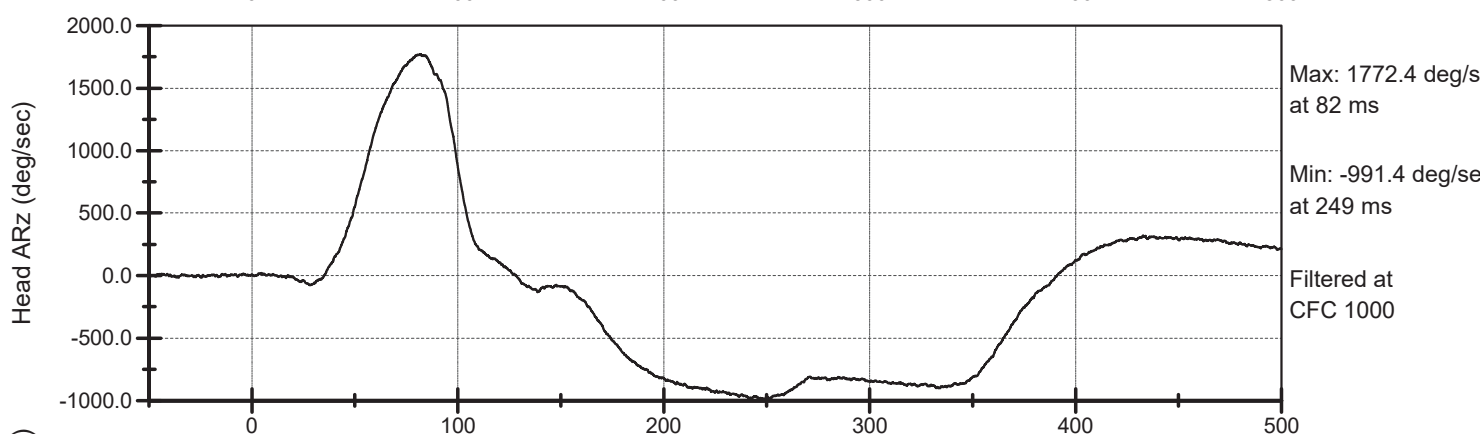
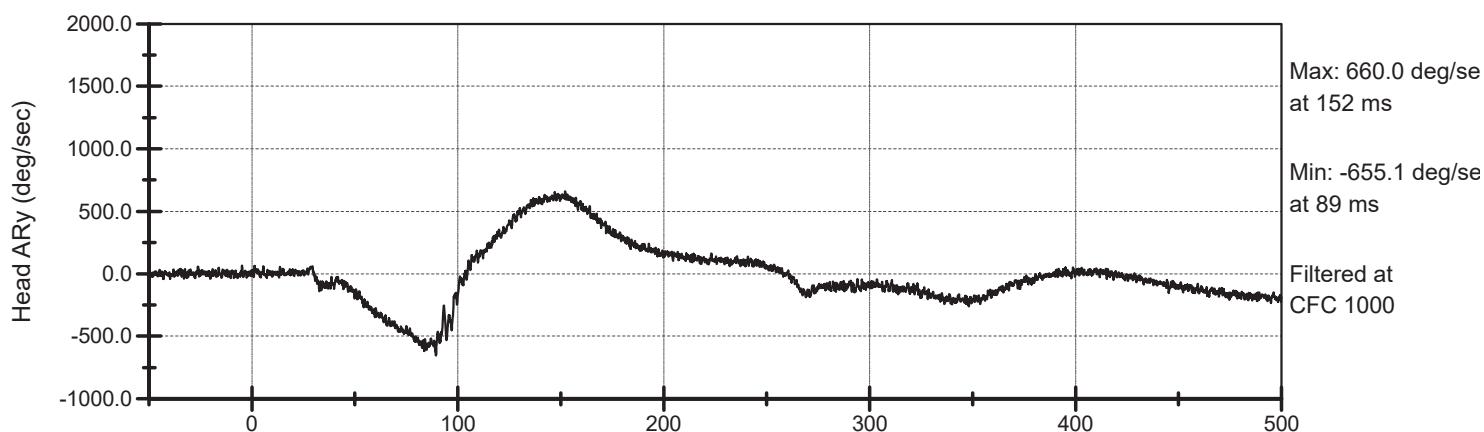
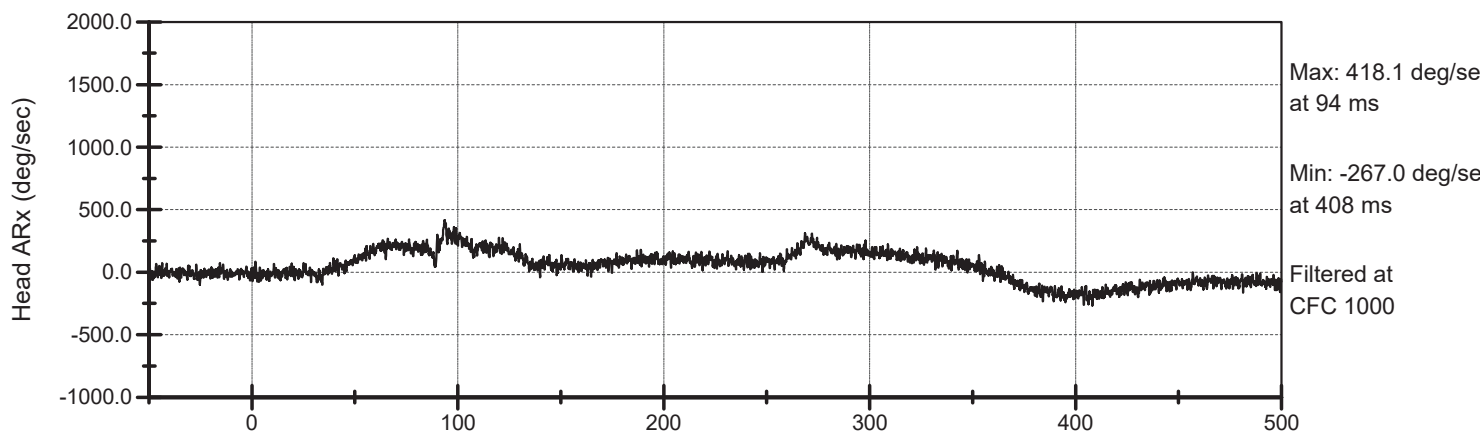


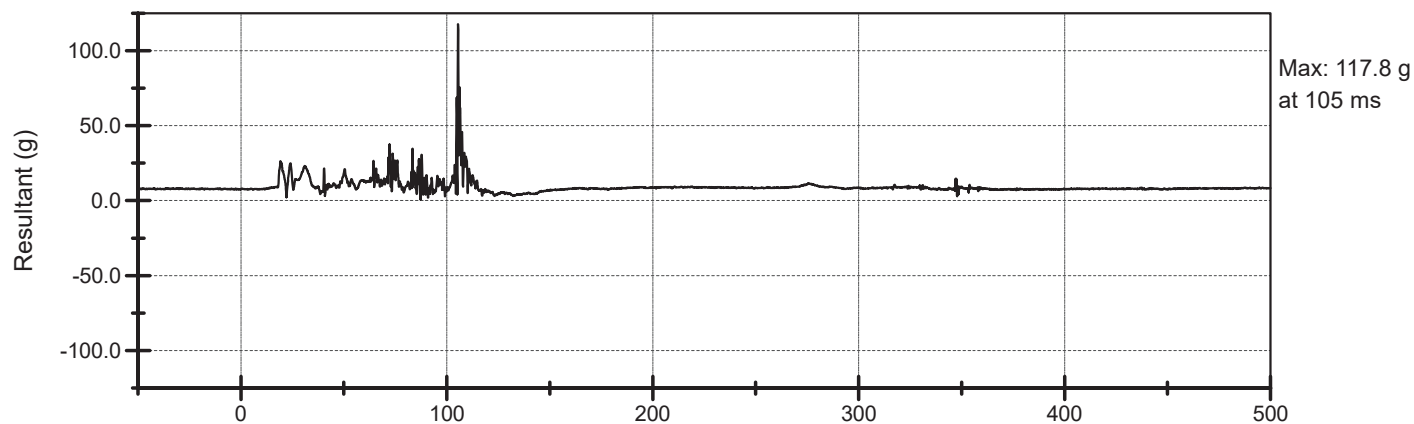
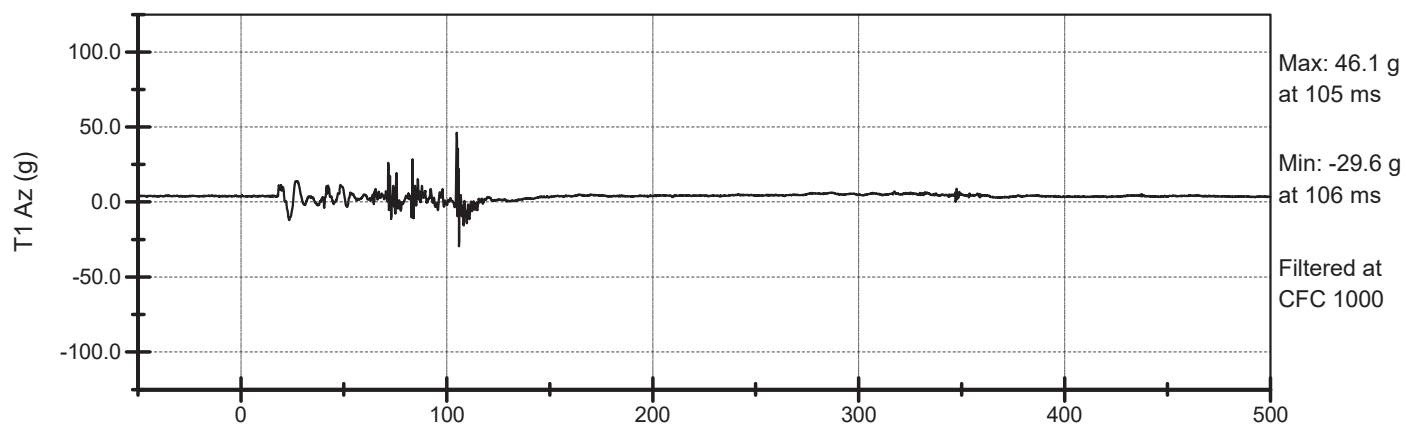
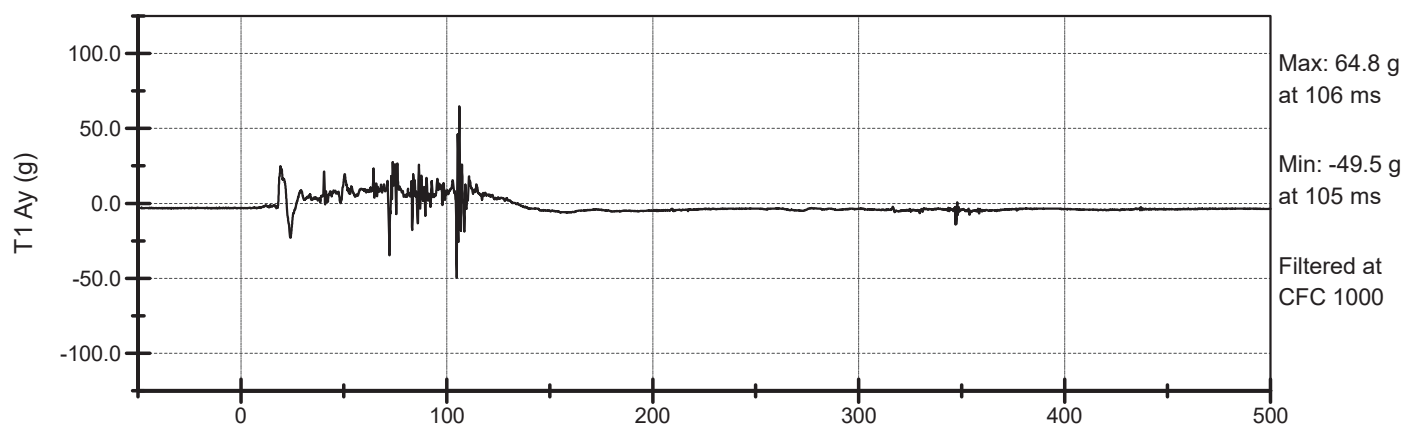
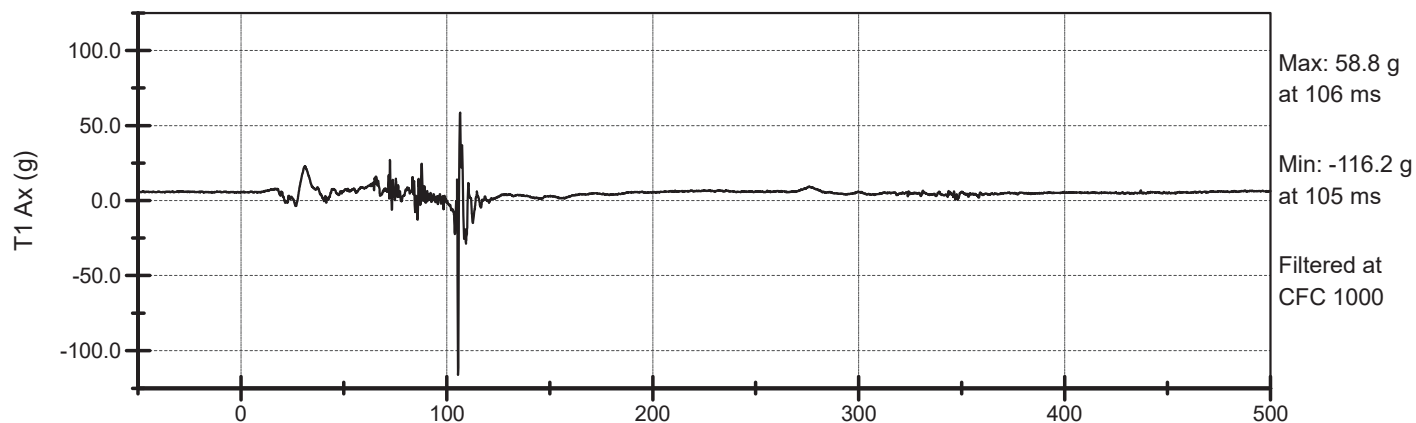


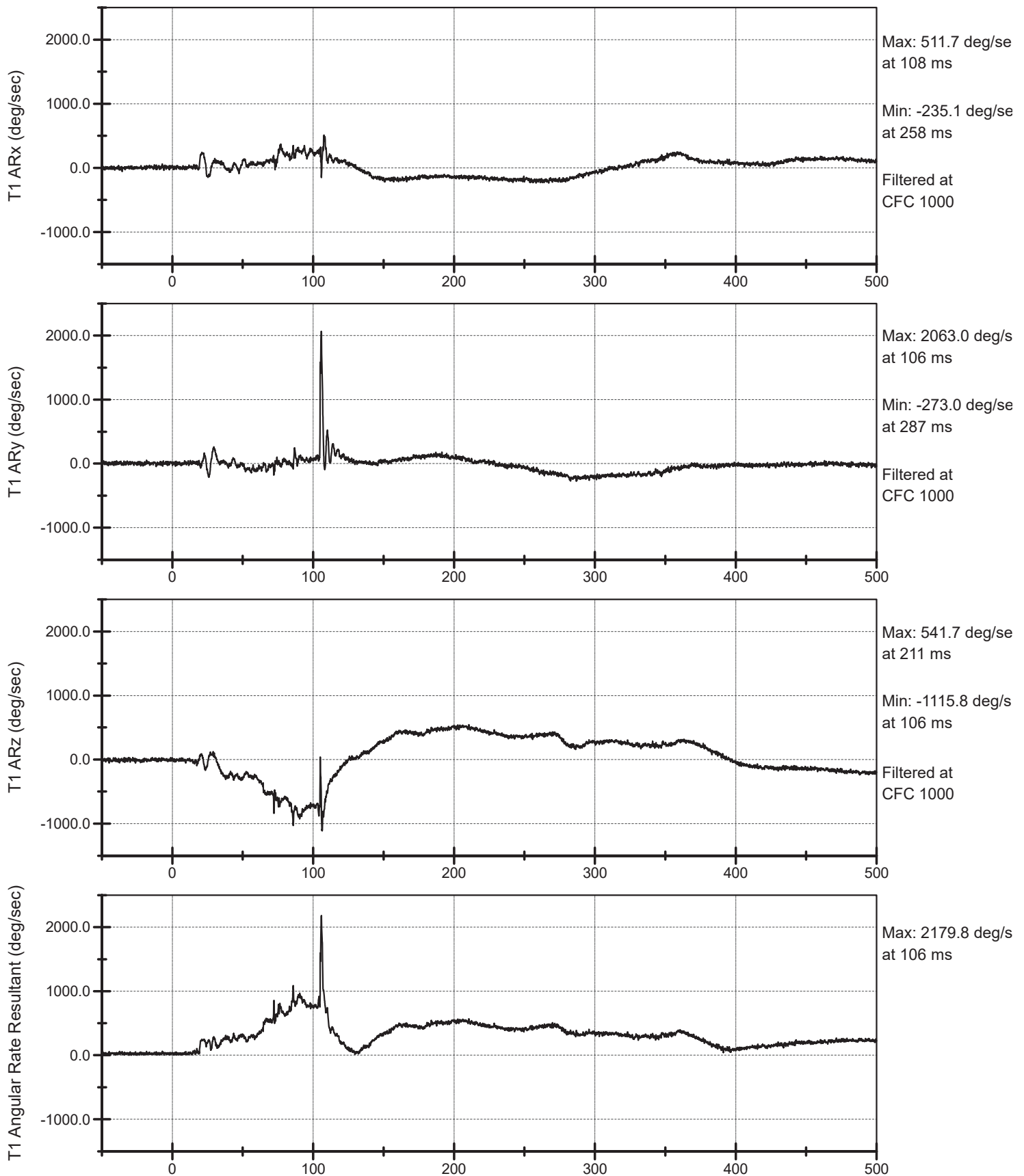


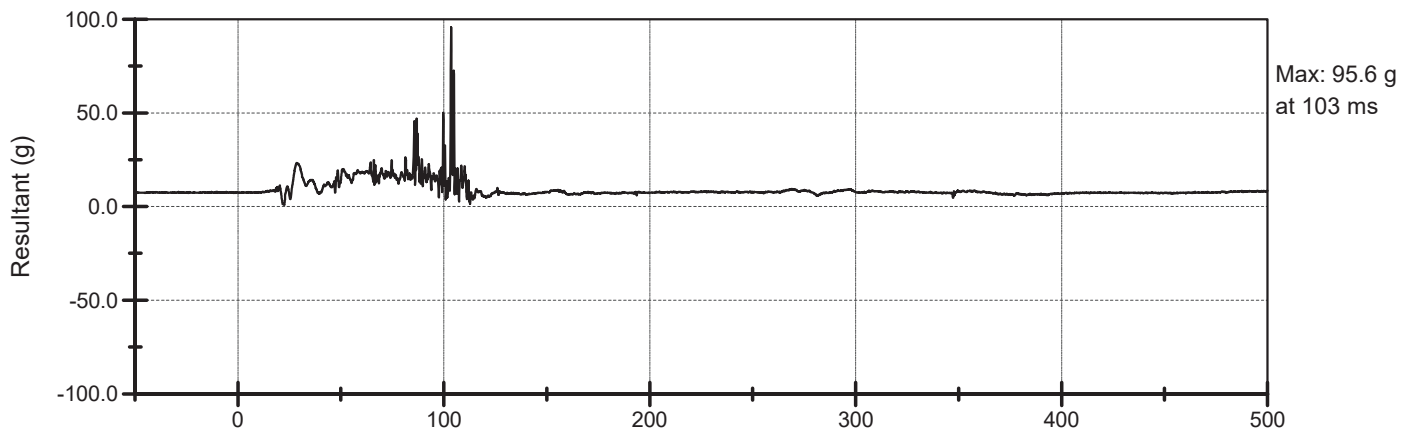
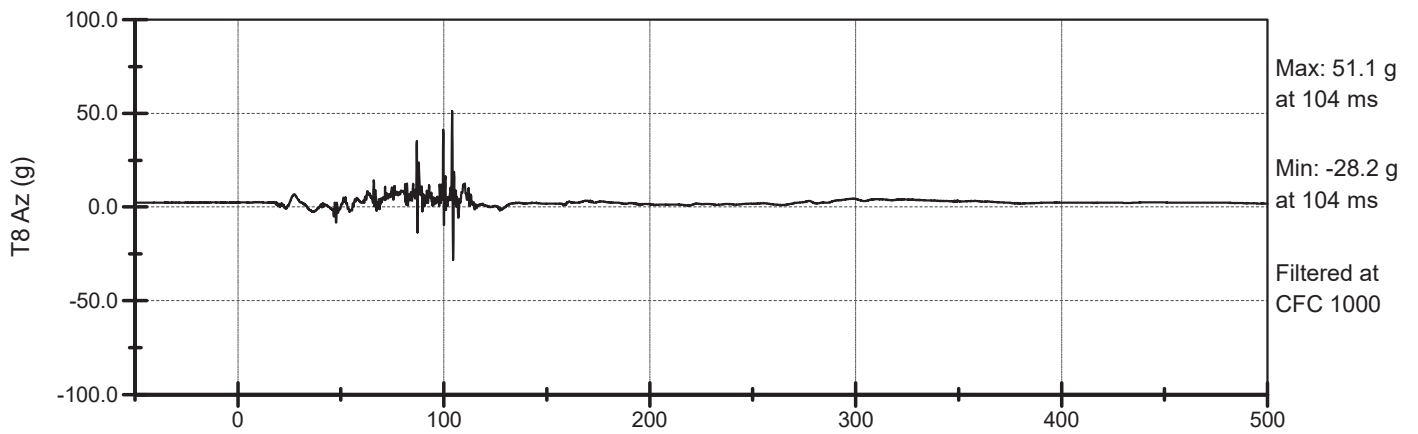
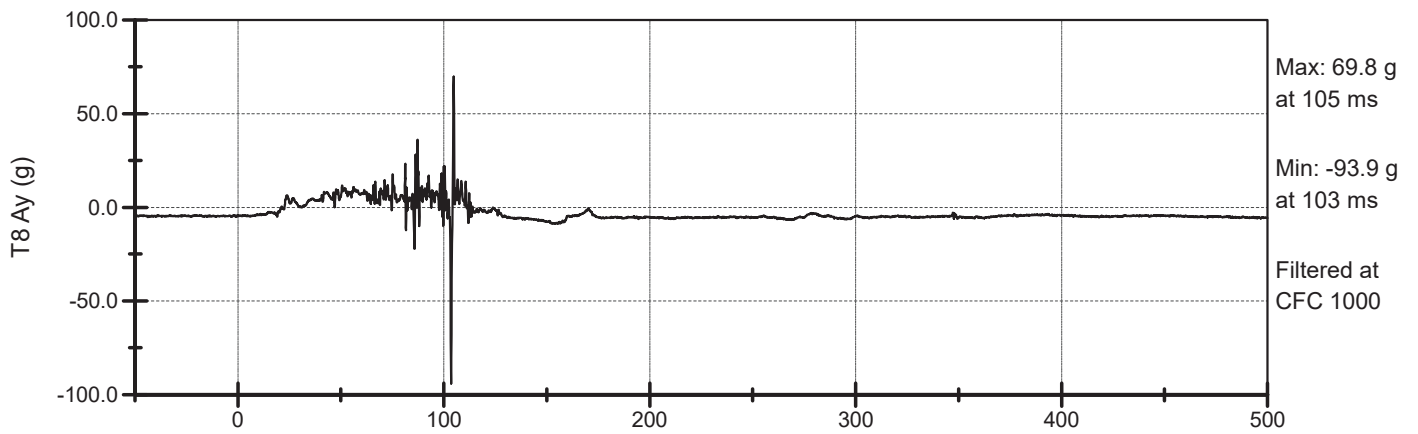
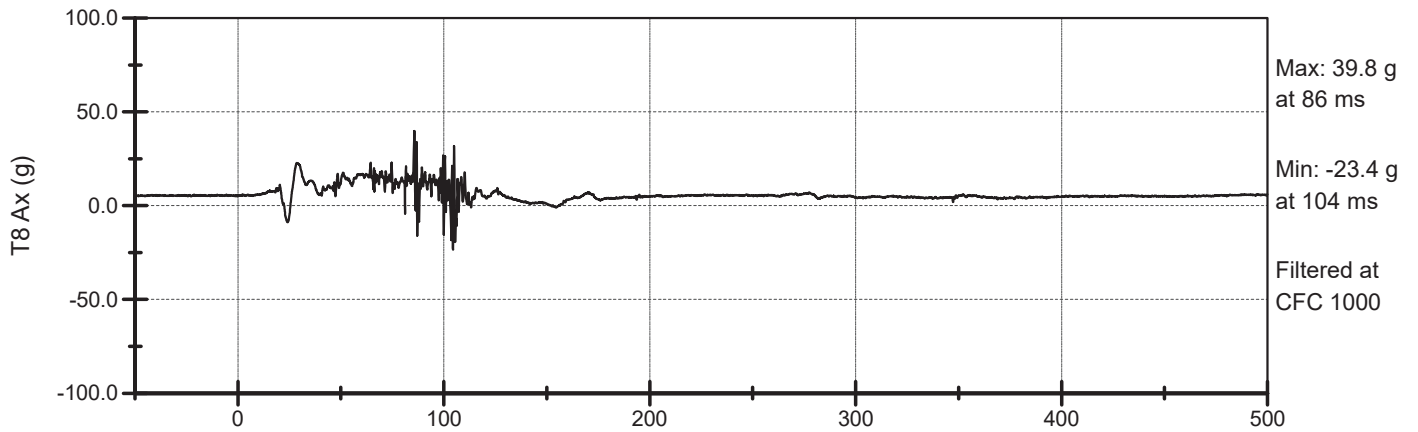


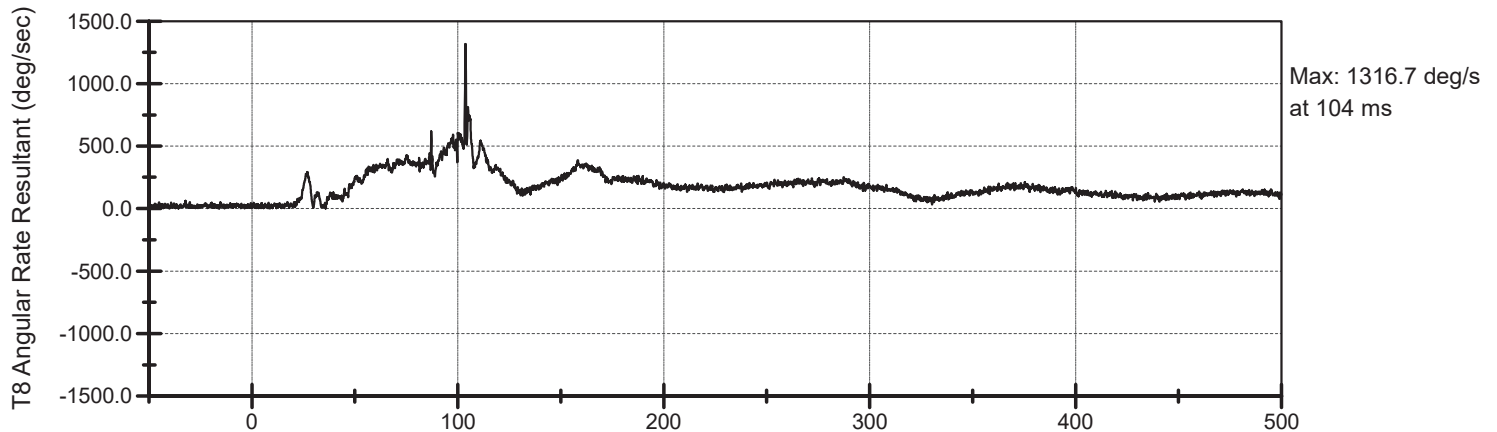
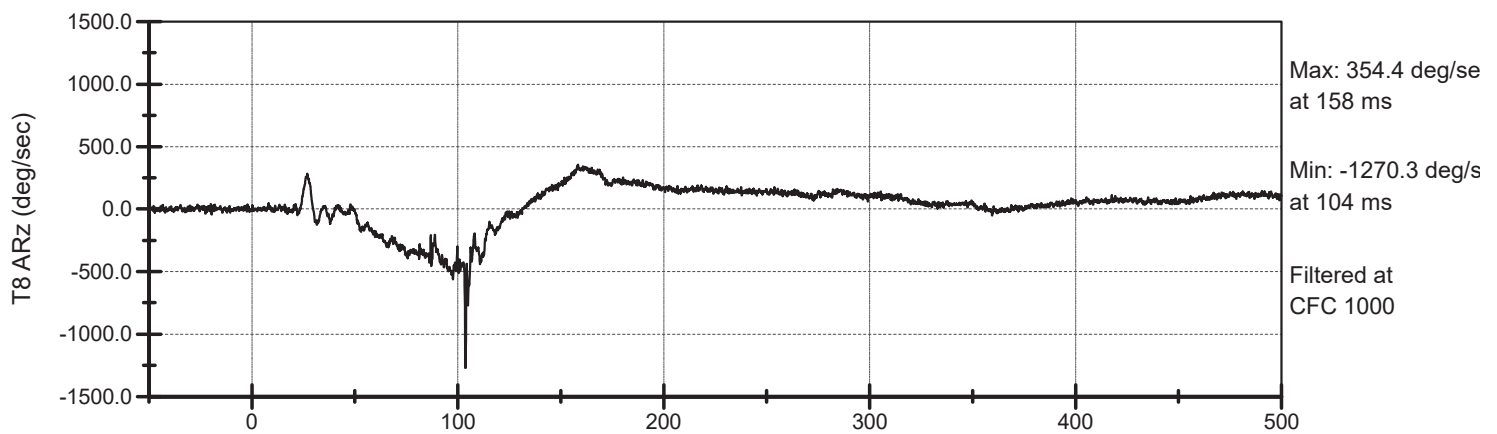
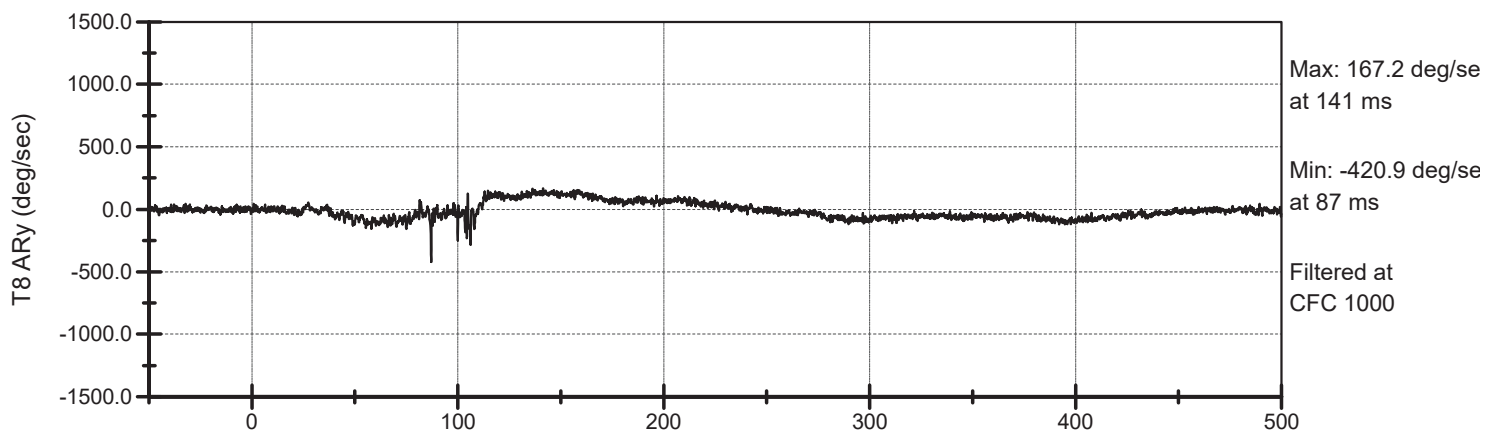
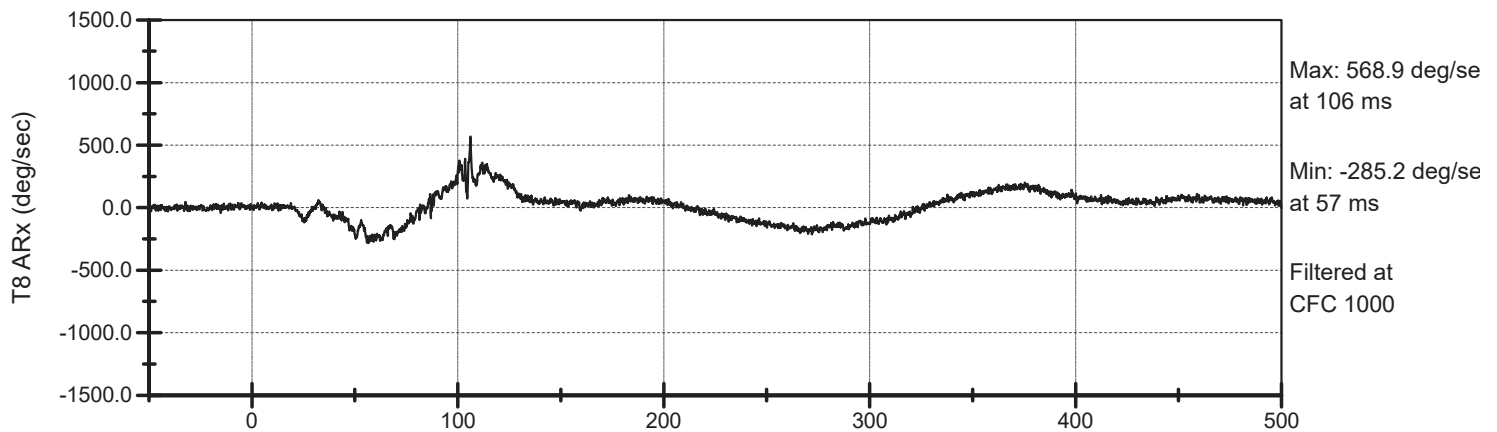


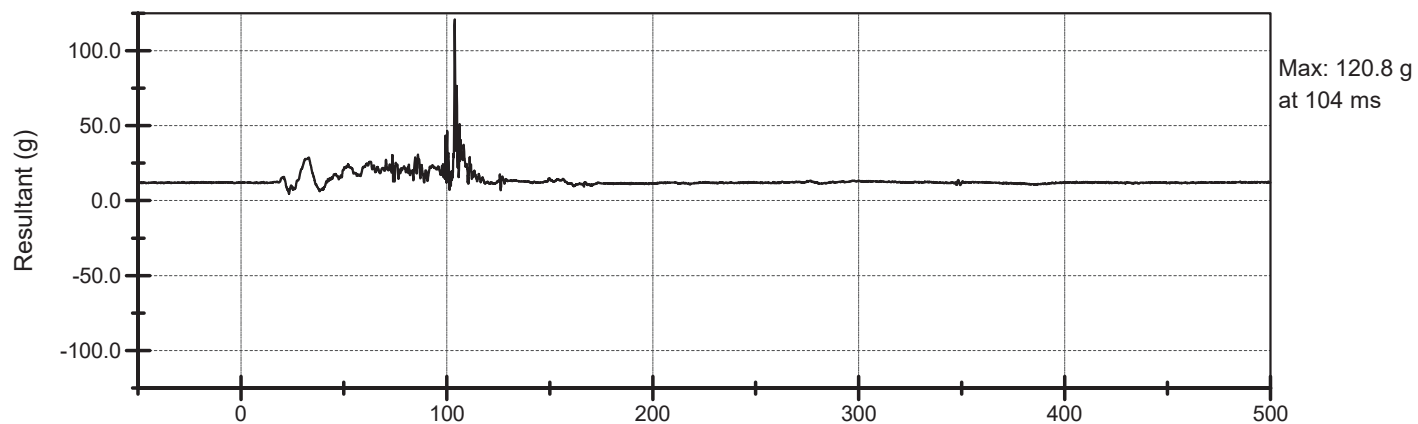
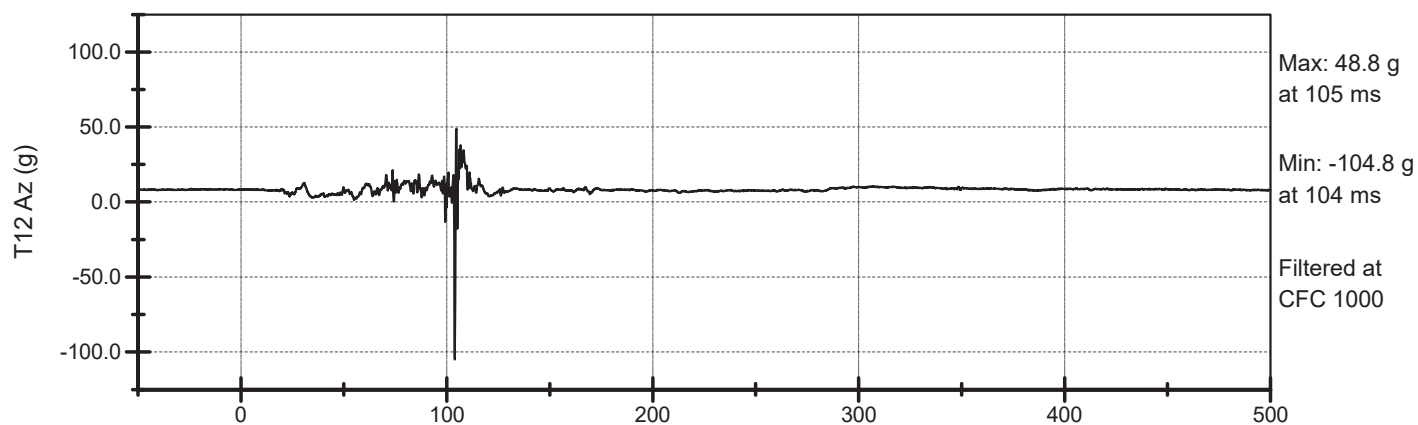
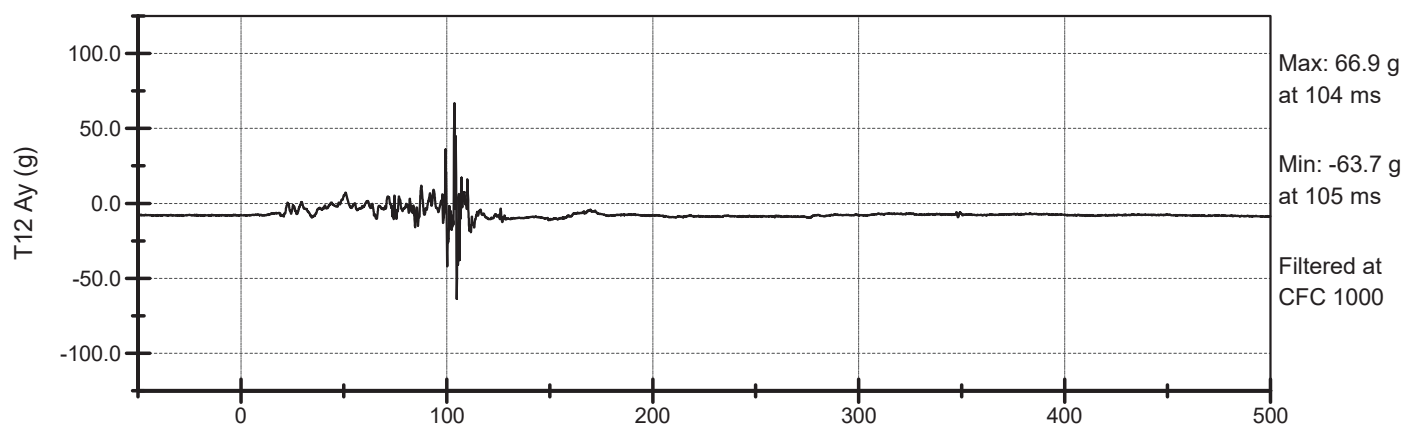
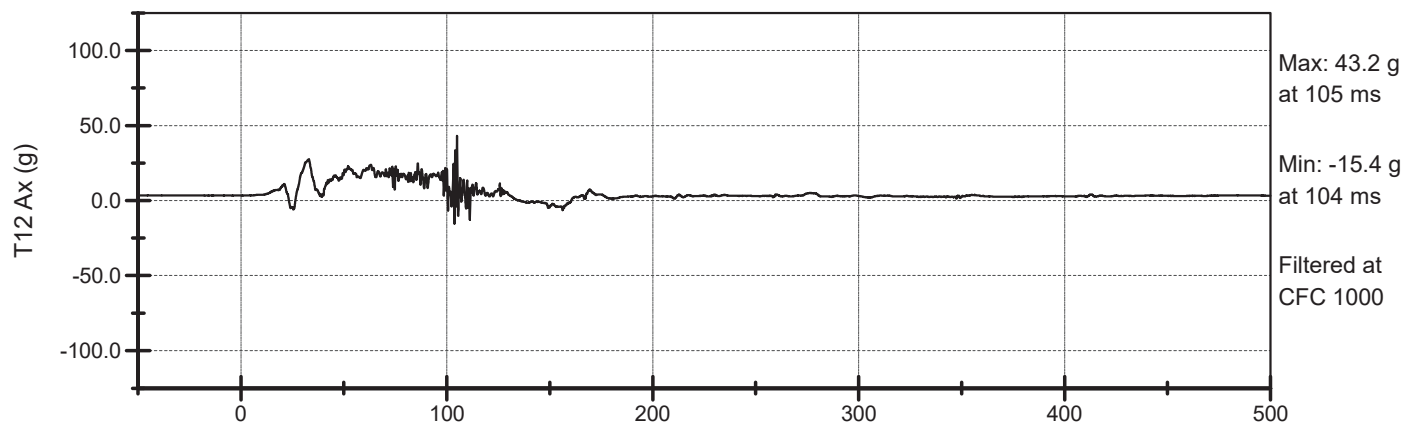


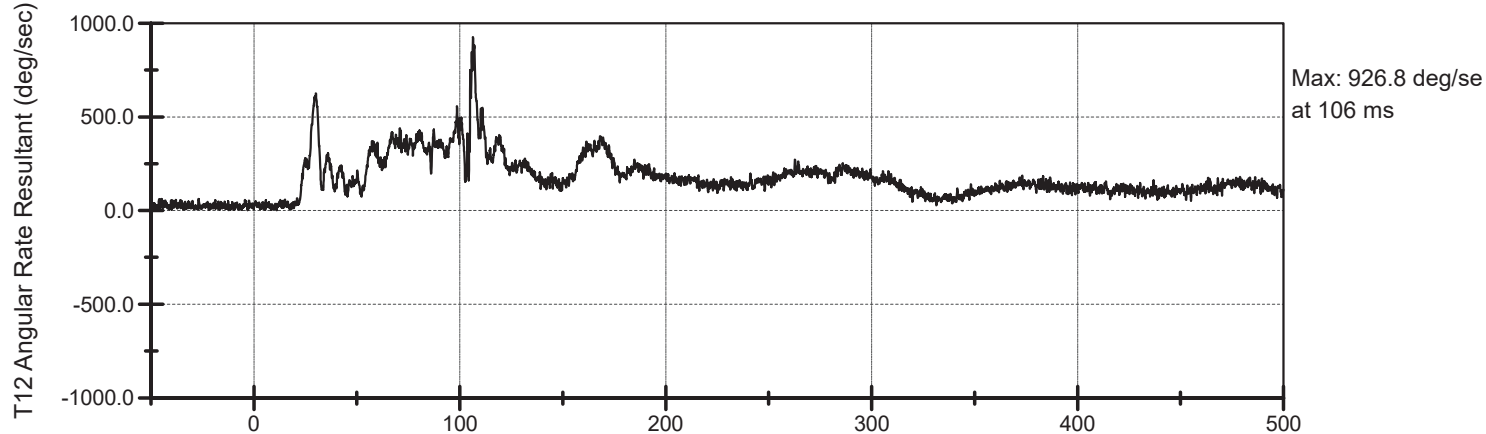
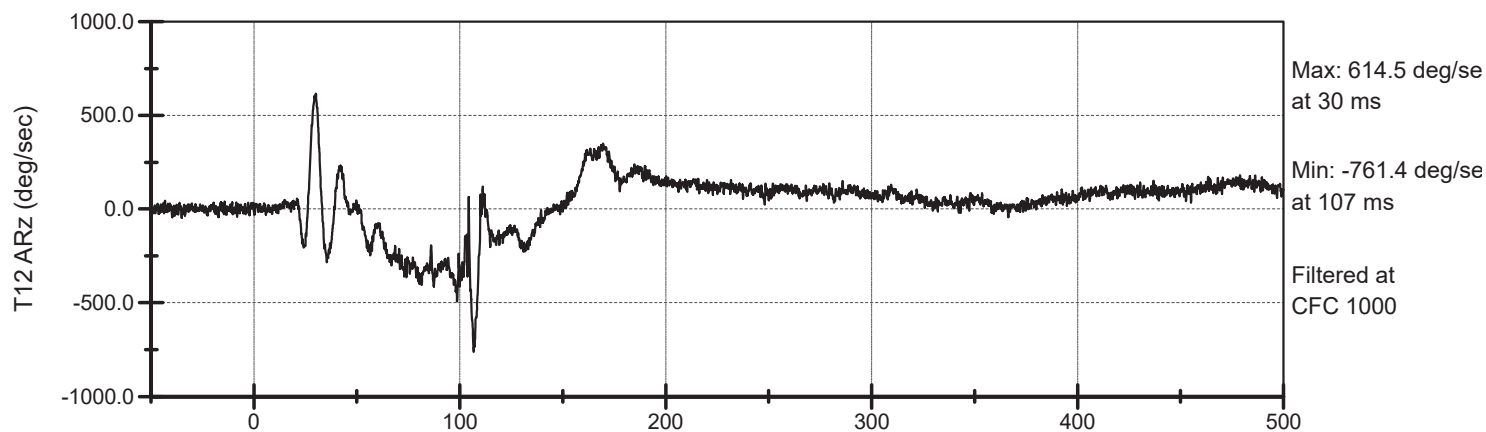
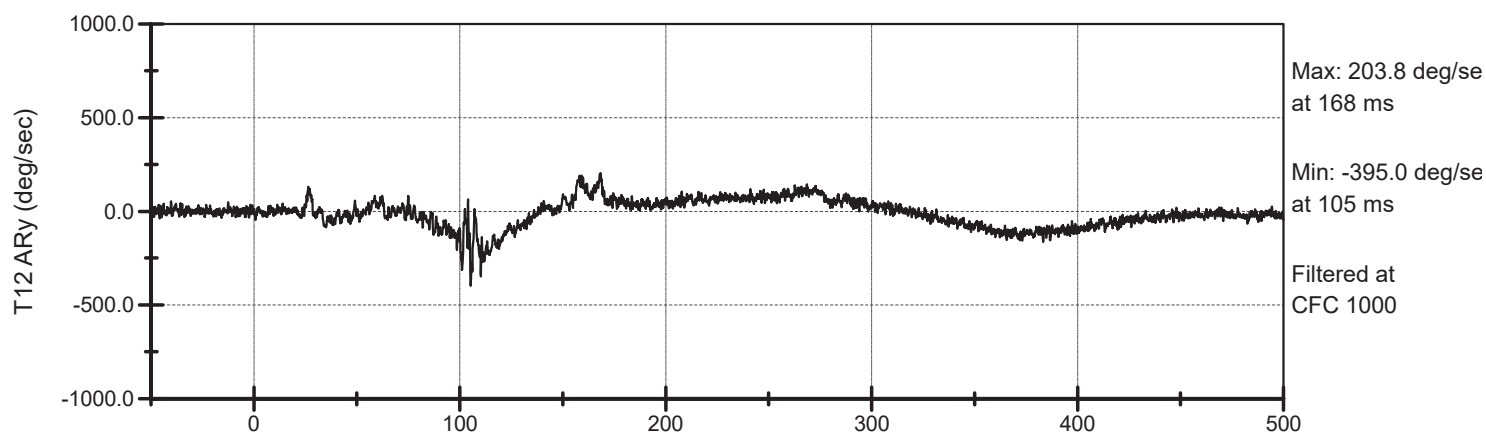
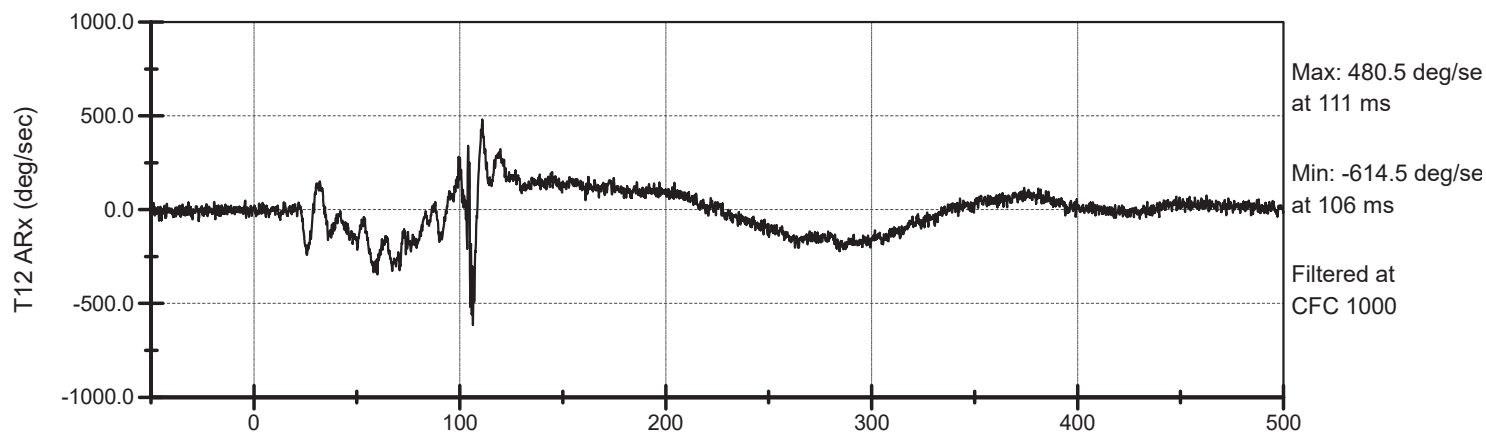


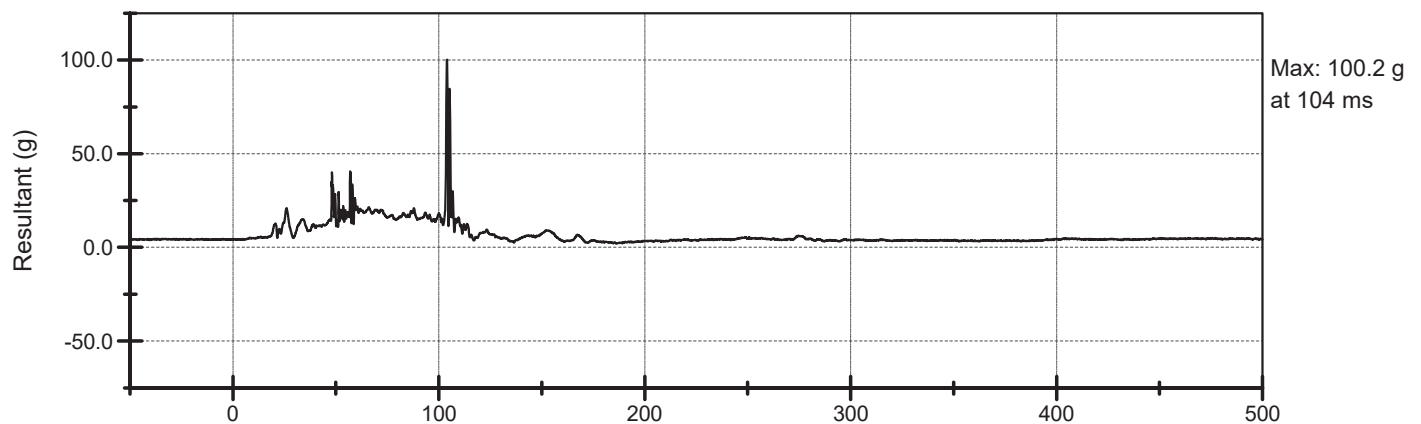
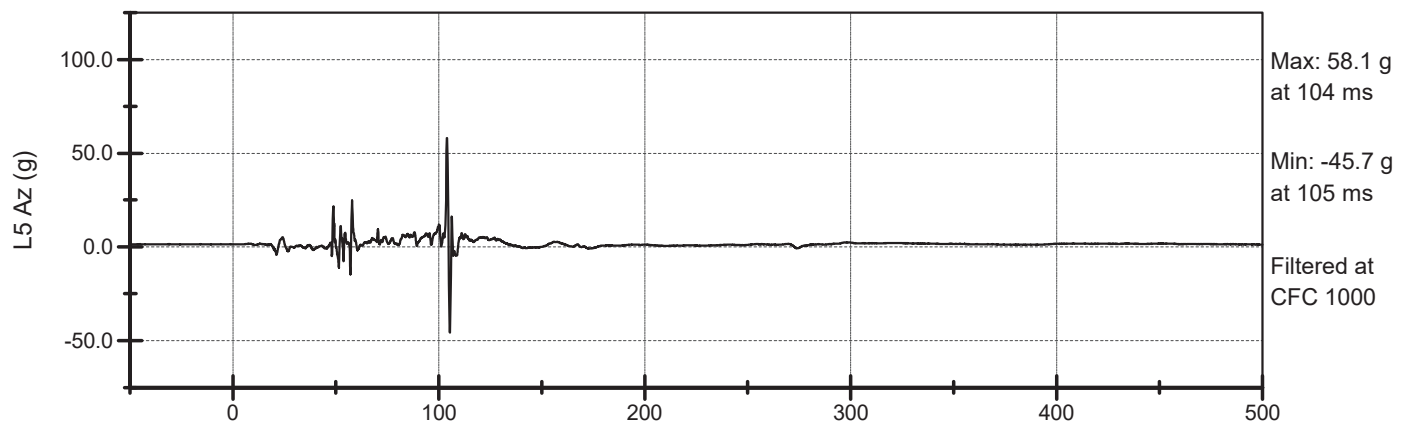
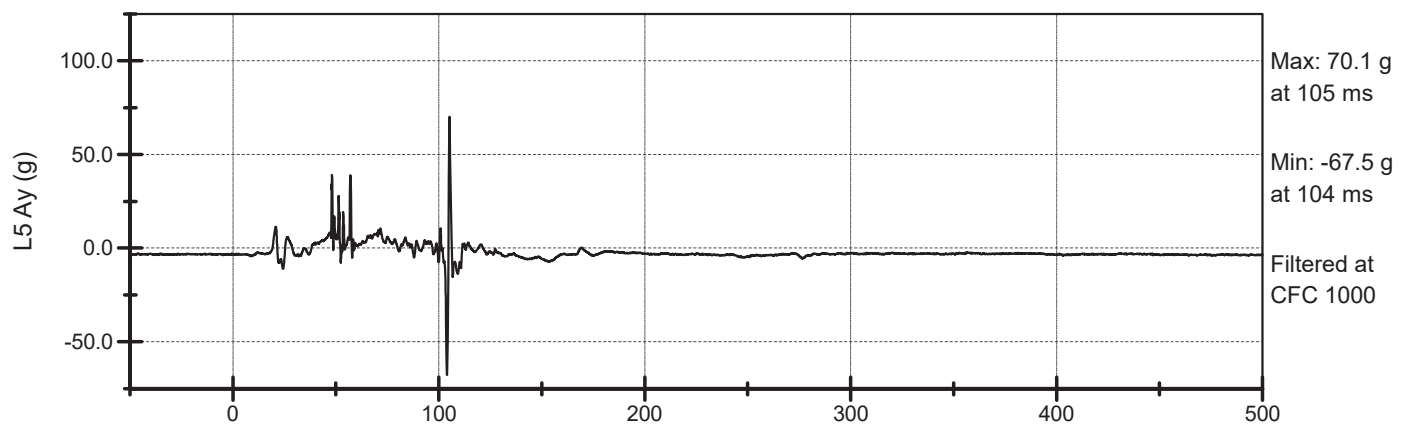
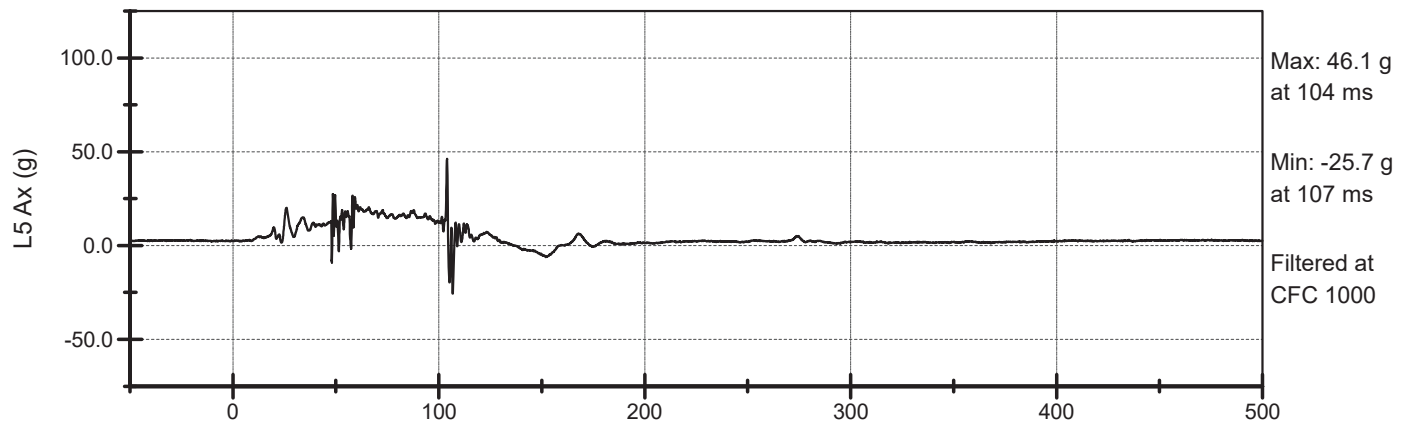


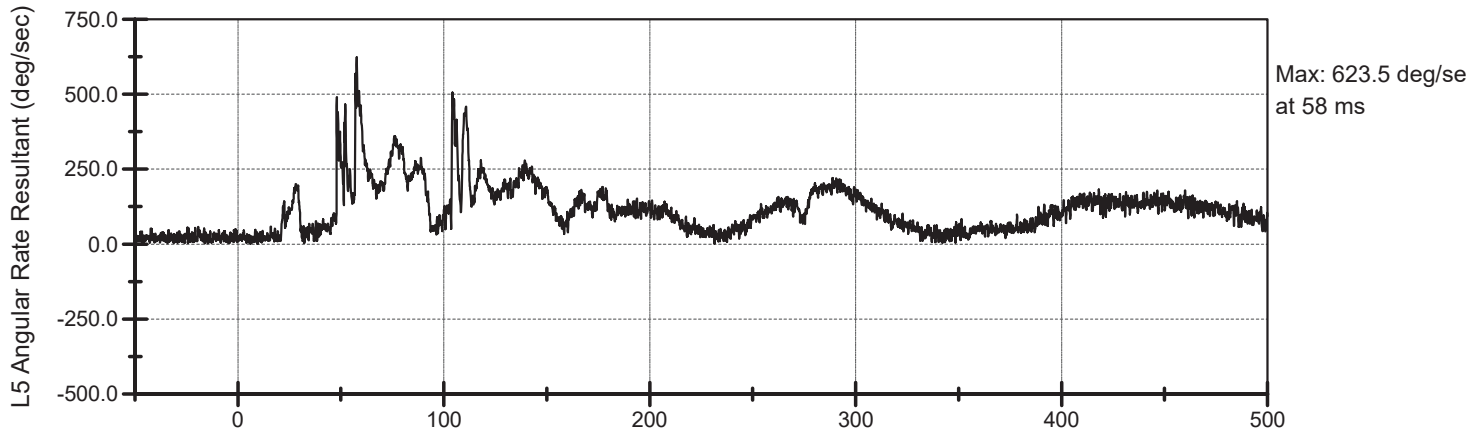
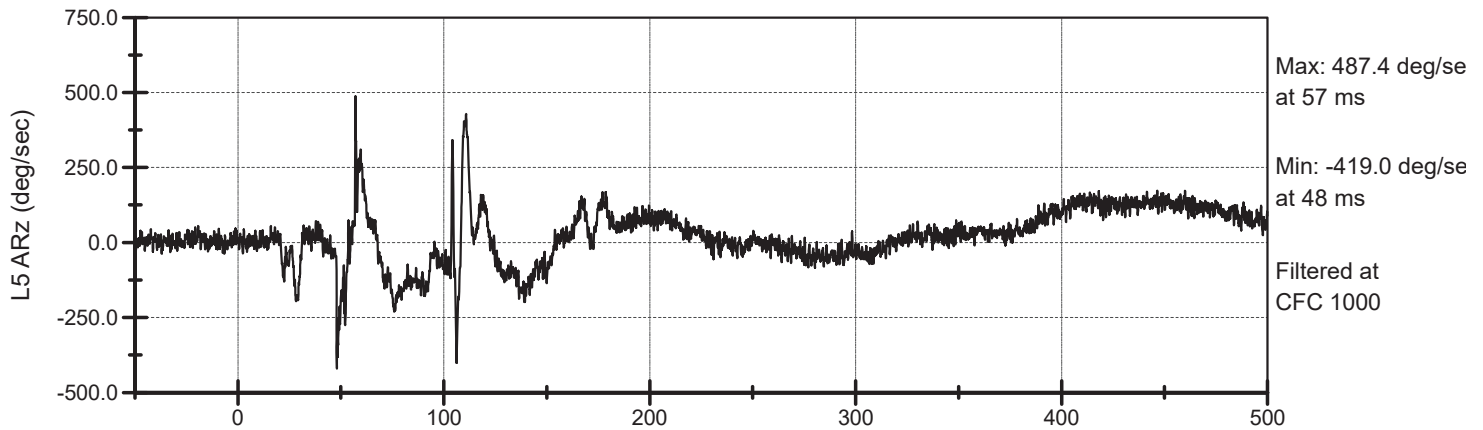
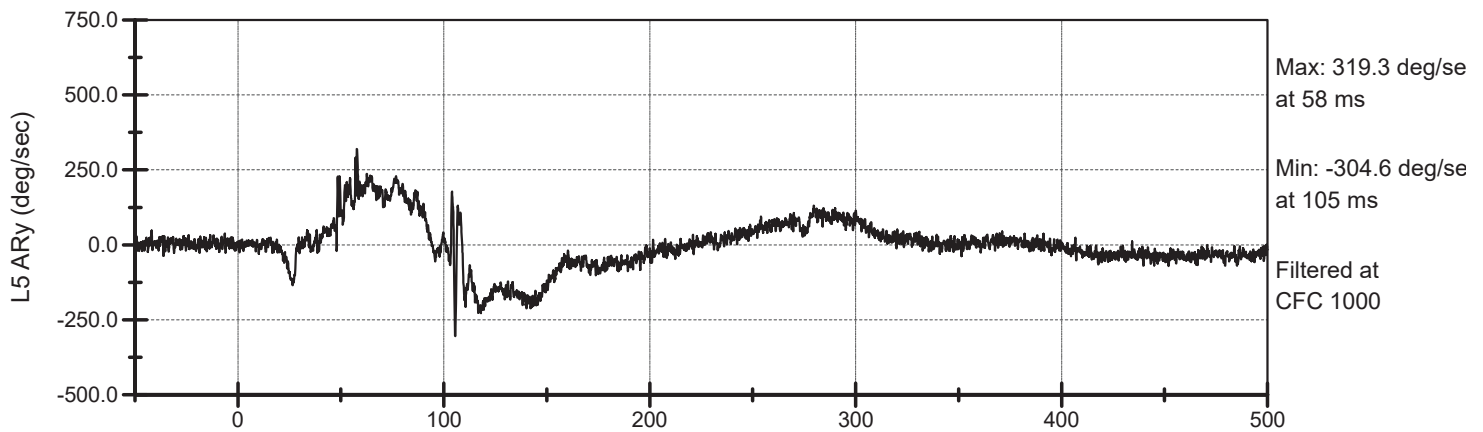
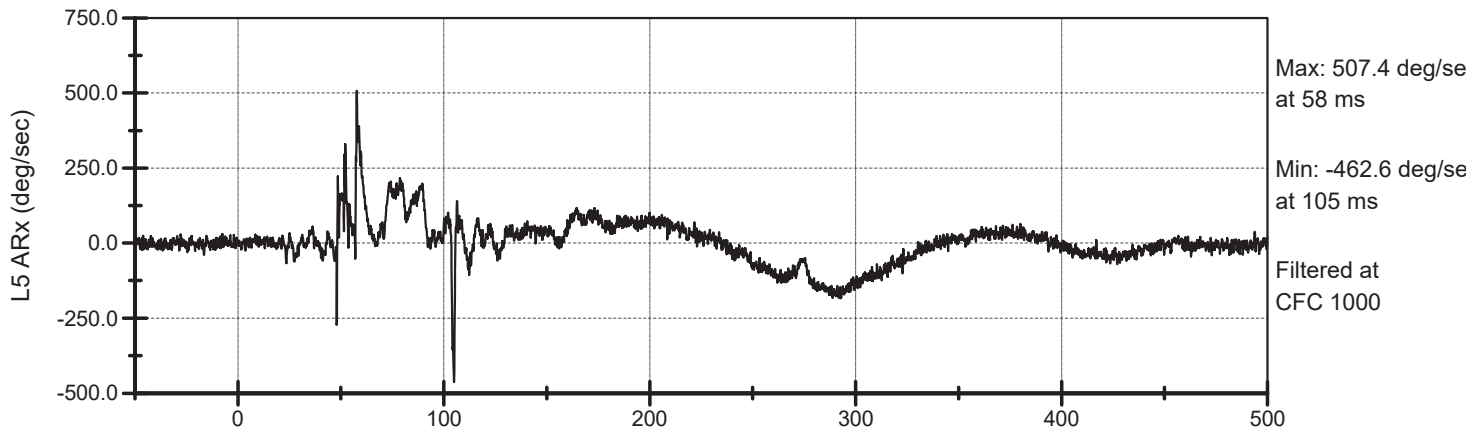


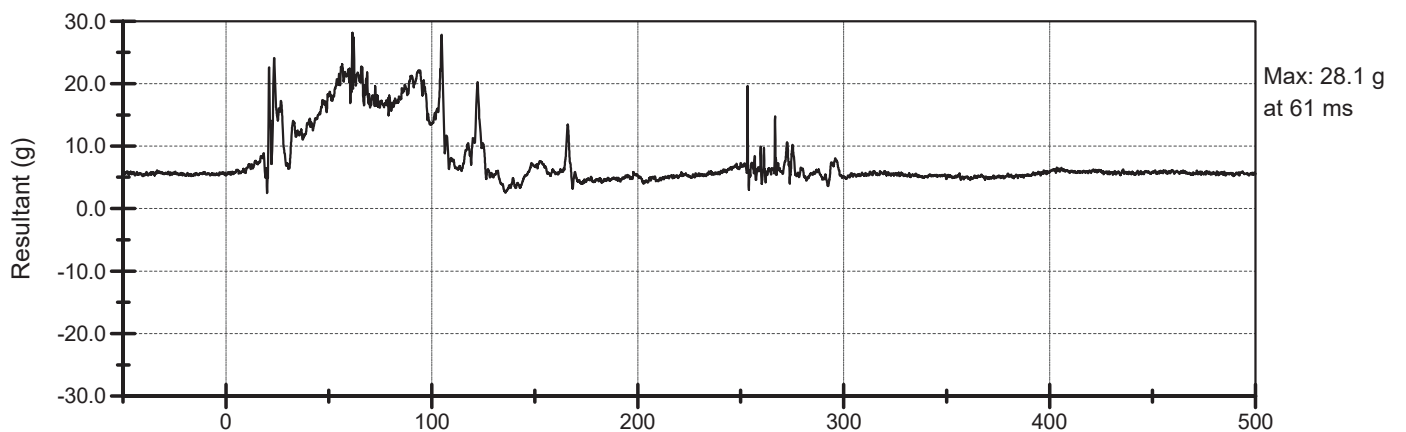
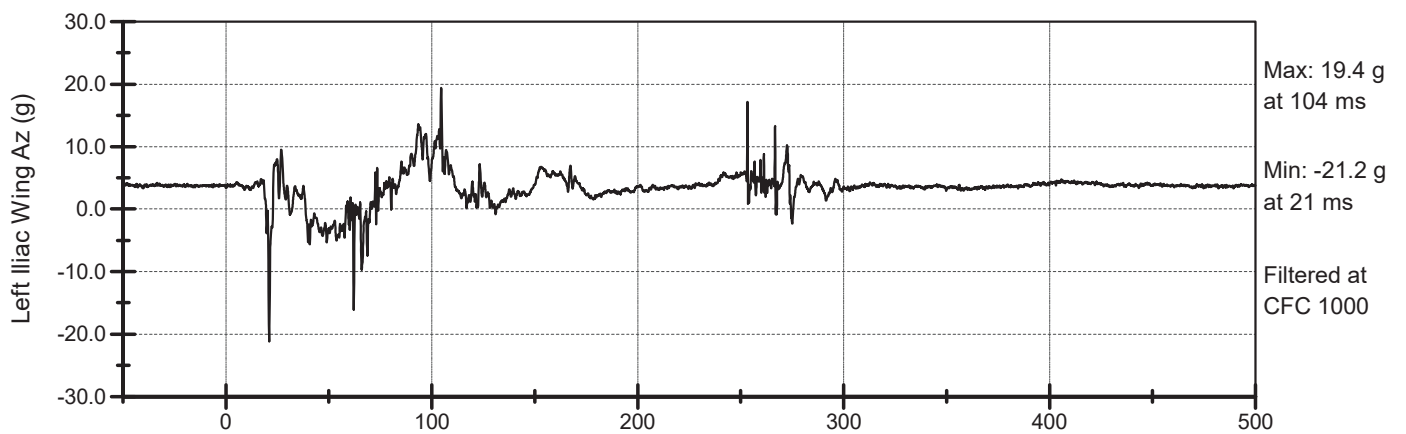
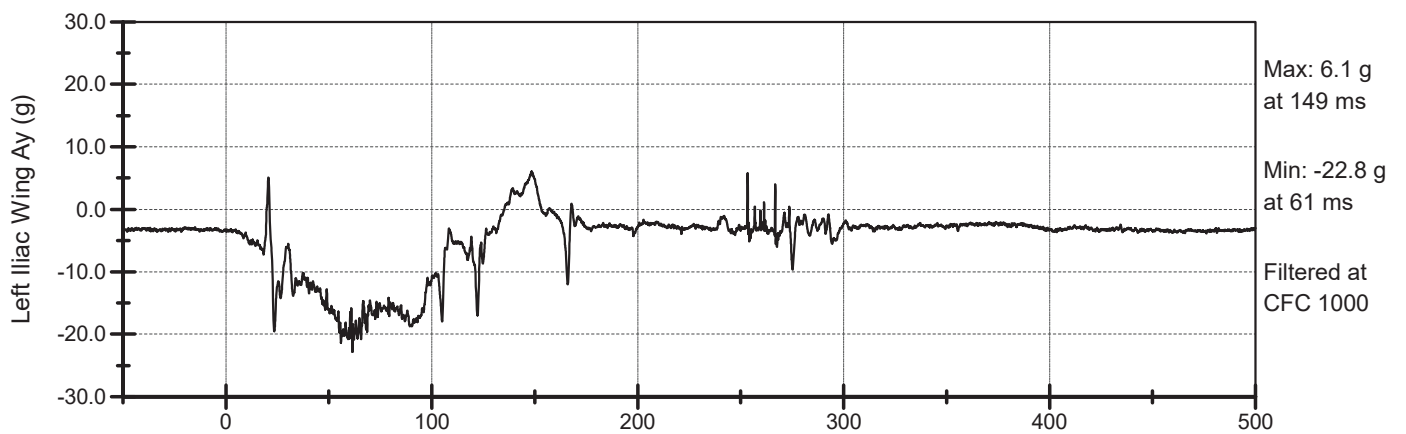
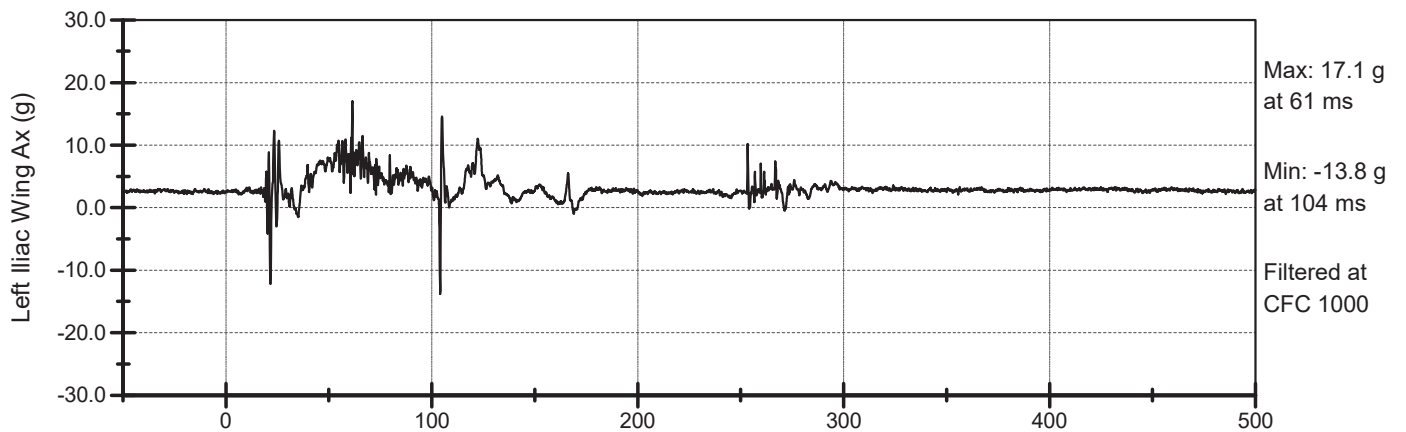




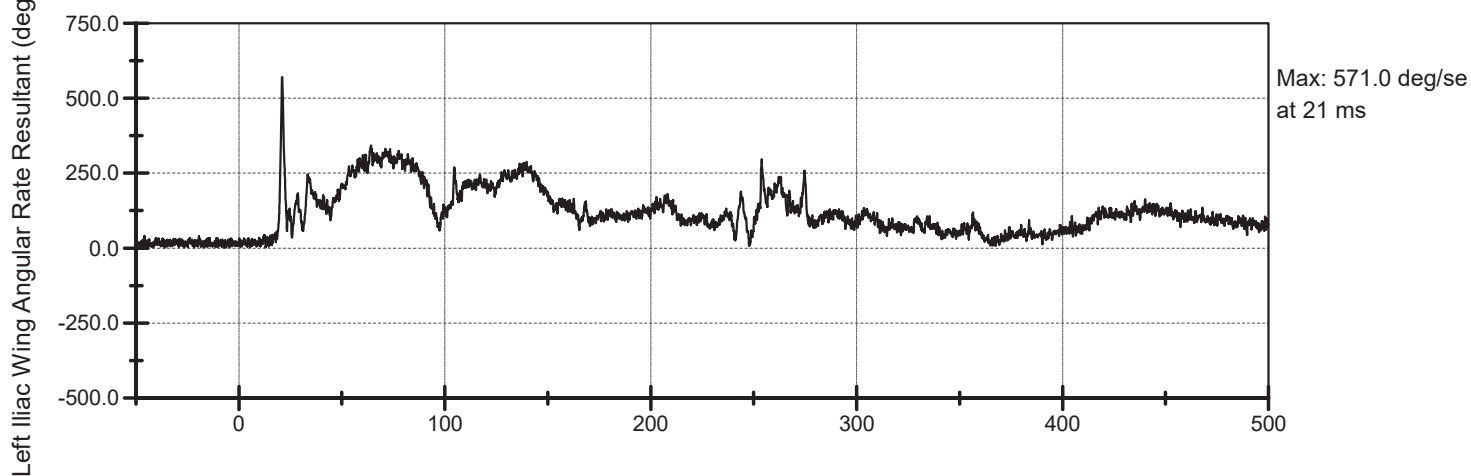
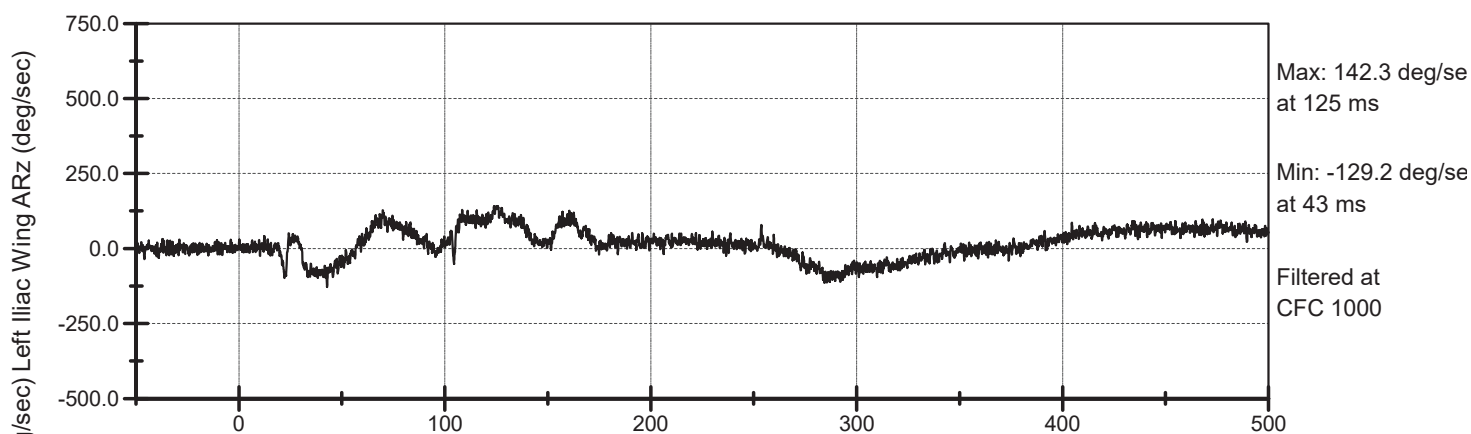
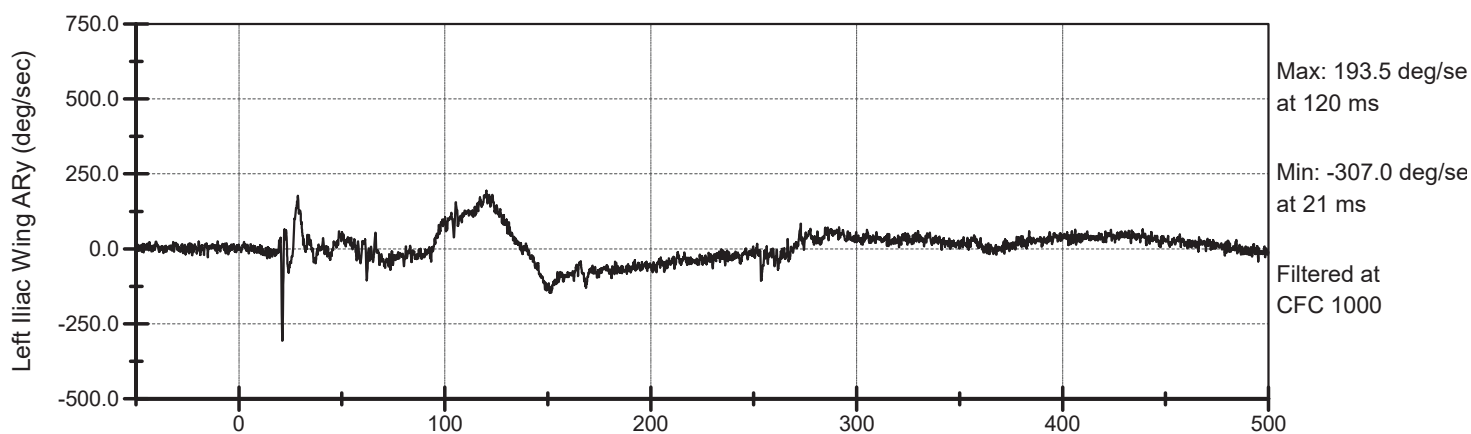
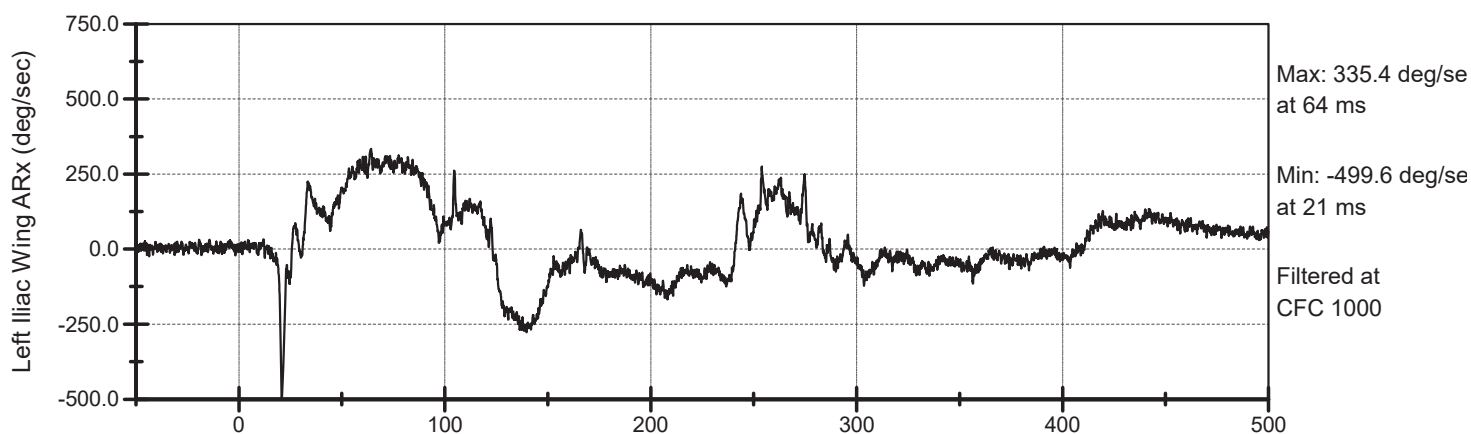




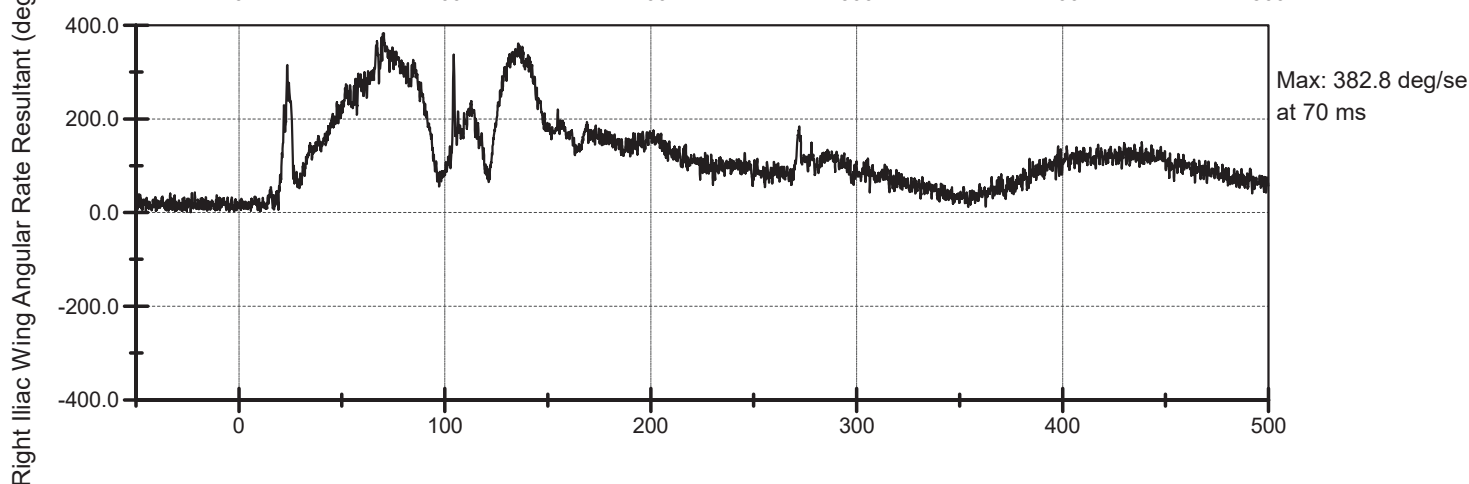
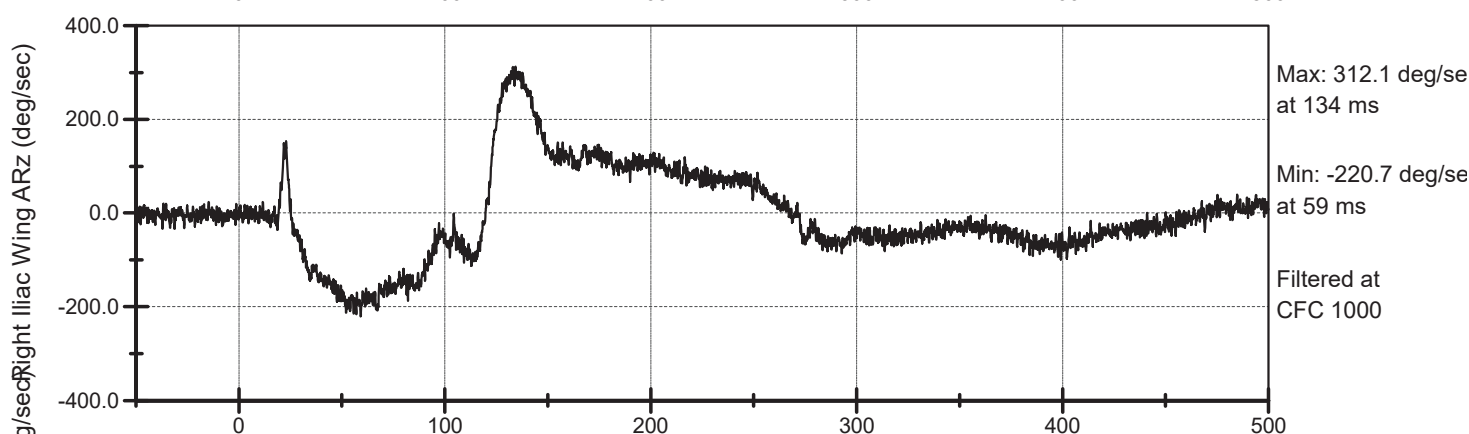
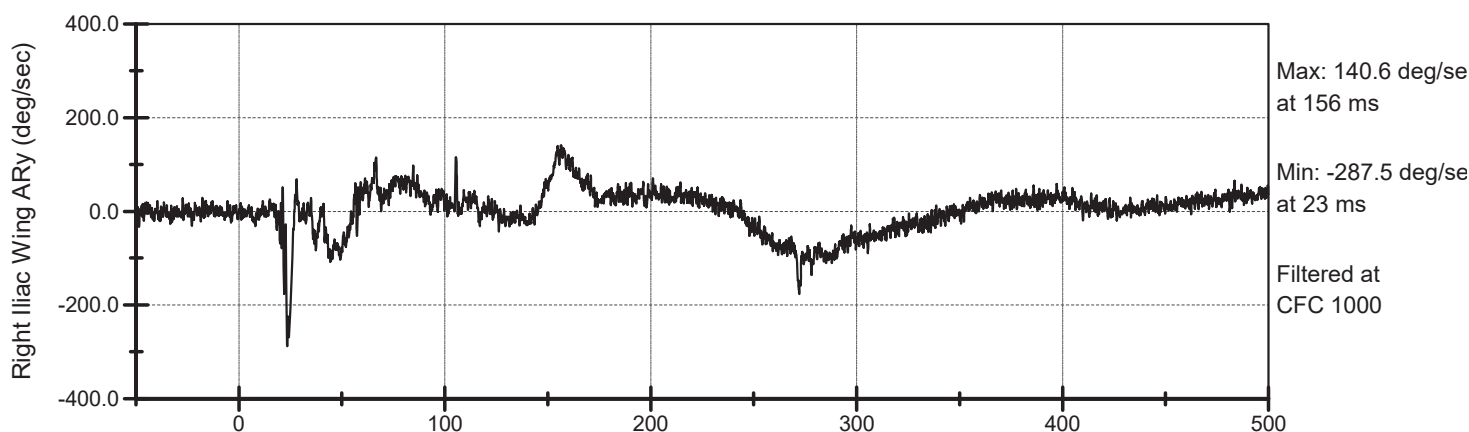
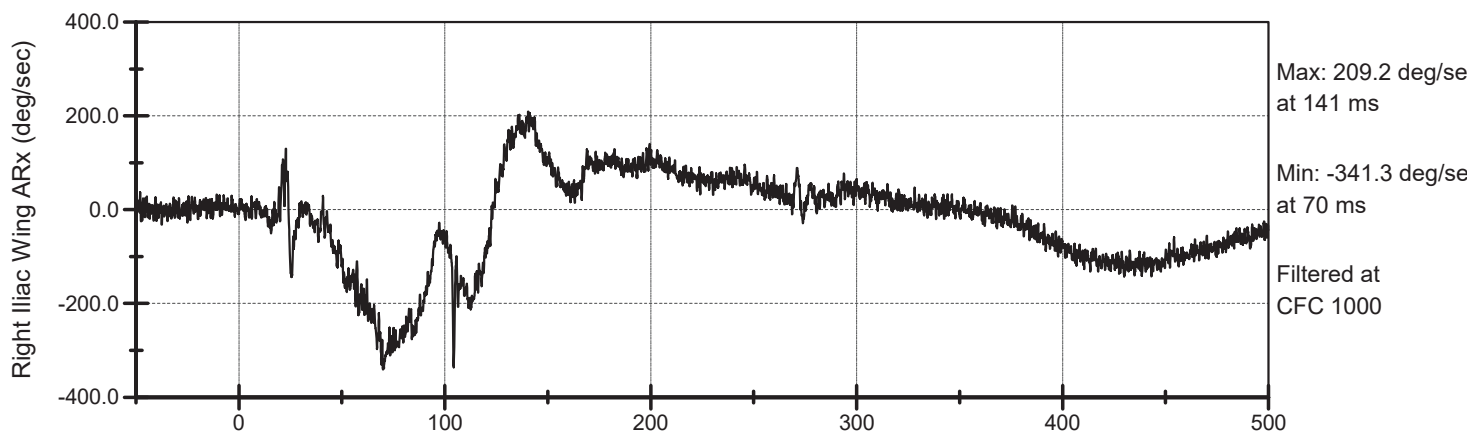


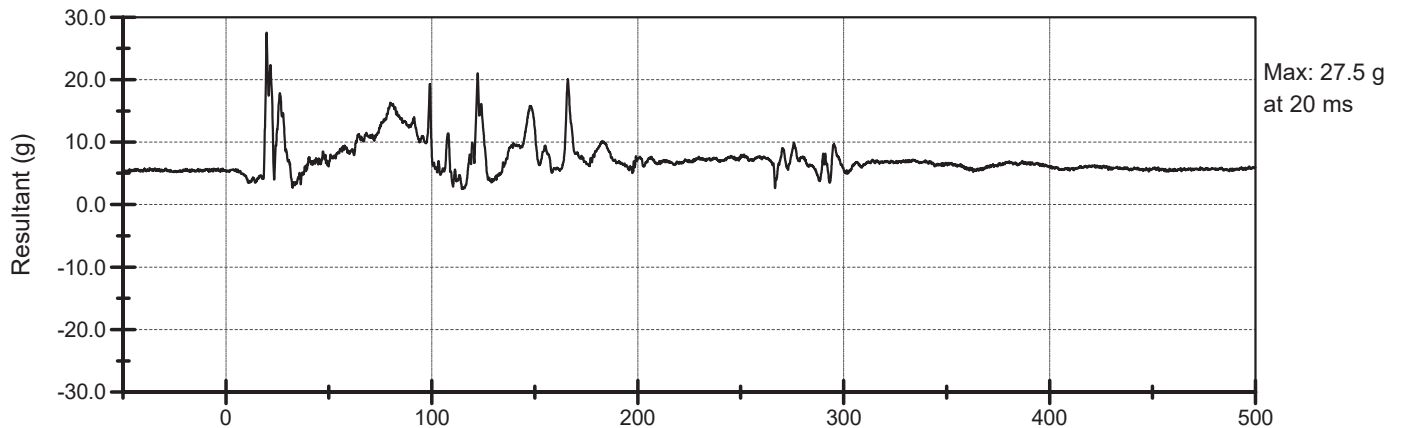
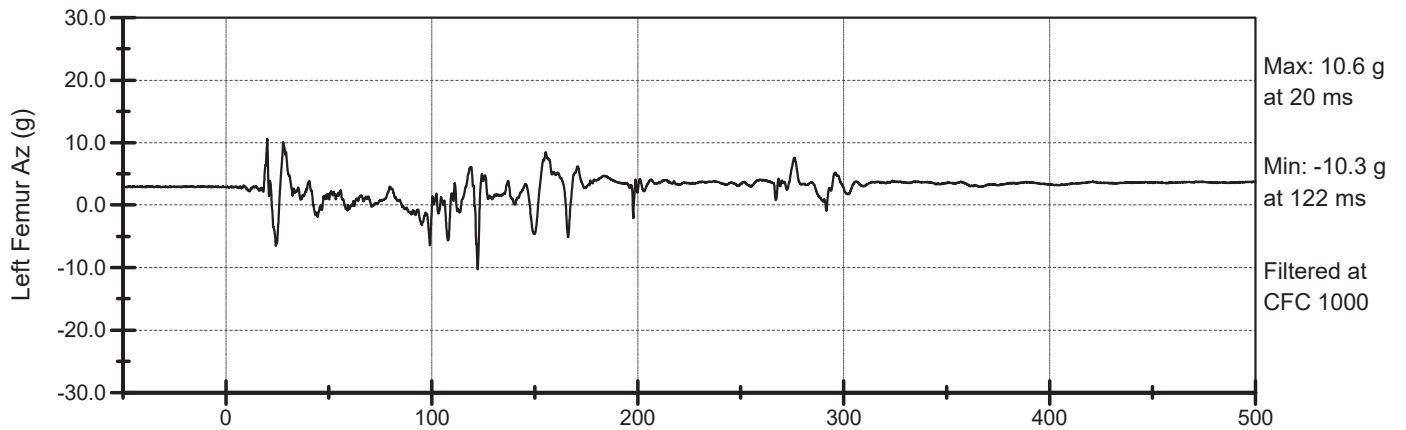
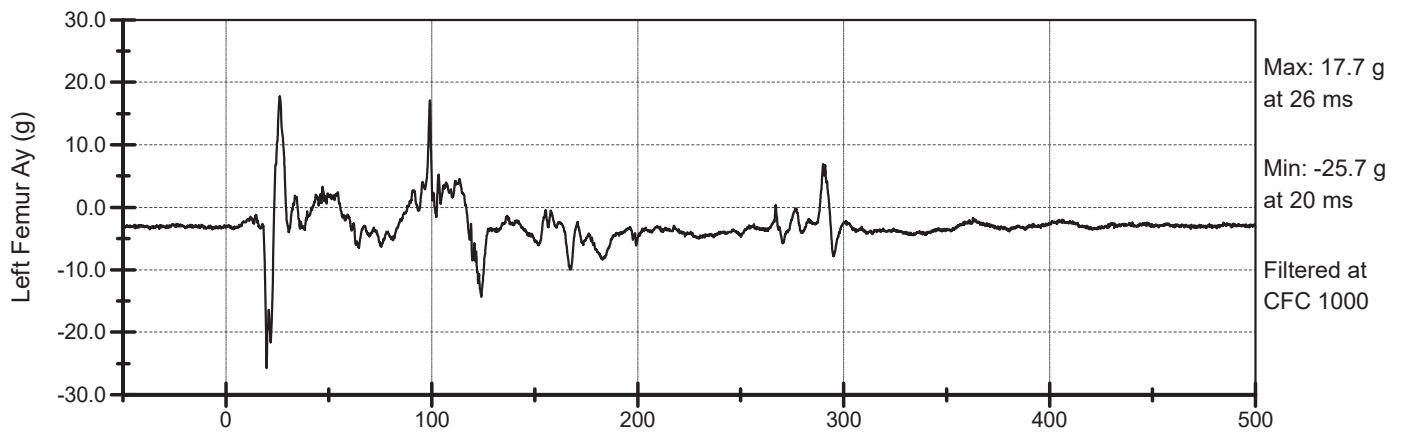
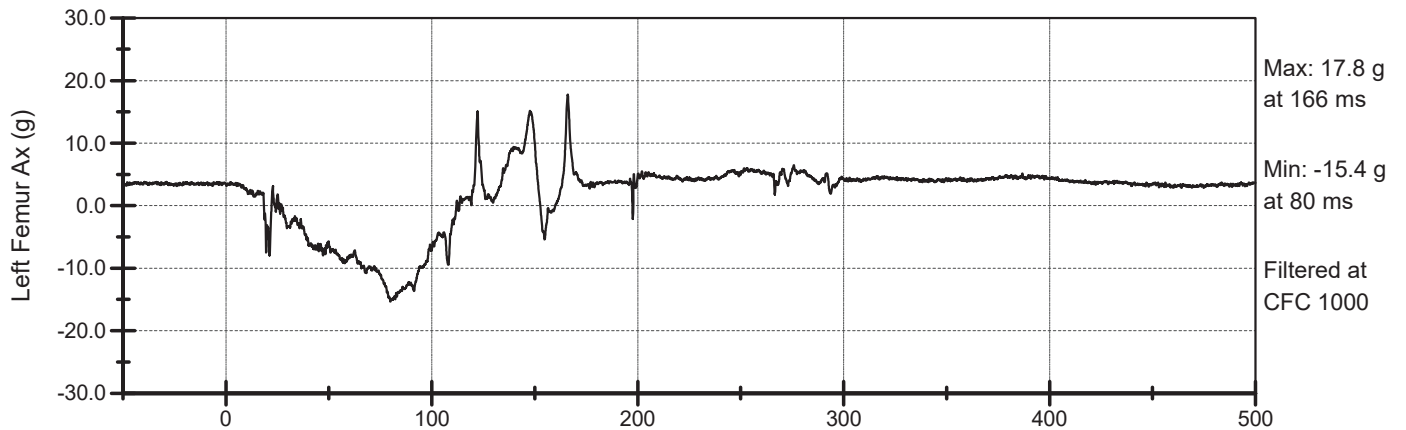


M | UMTRI Left Iliac Wing Angular Rate AV2105 001

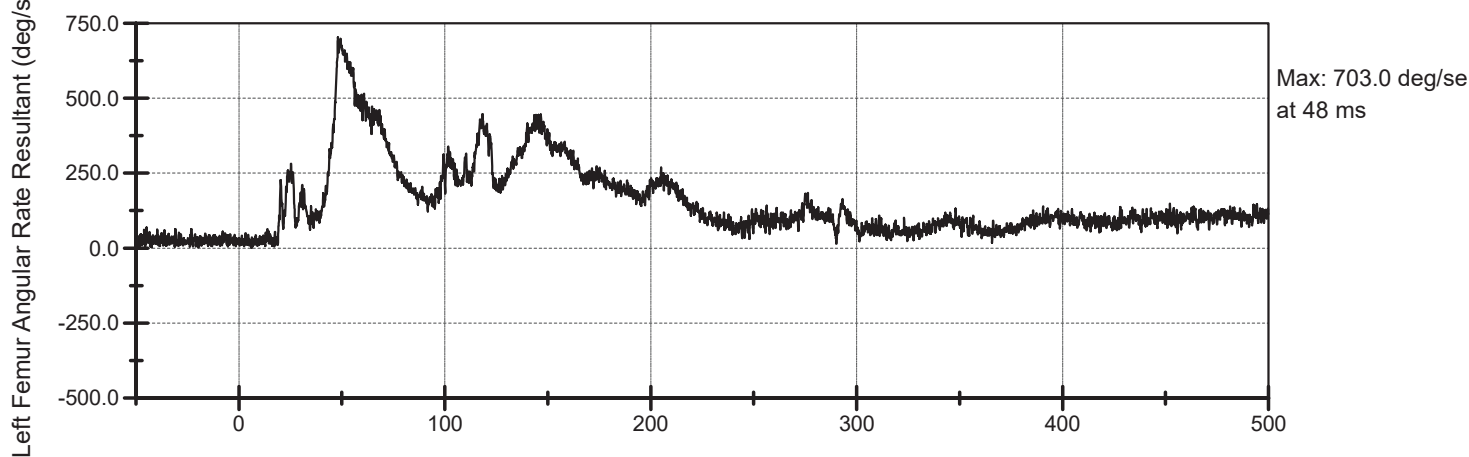
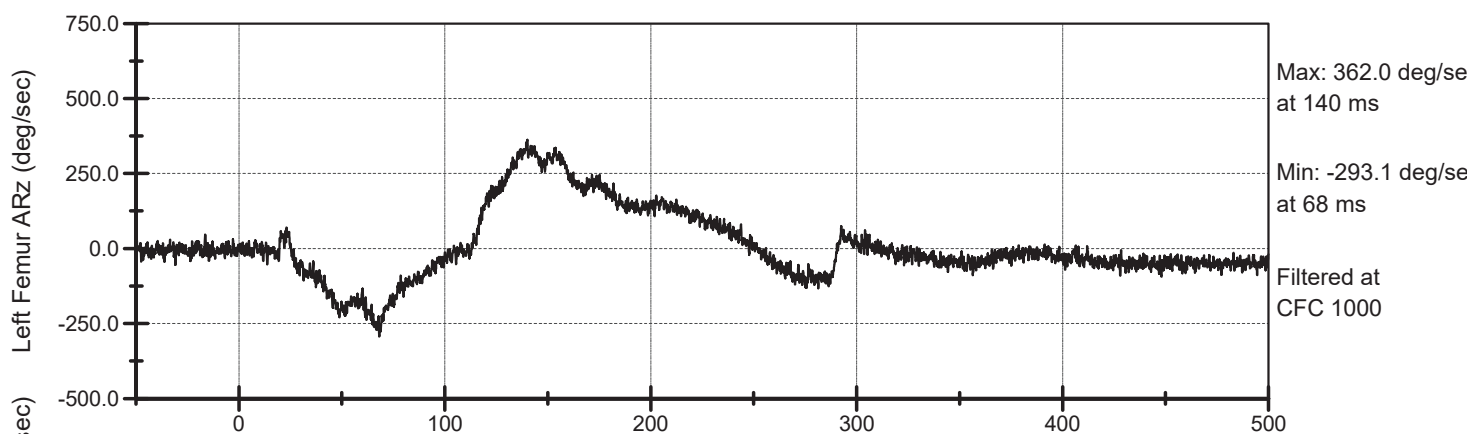
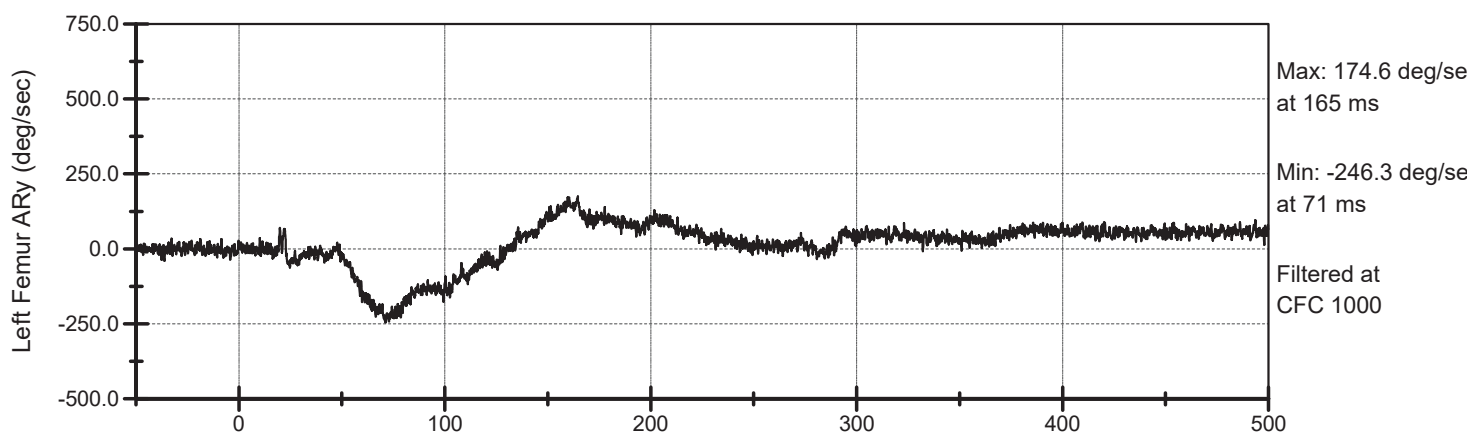
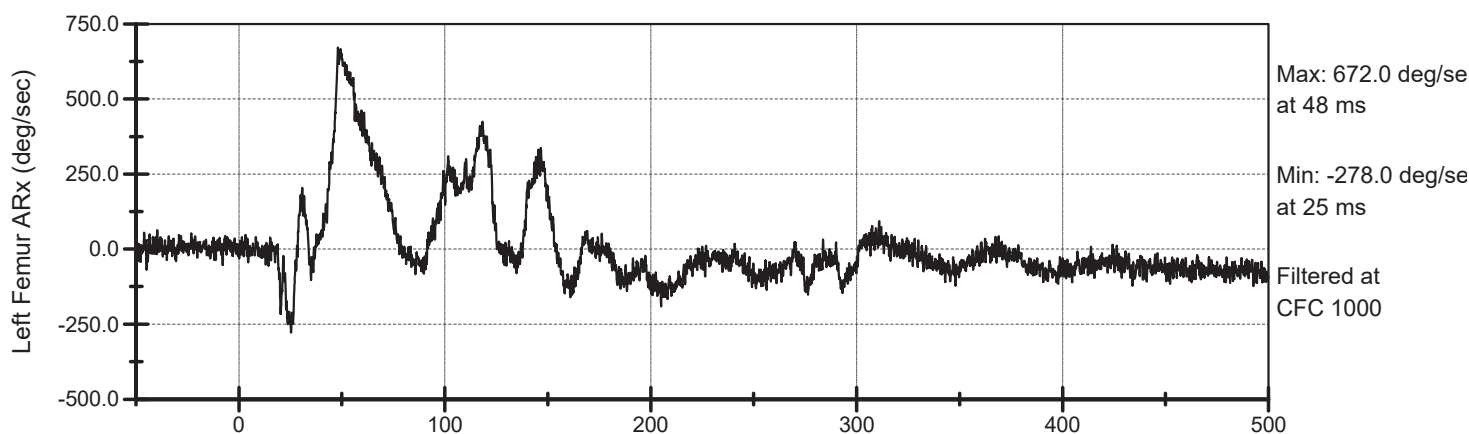


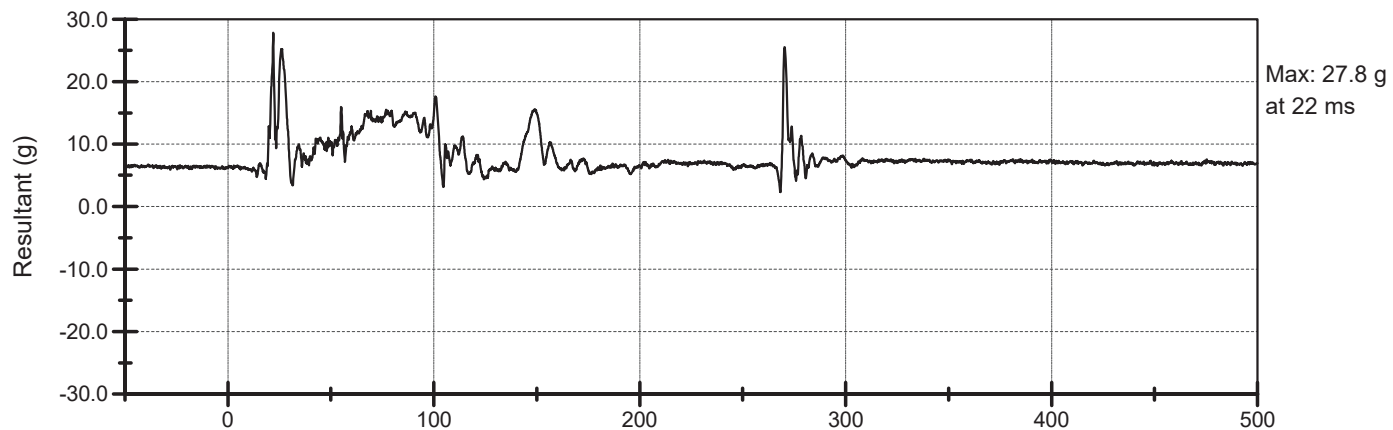
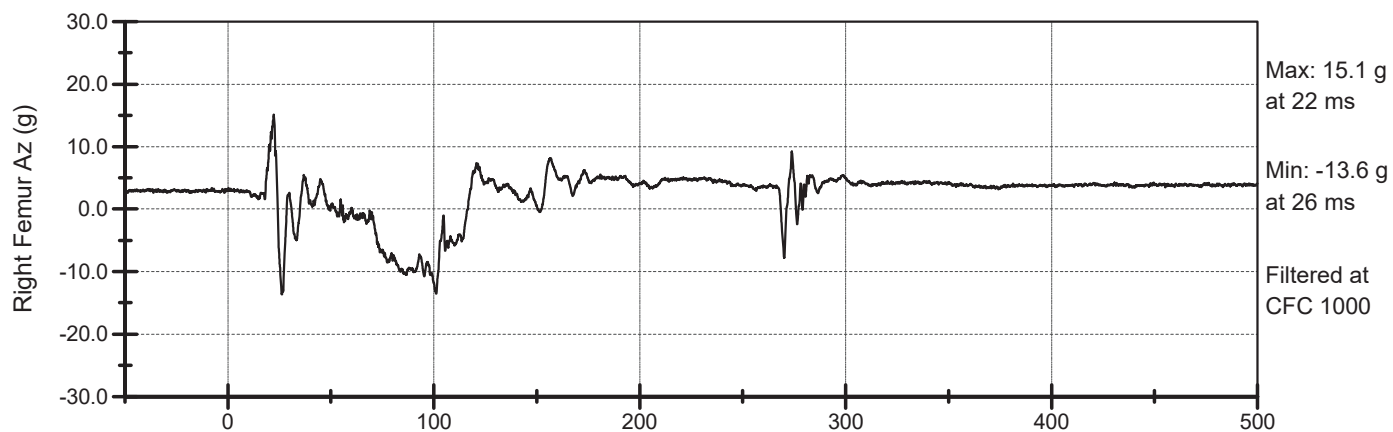
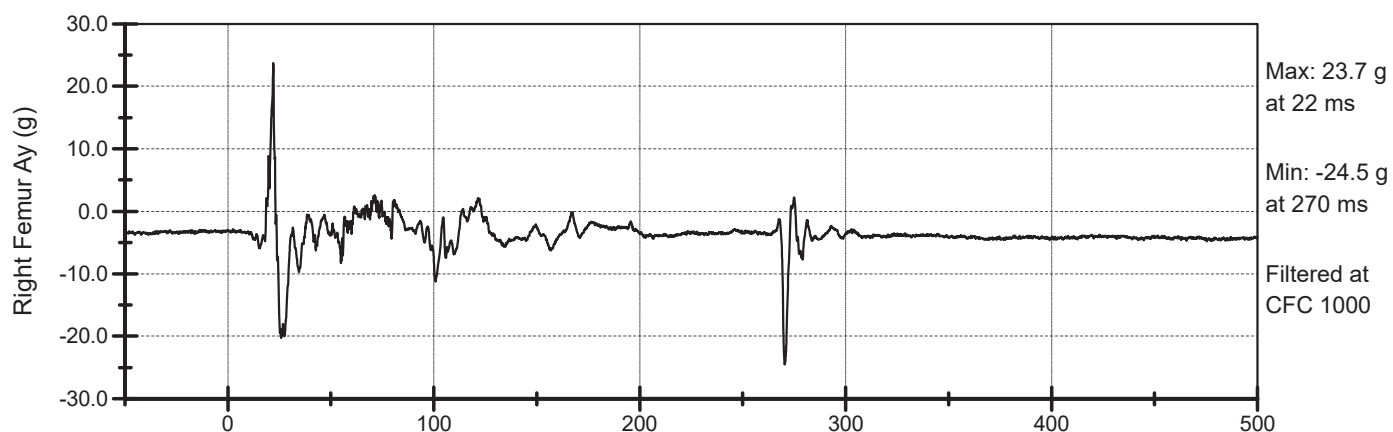
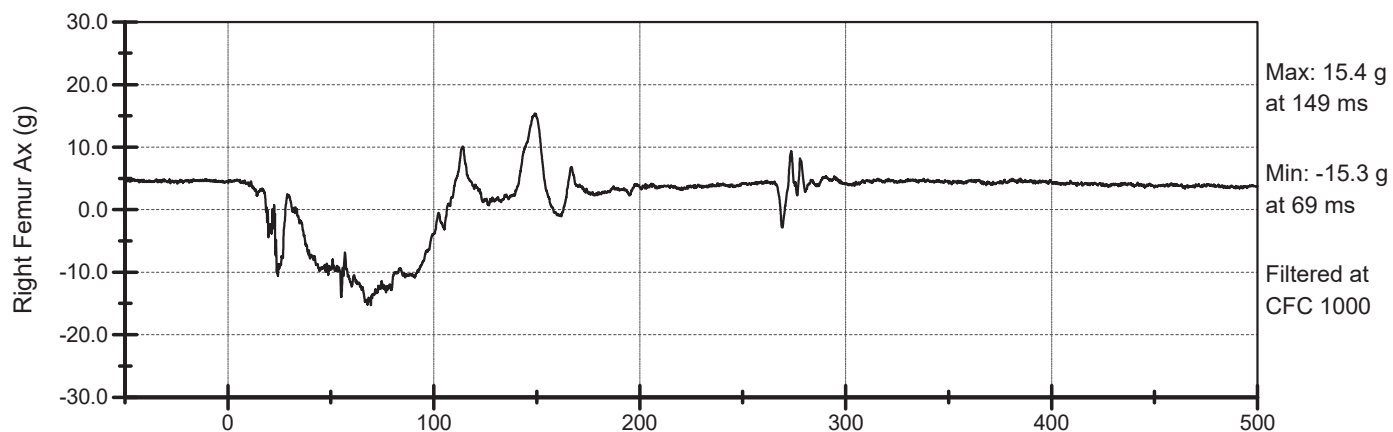
M | UMTRI Right Iliac Wing Angular Rate AV2105 001



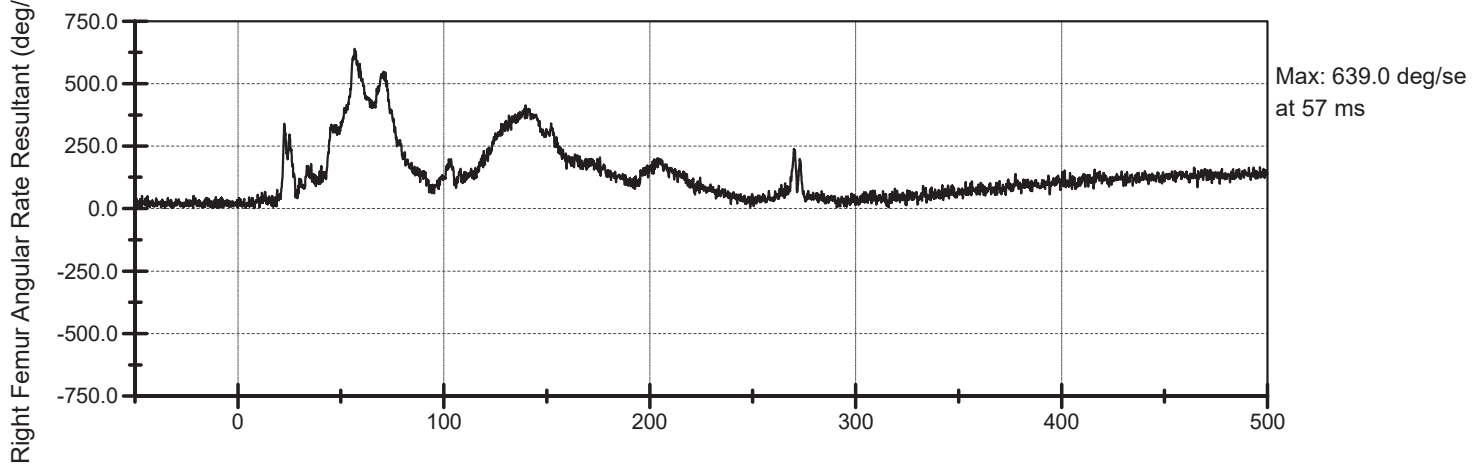
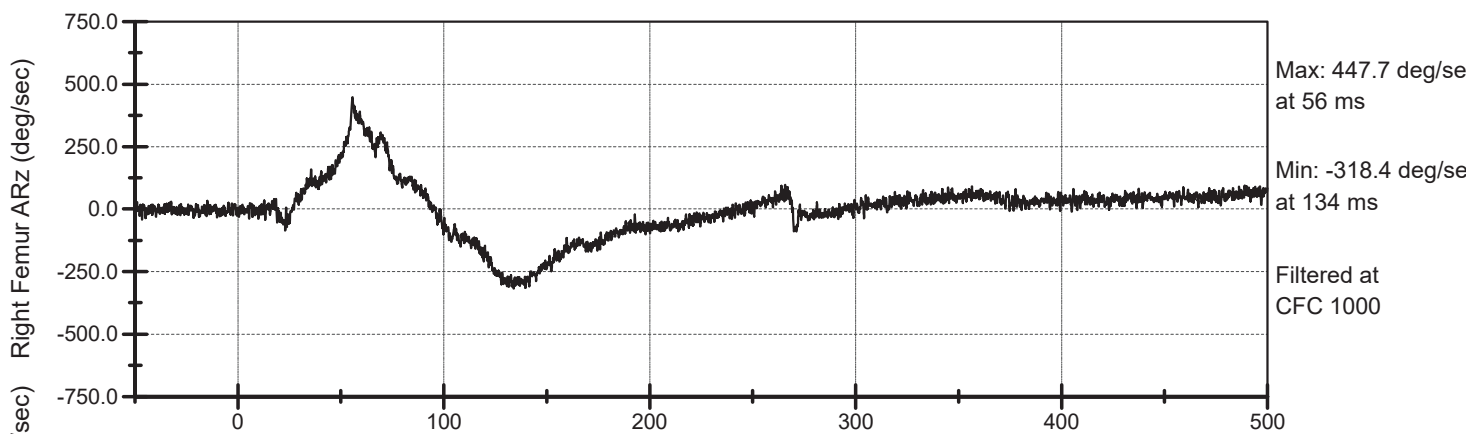
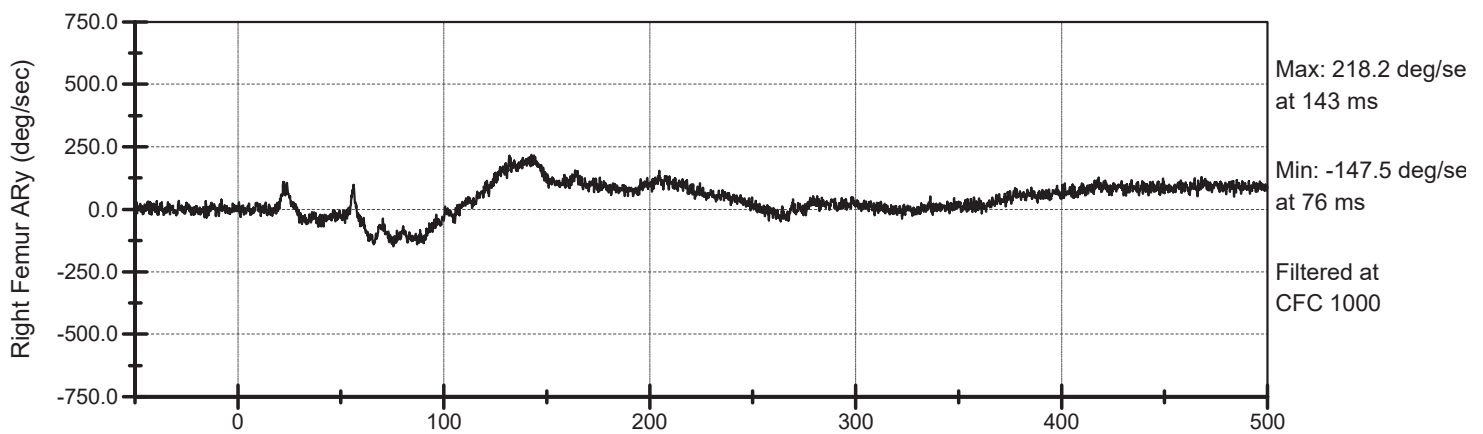
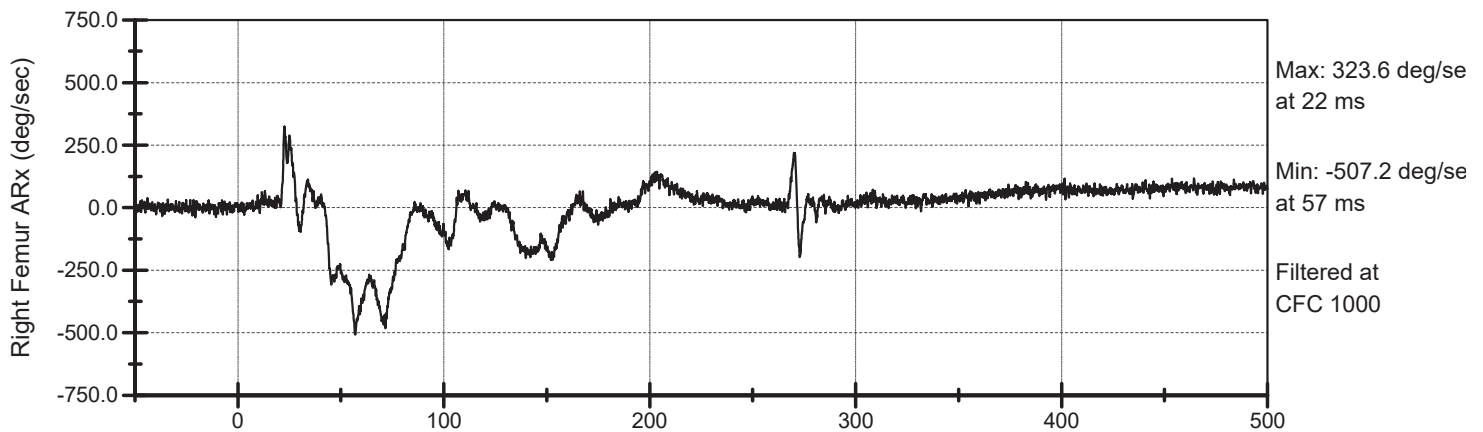


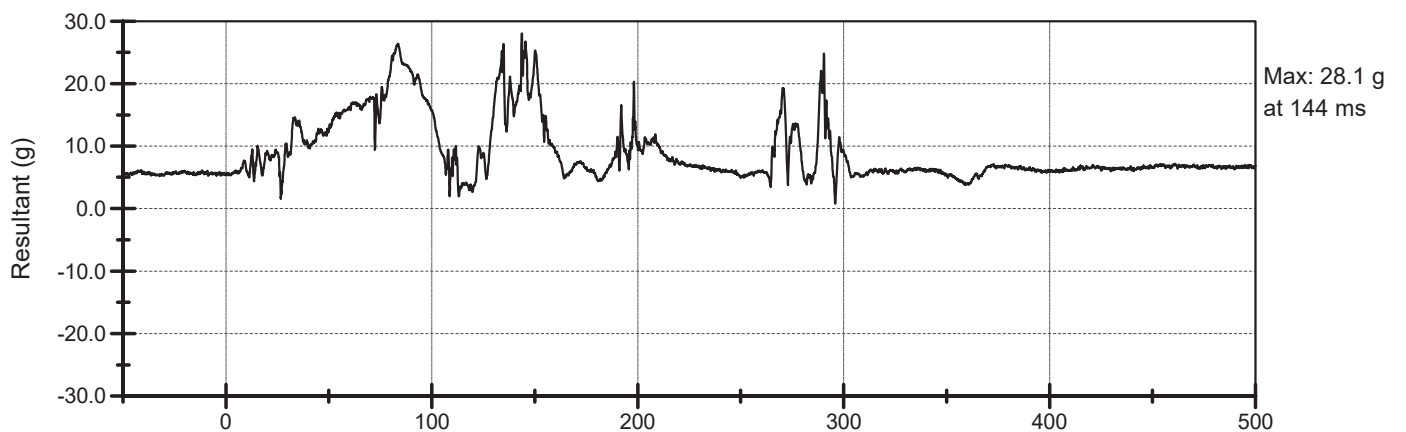
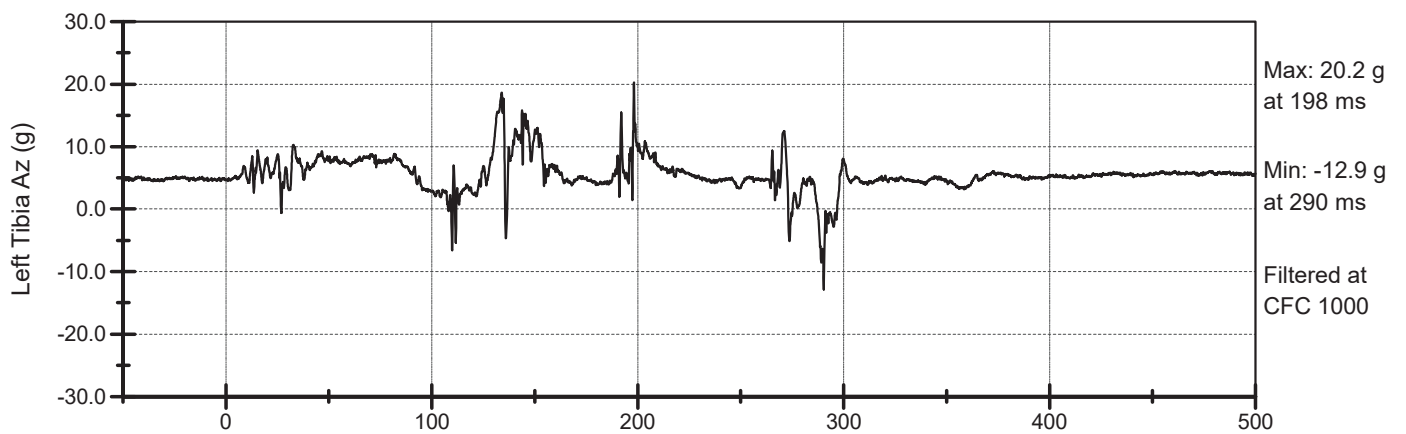
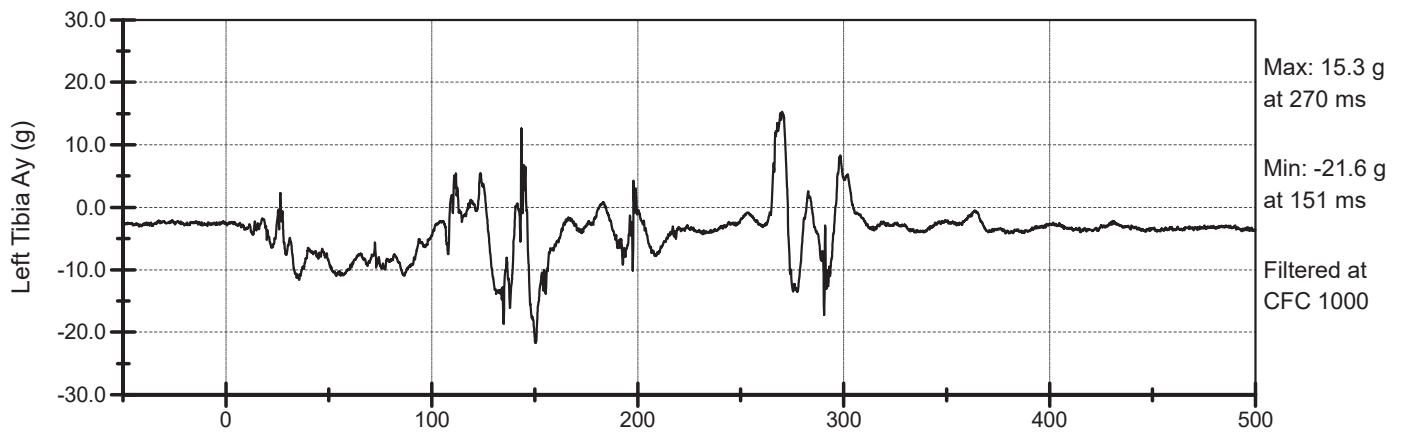
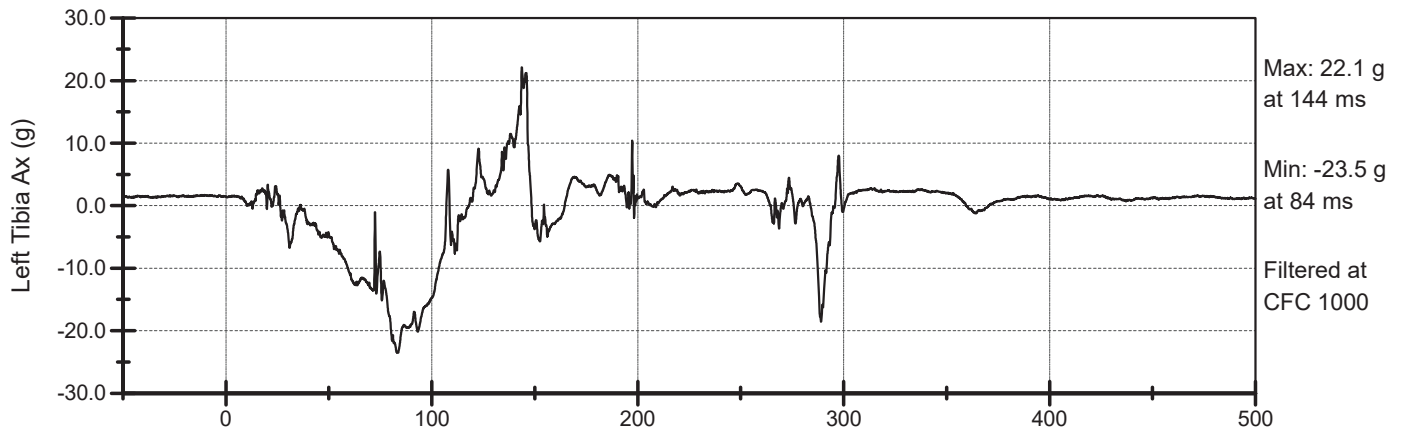
M | UMTRI Left Femur Angular Rate AV2105 001





M | UMTRI Right Femur Angular Rate AV2105 001



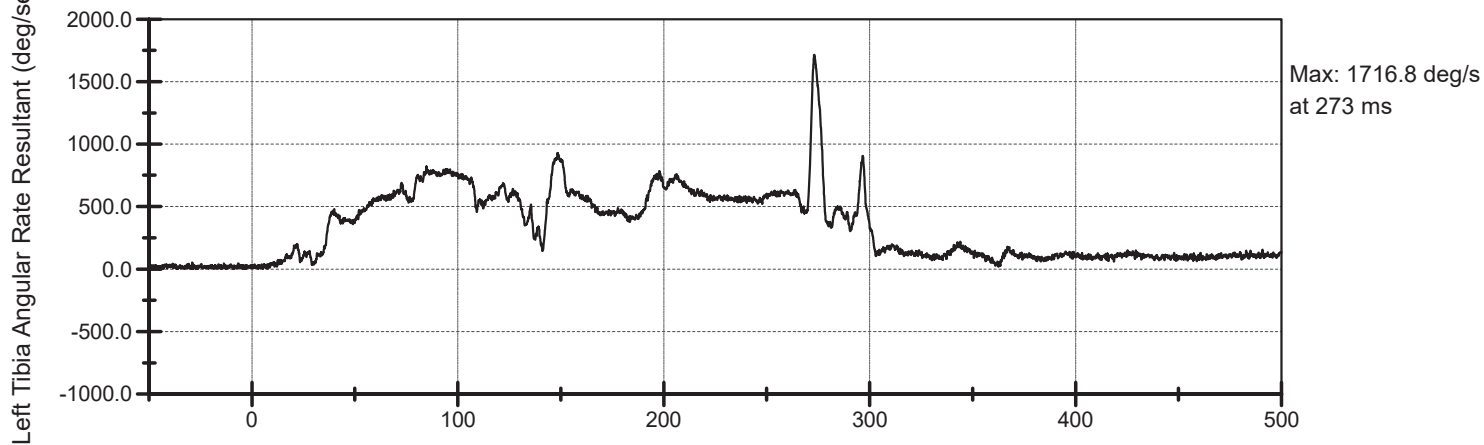
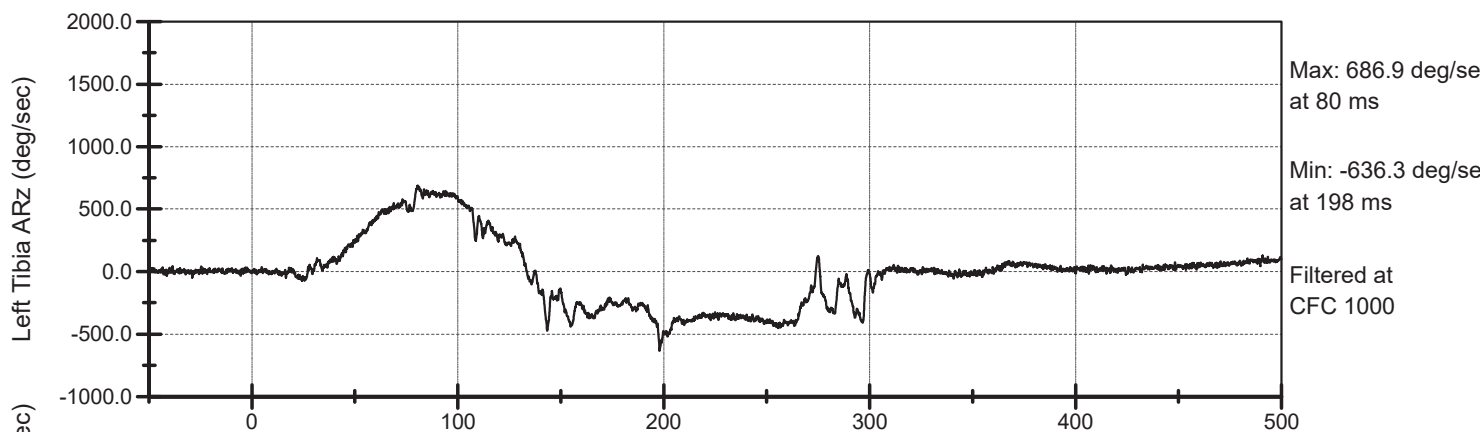
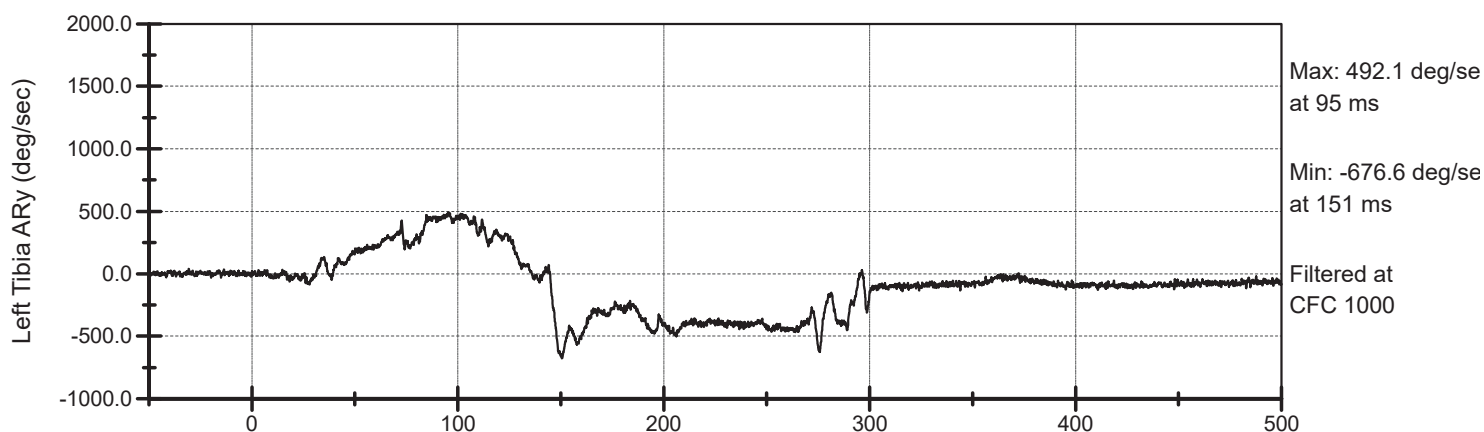
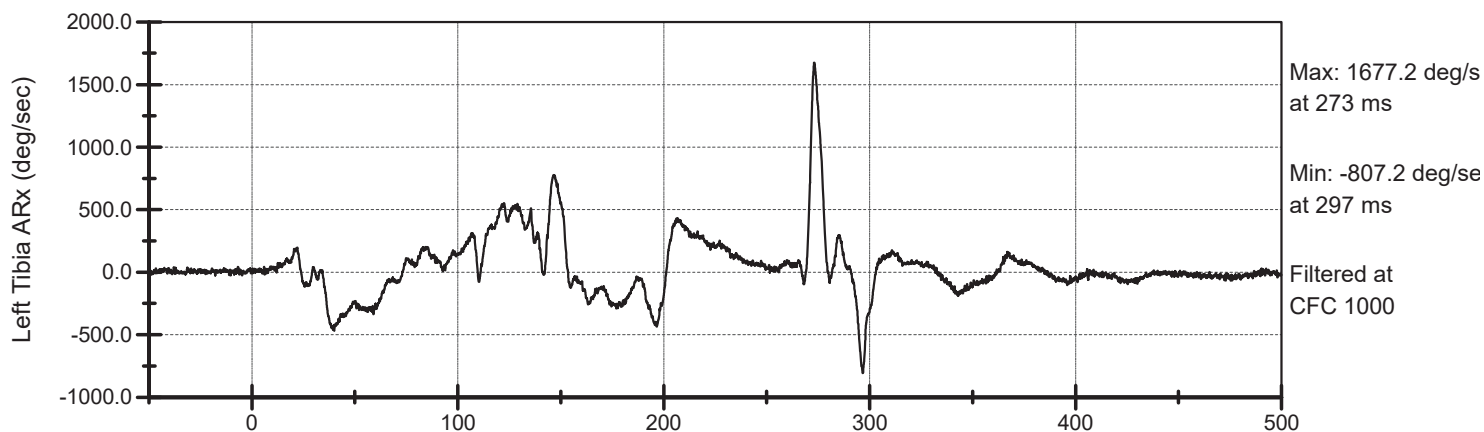


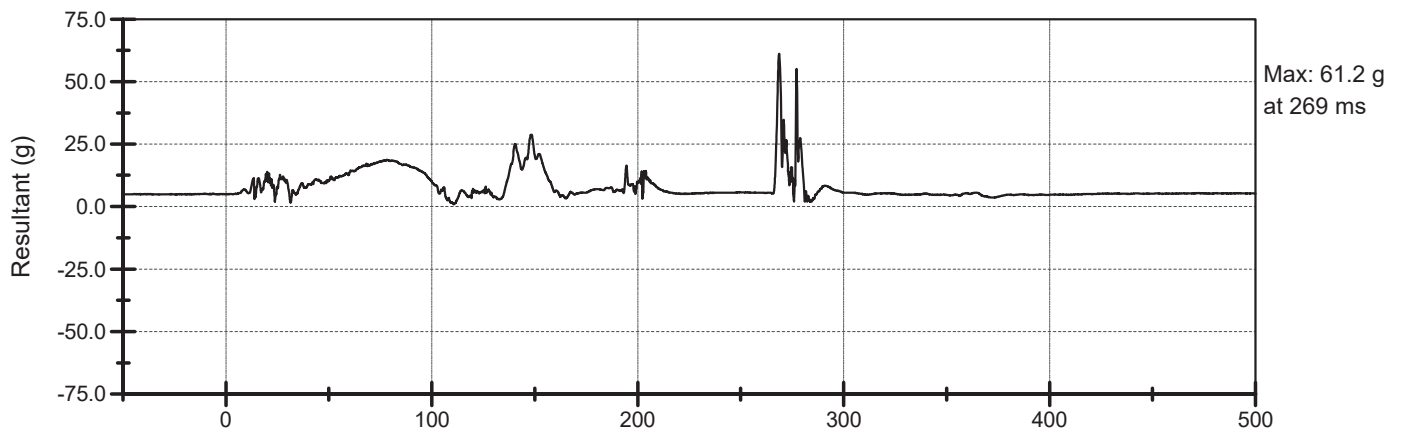
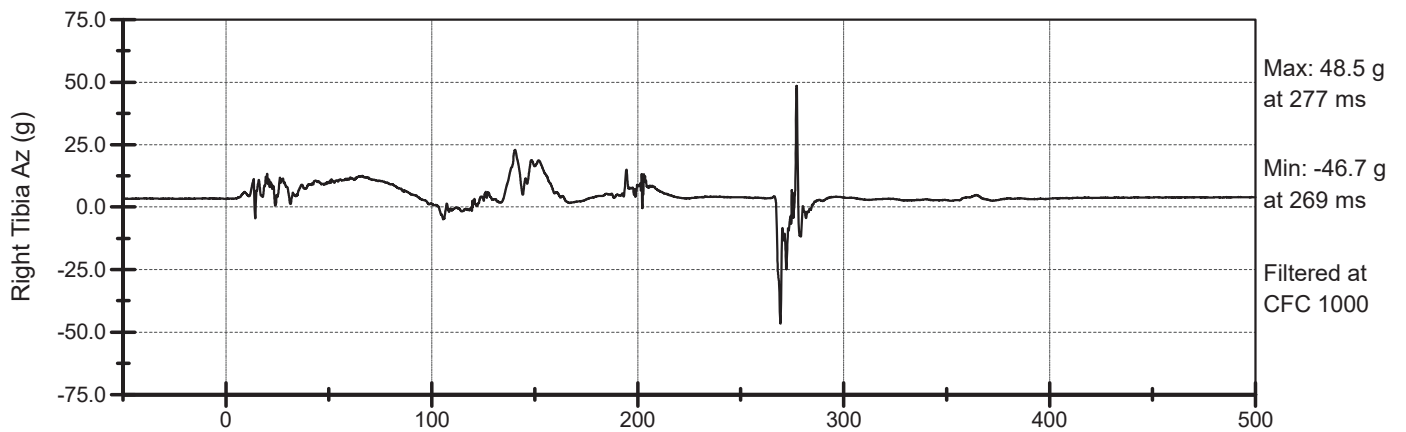
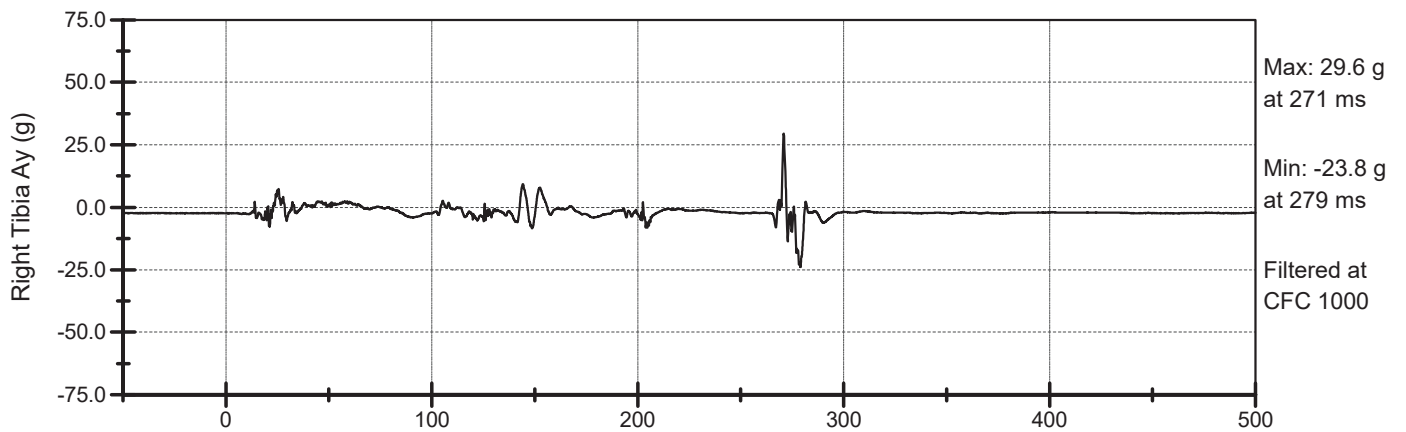
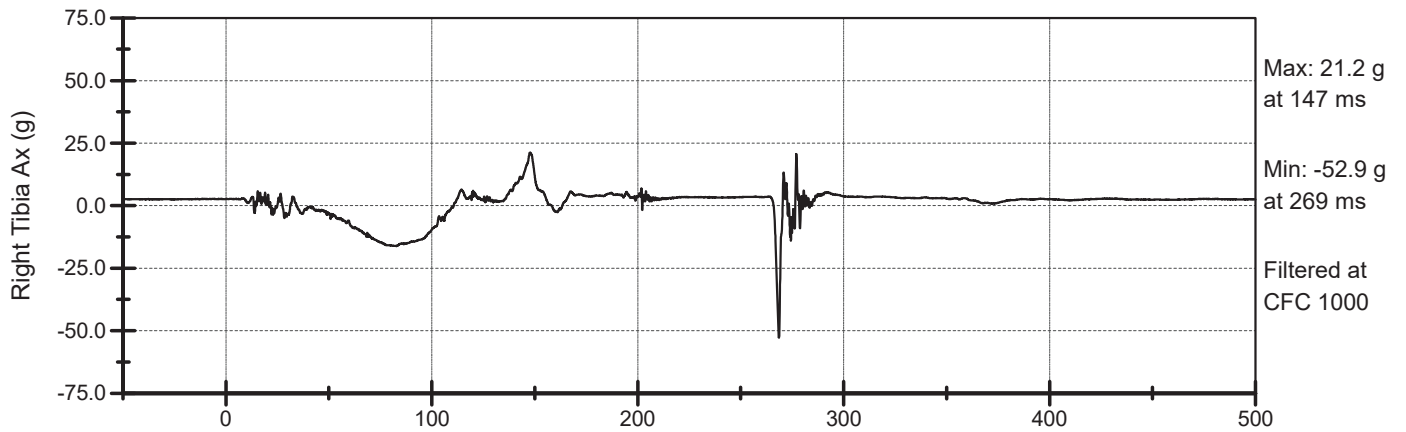


UMTRI

Left Tibia Angular Rate

AV2105 001

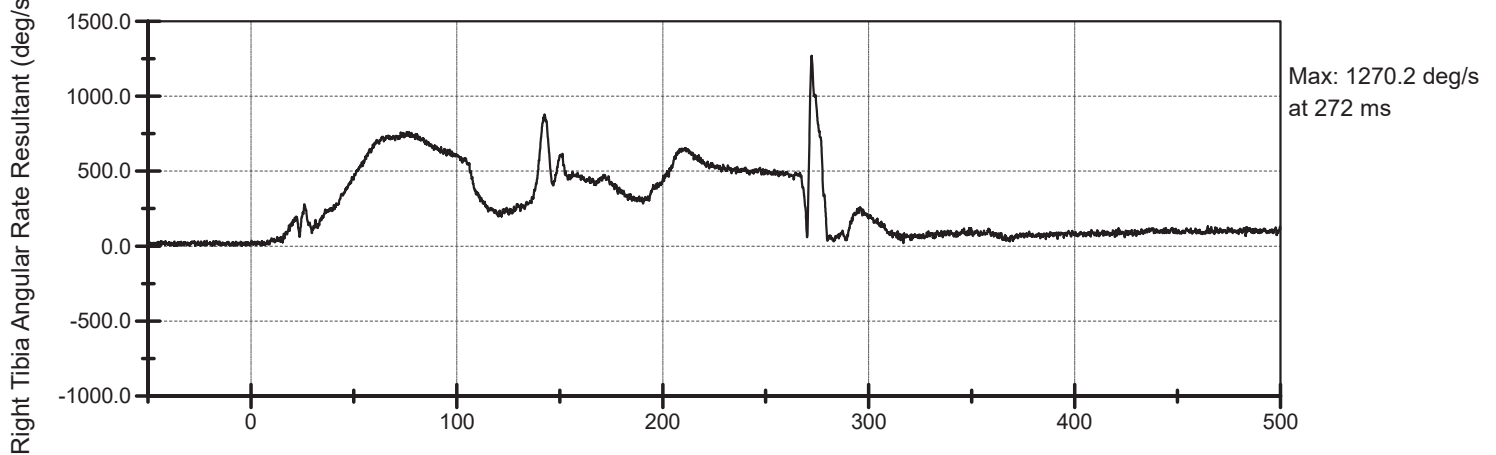
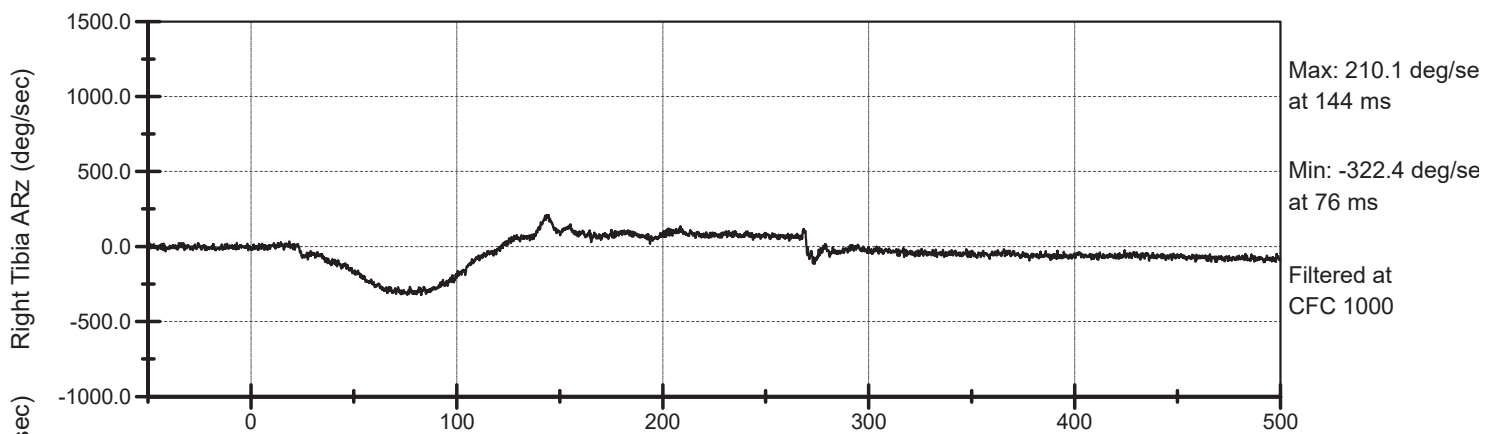
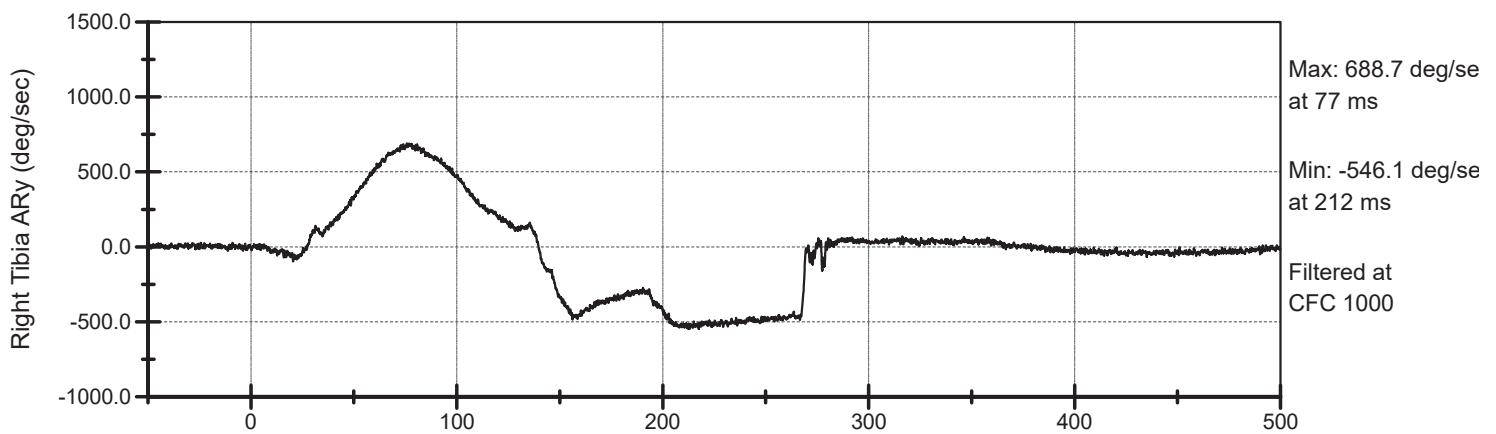
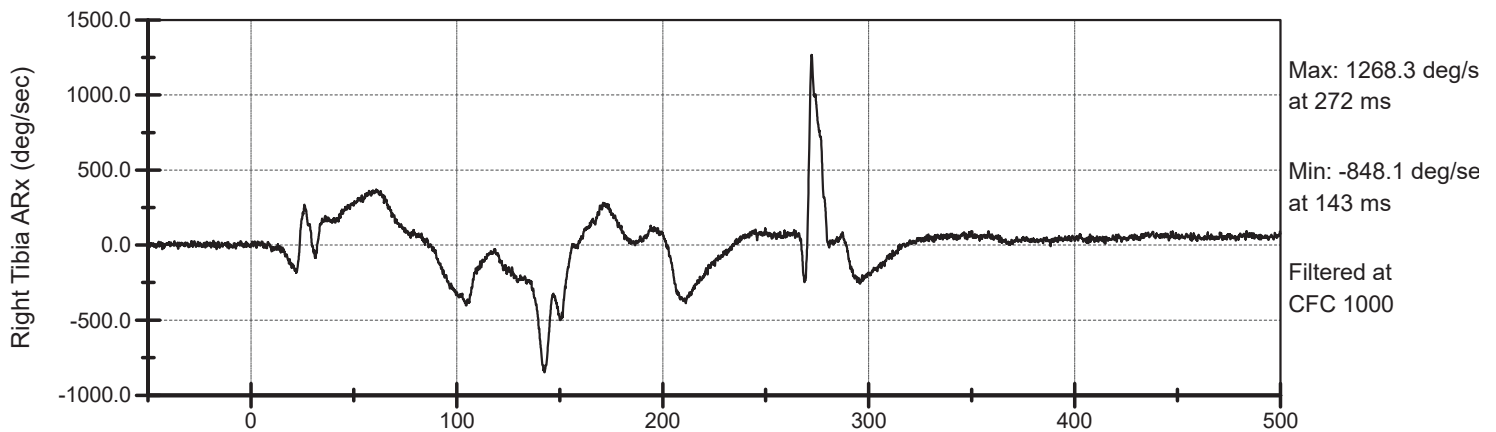


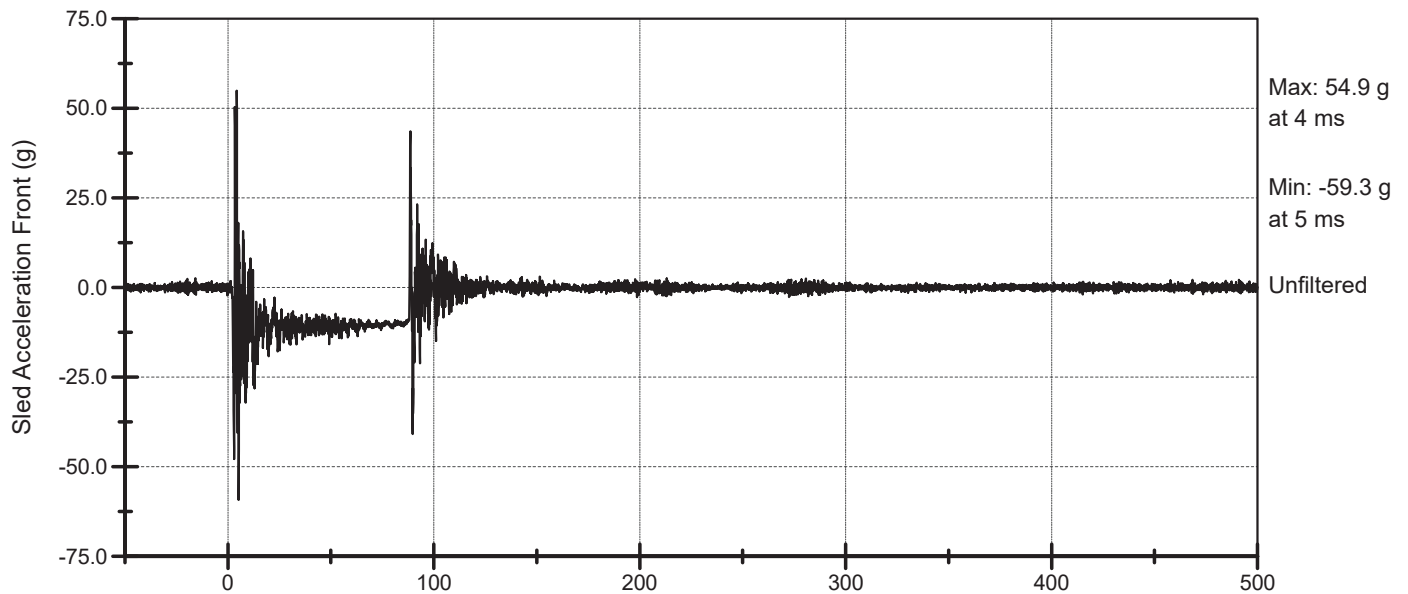
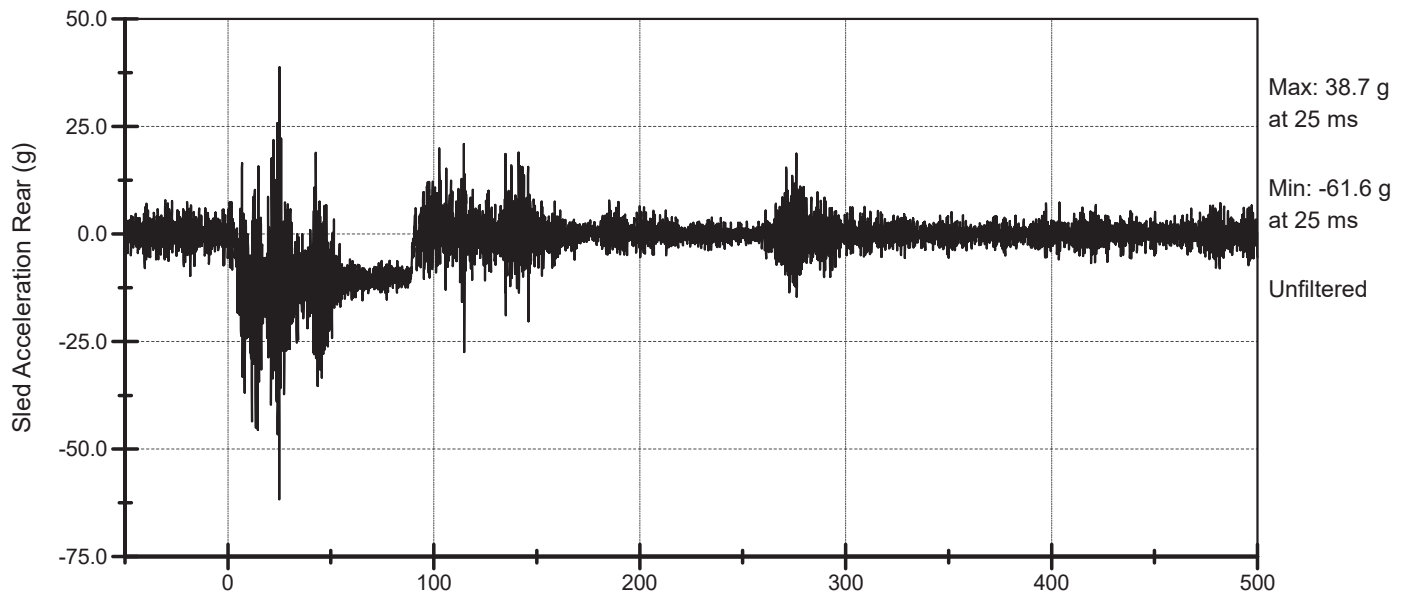
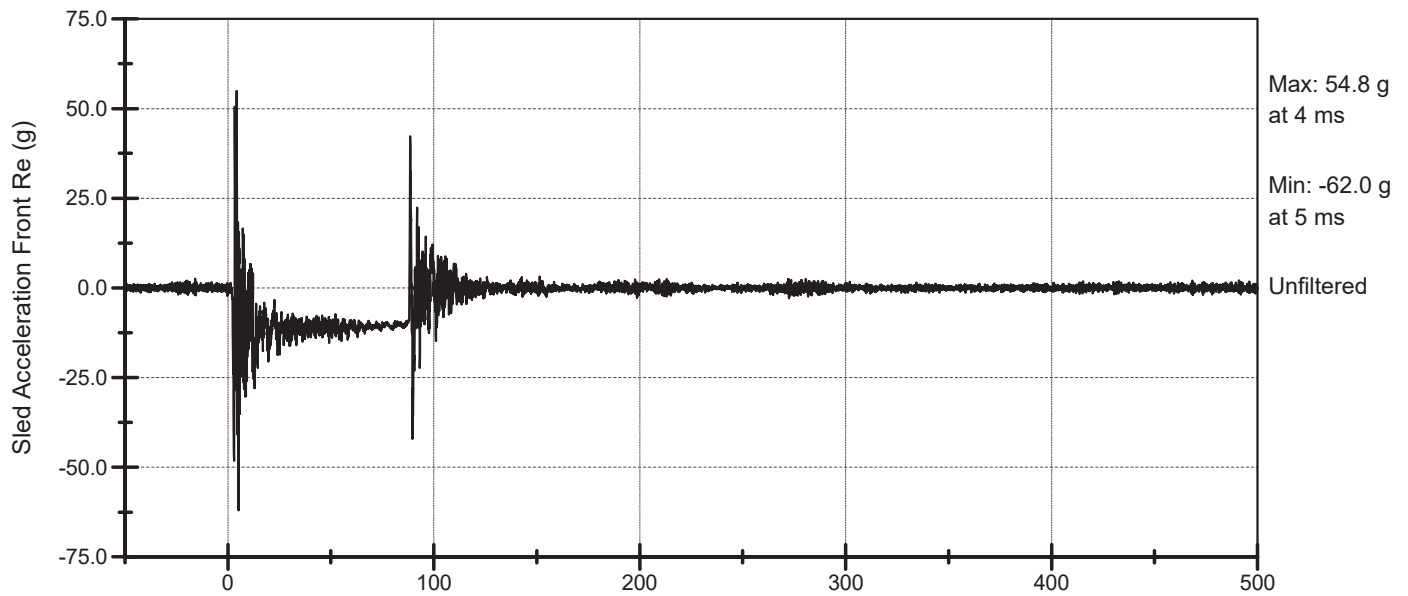


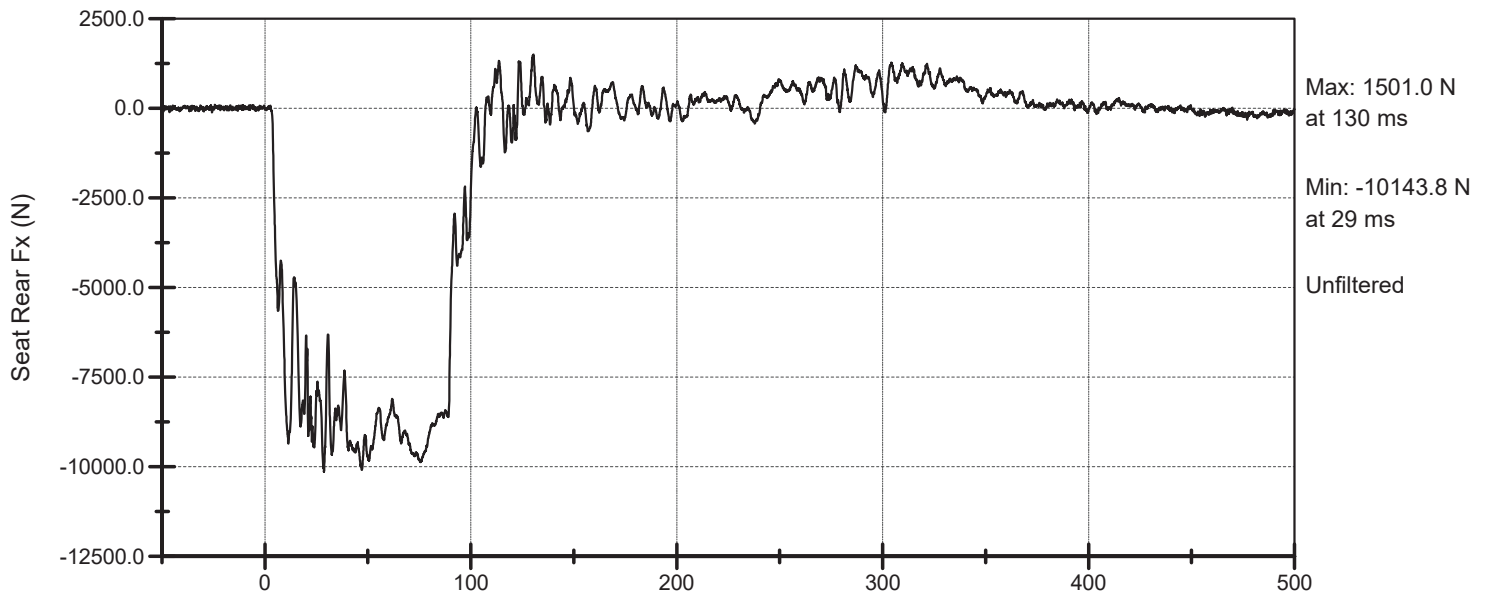
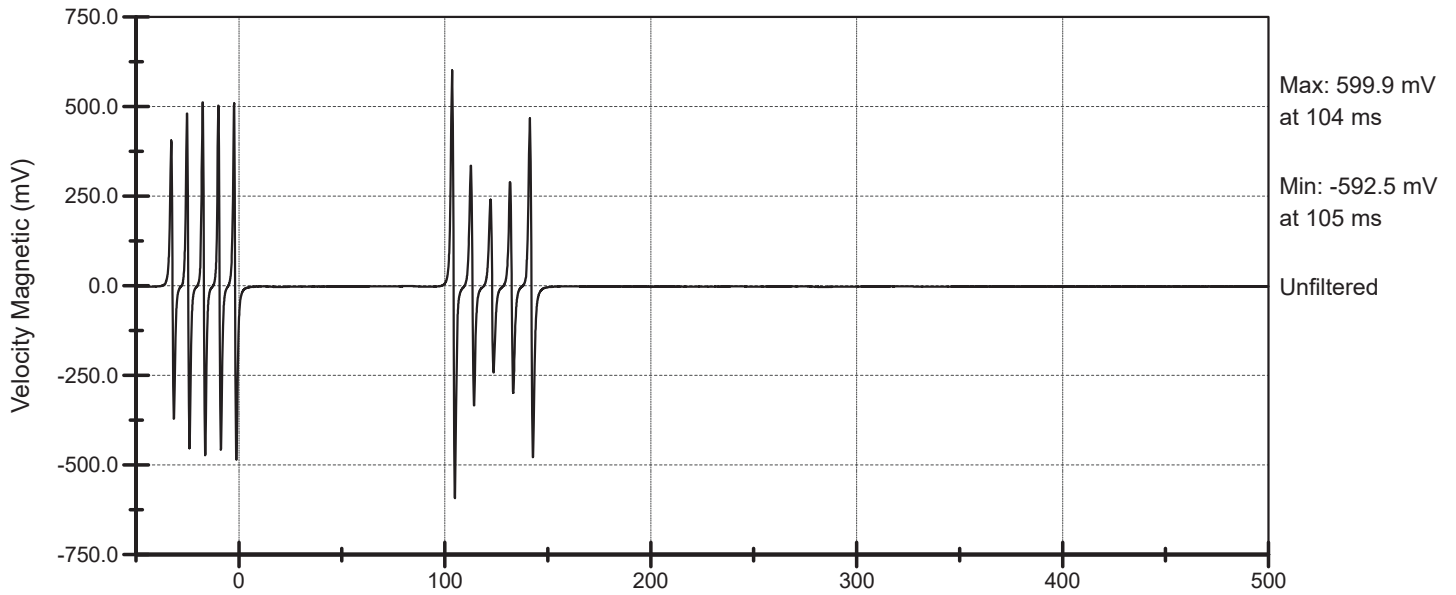
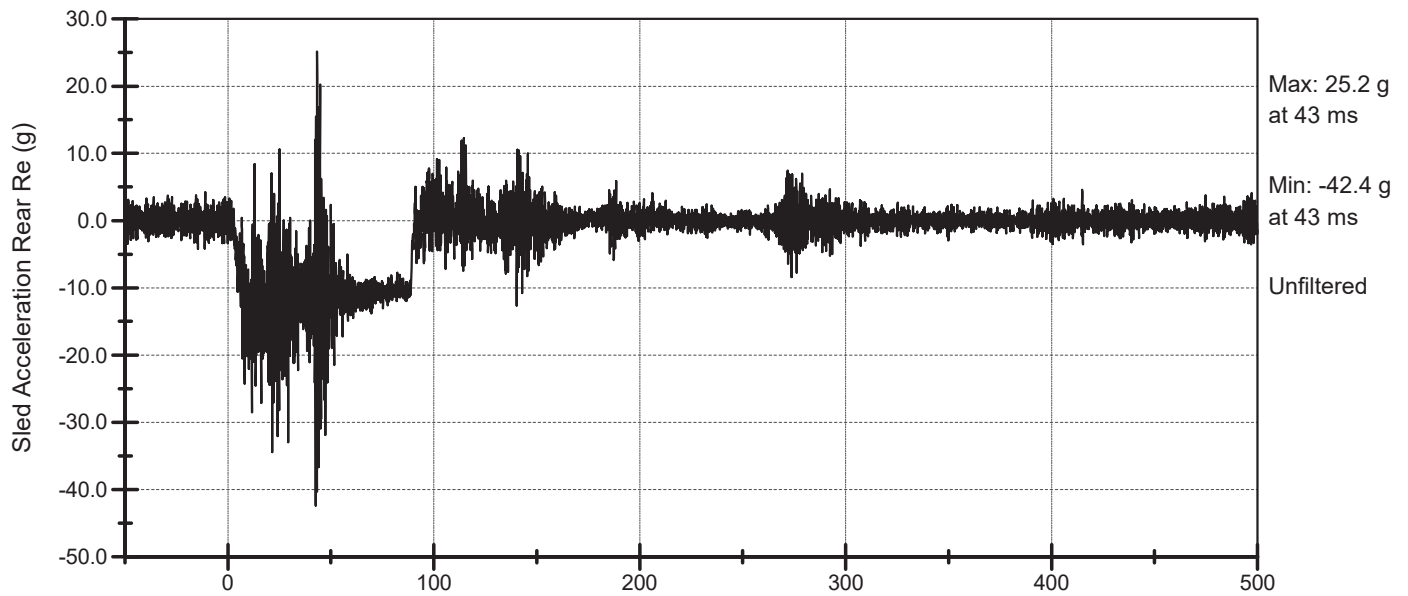


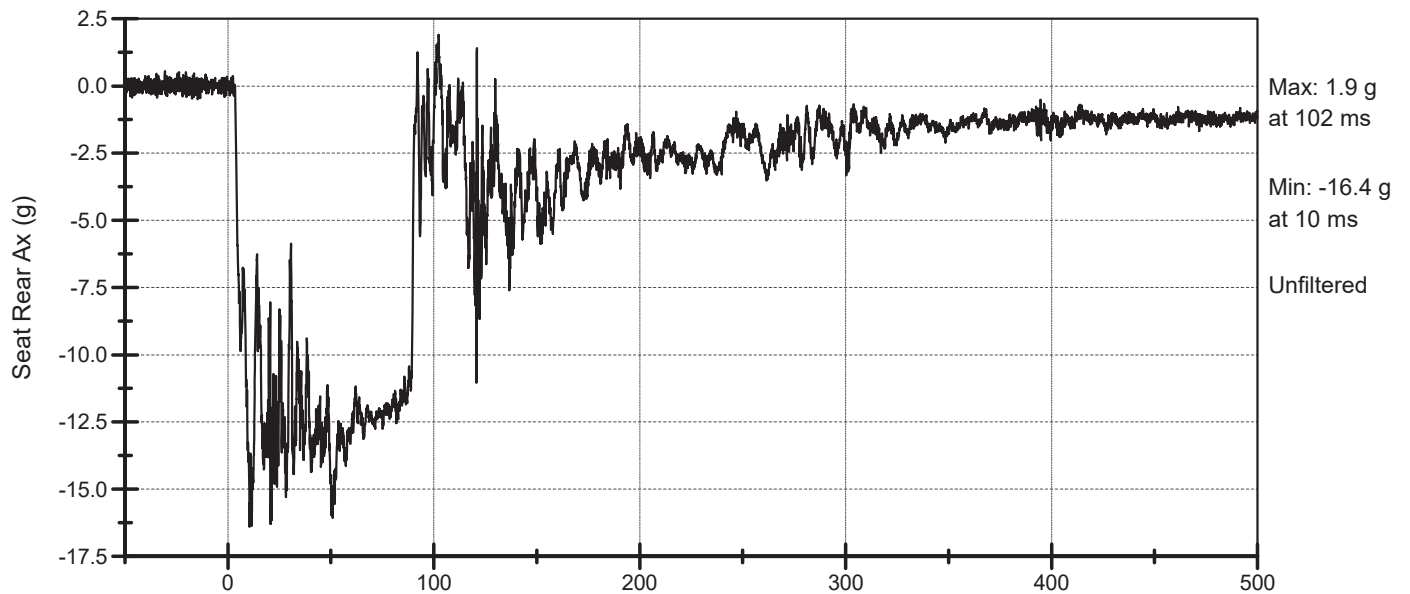
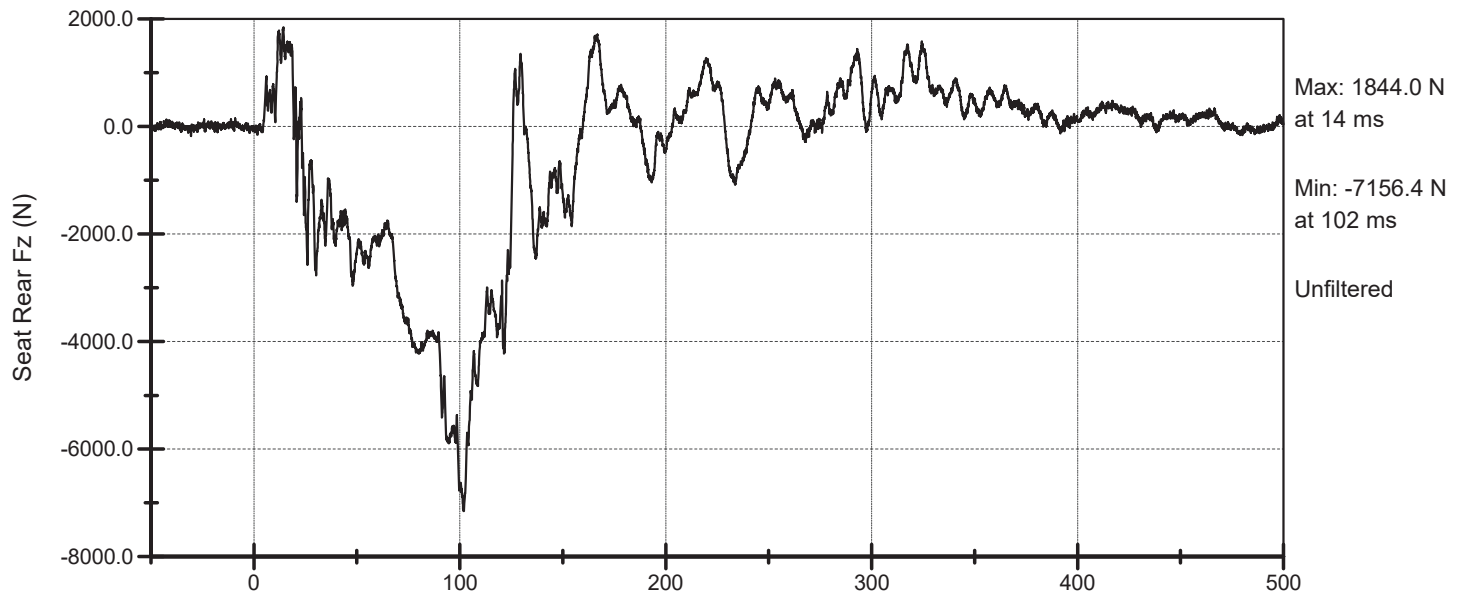
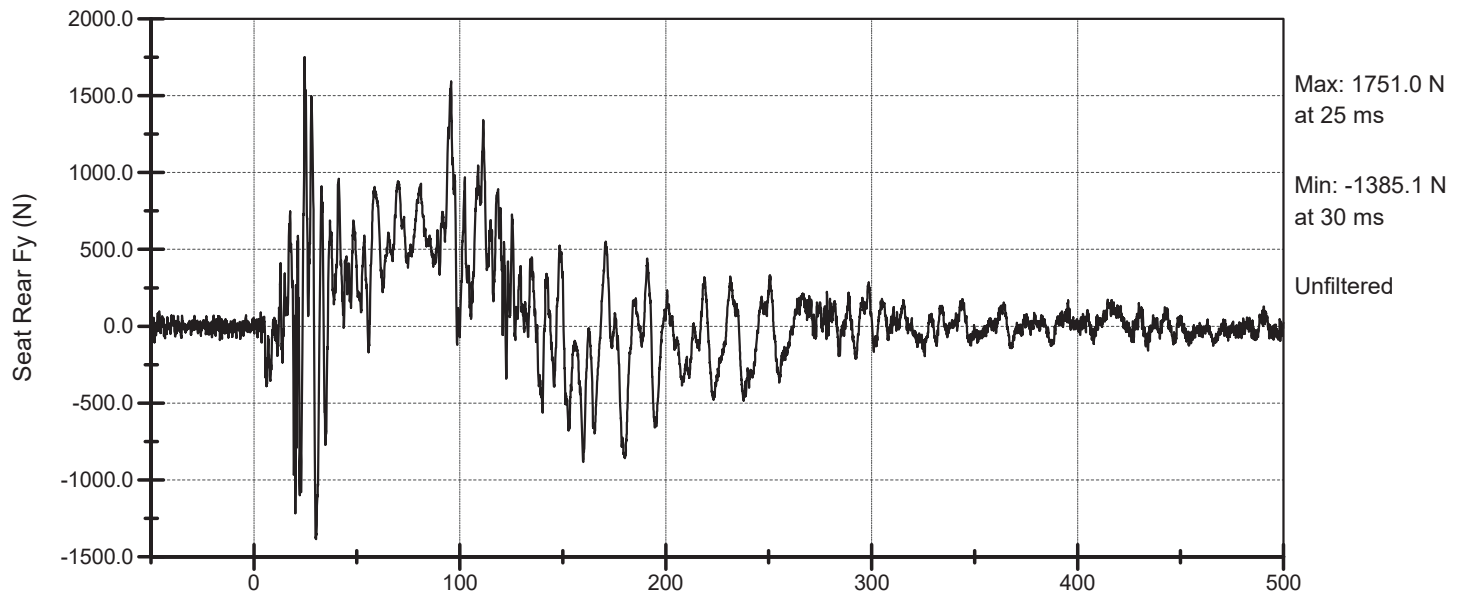
UMTRI

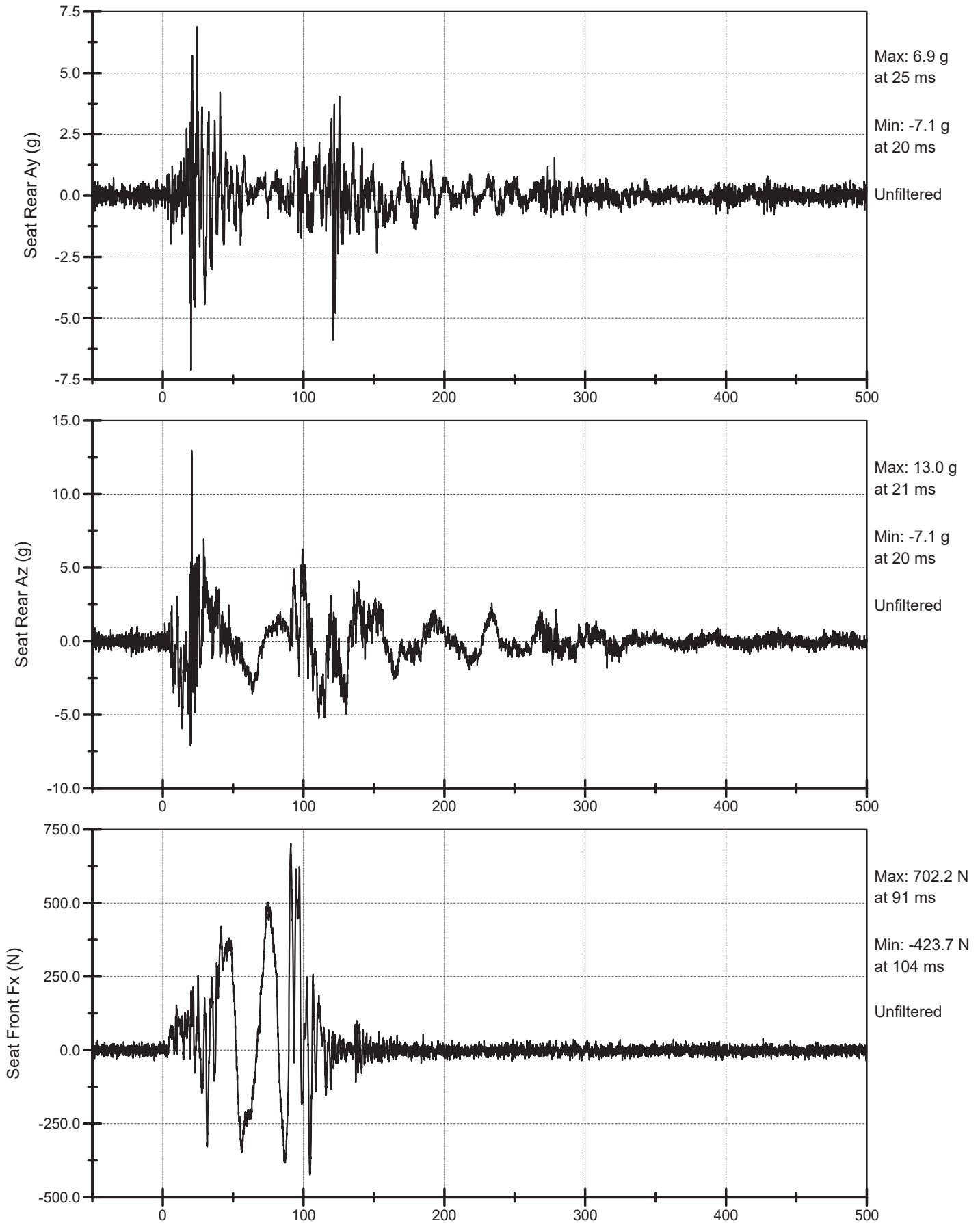
Right Tibia Angular Rate AV2105 001

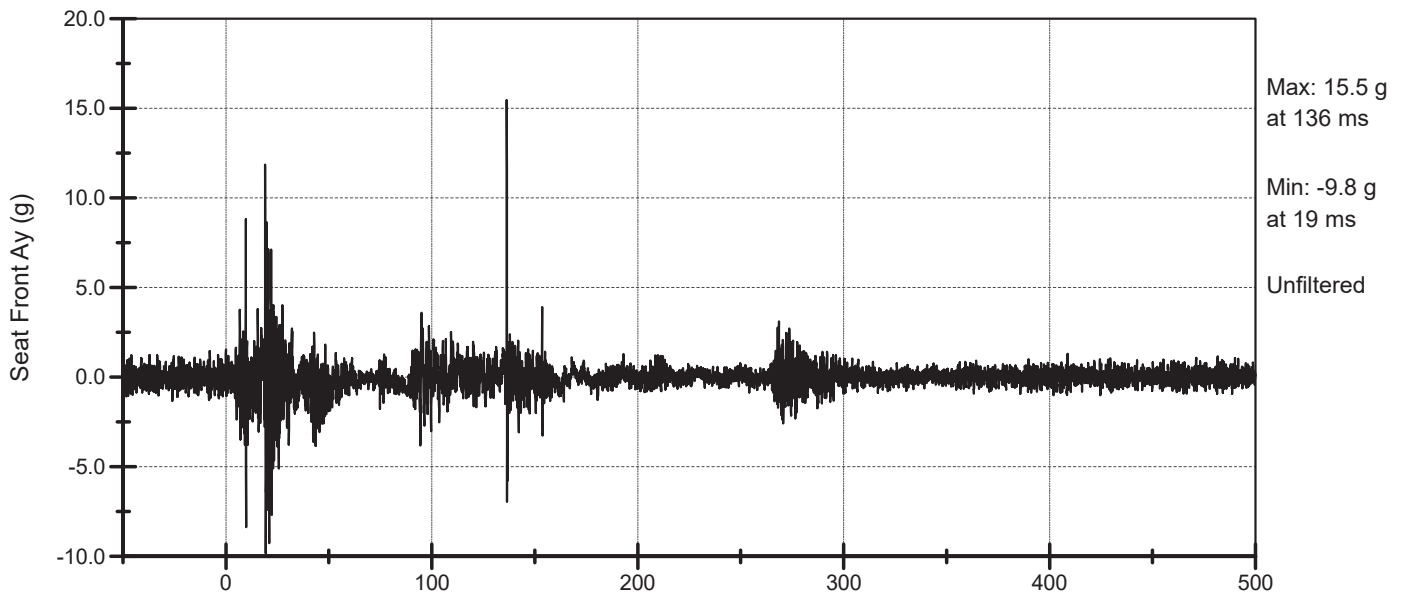
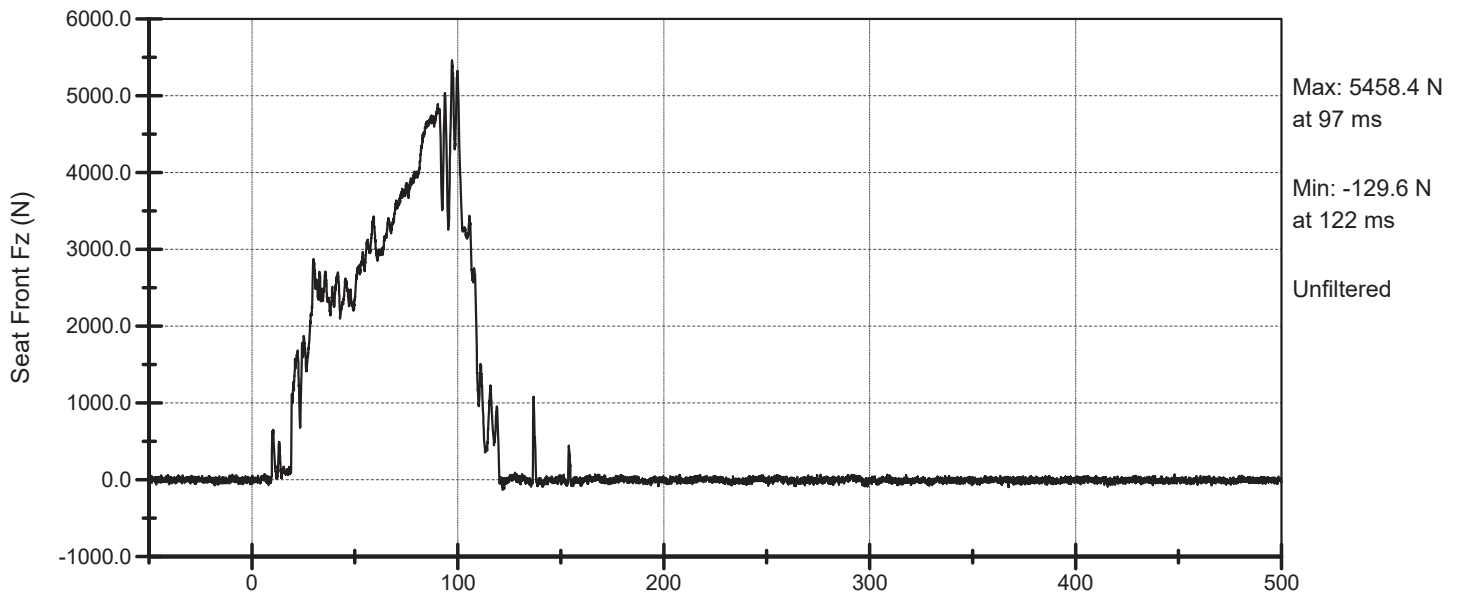
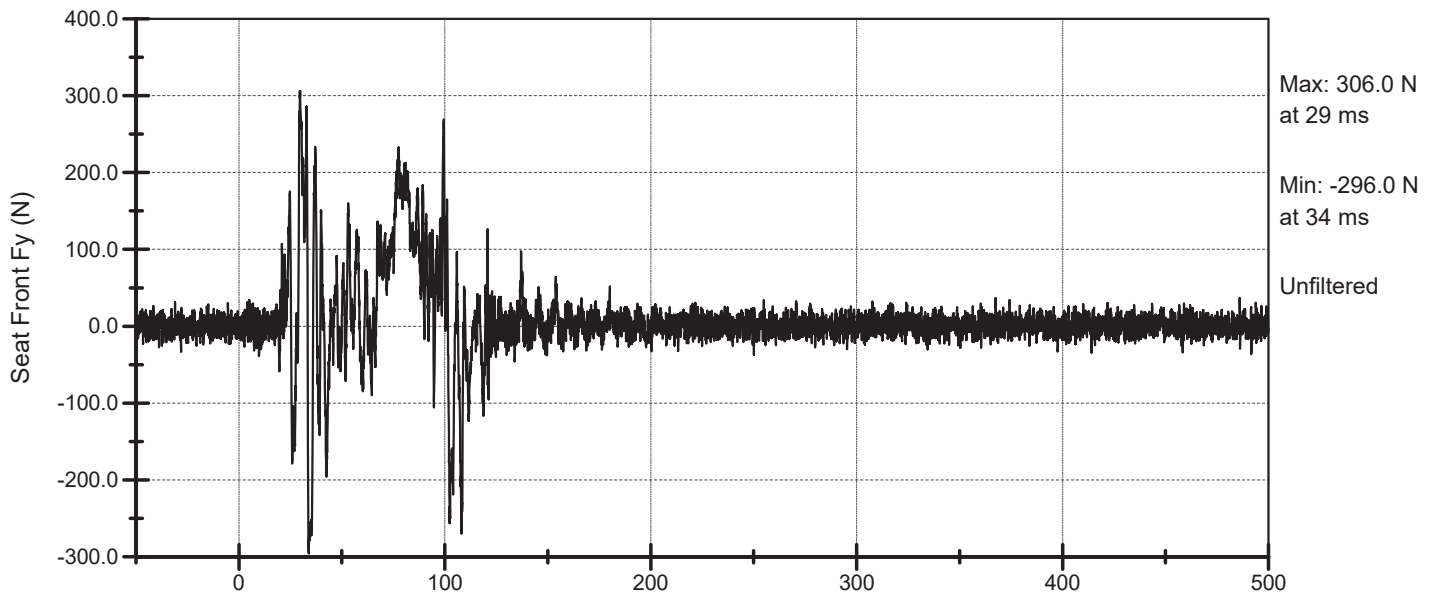


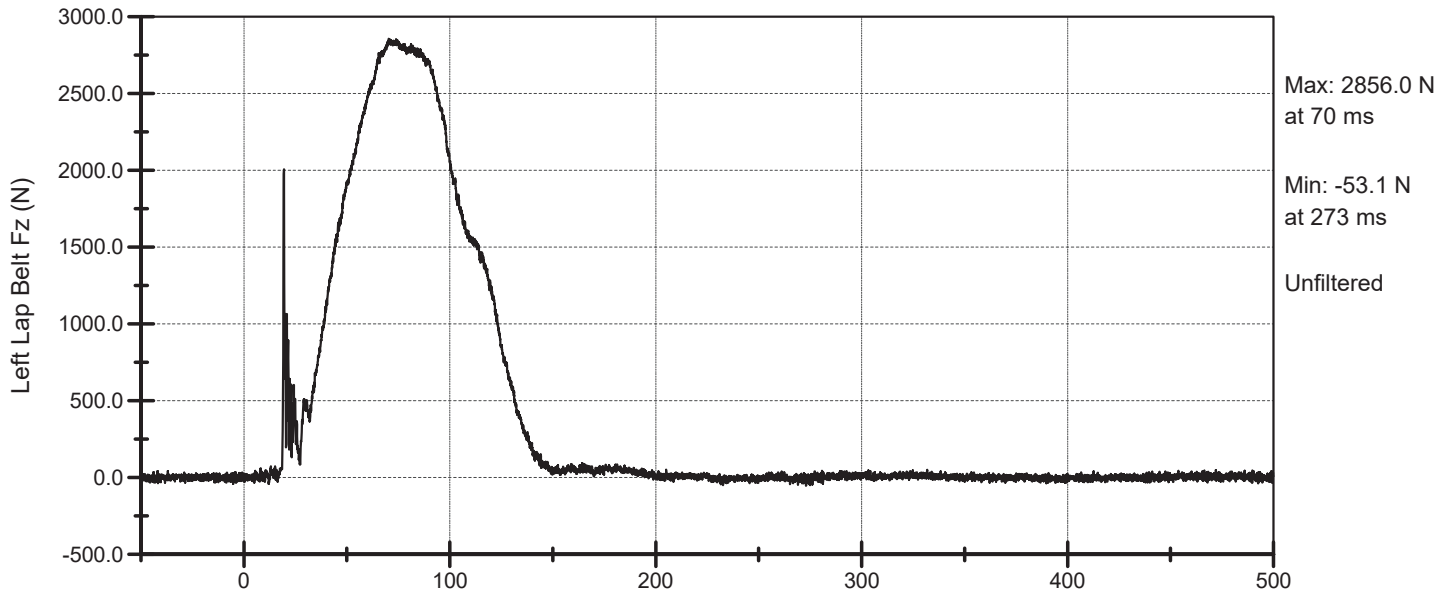
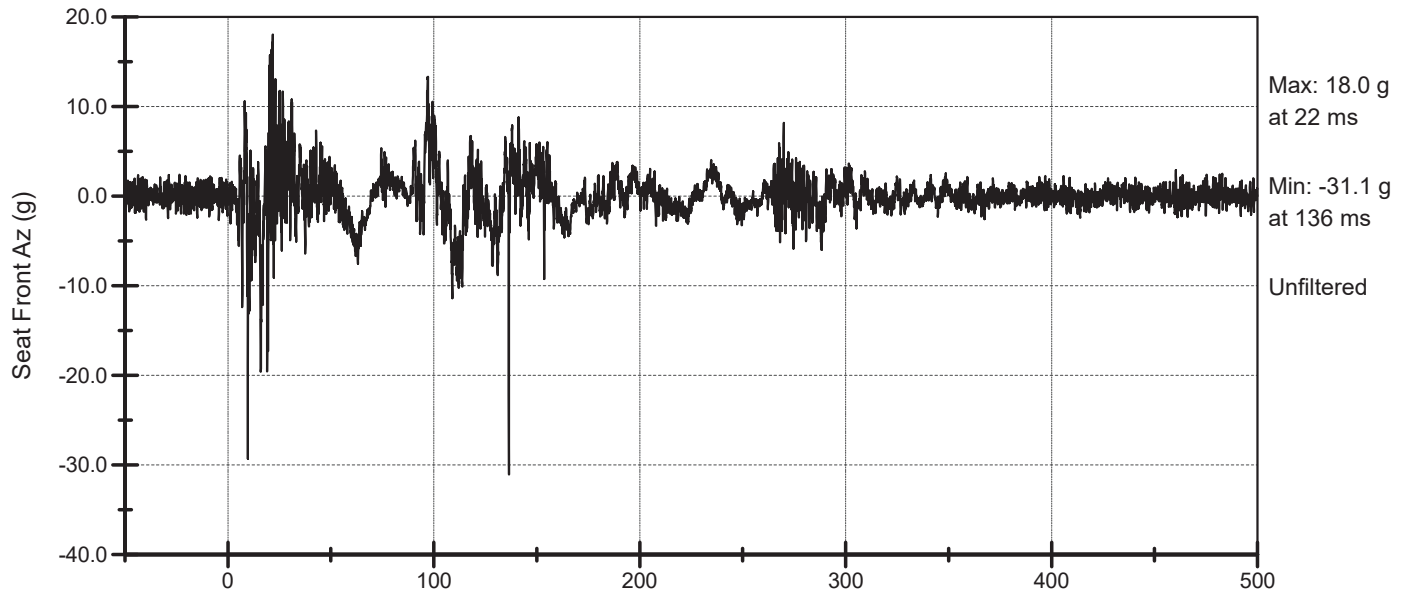
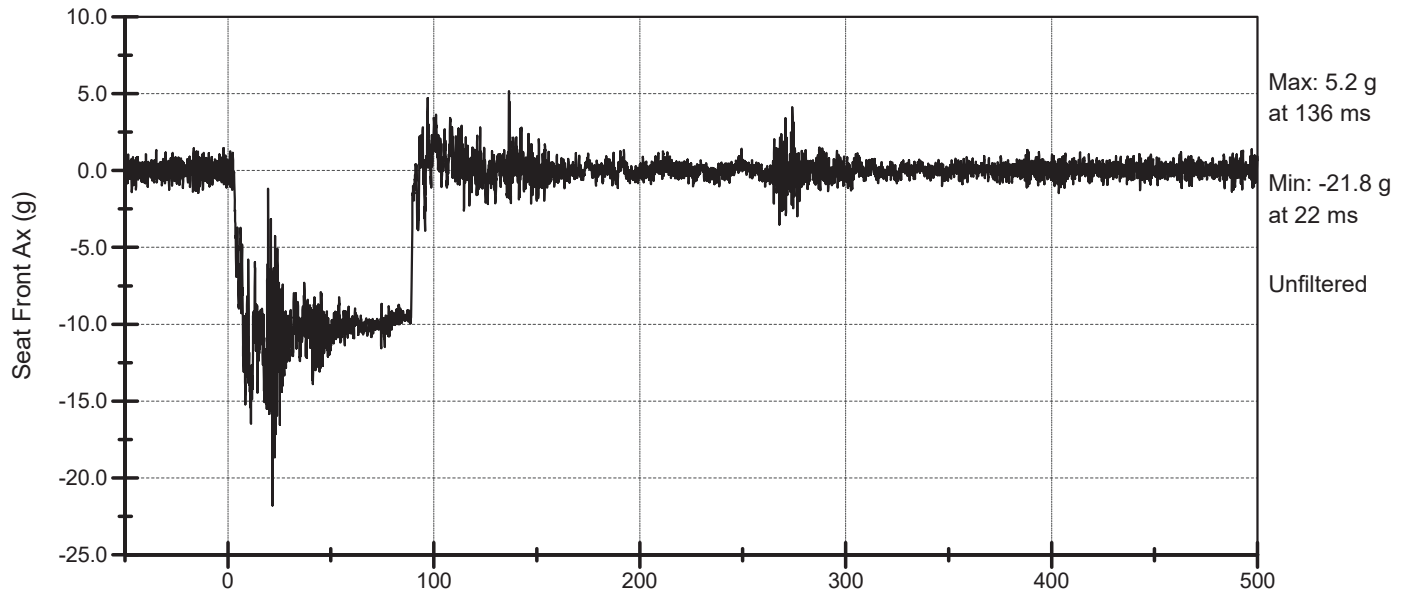


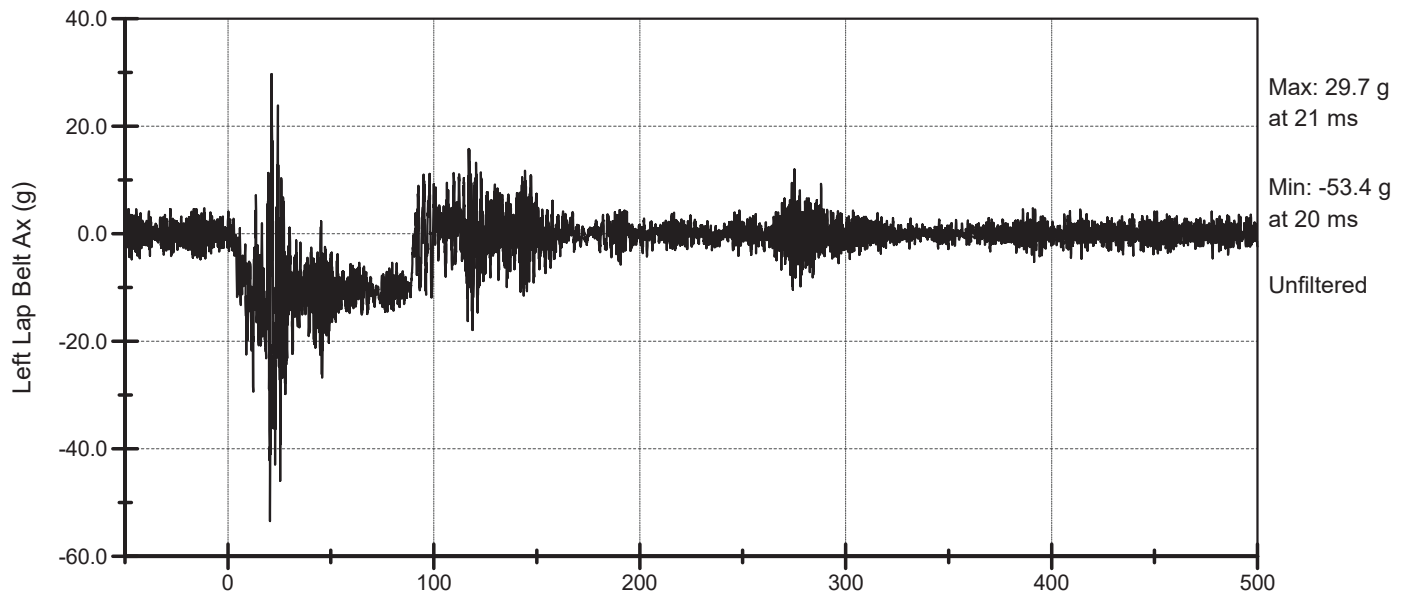
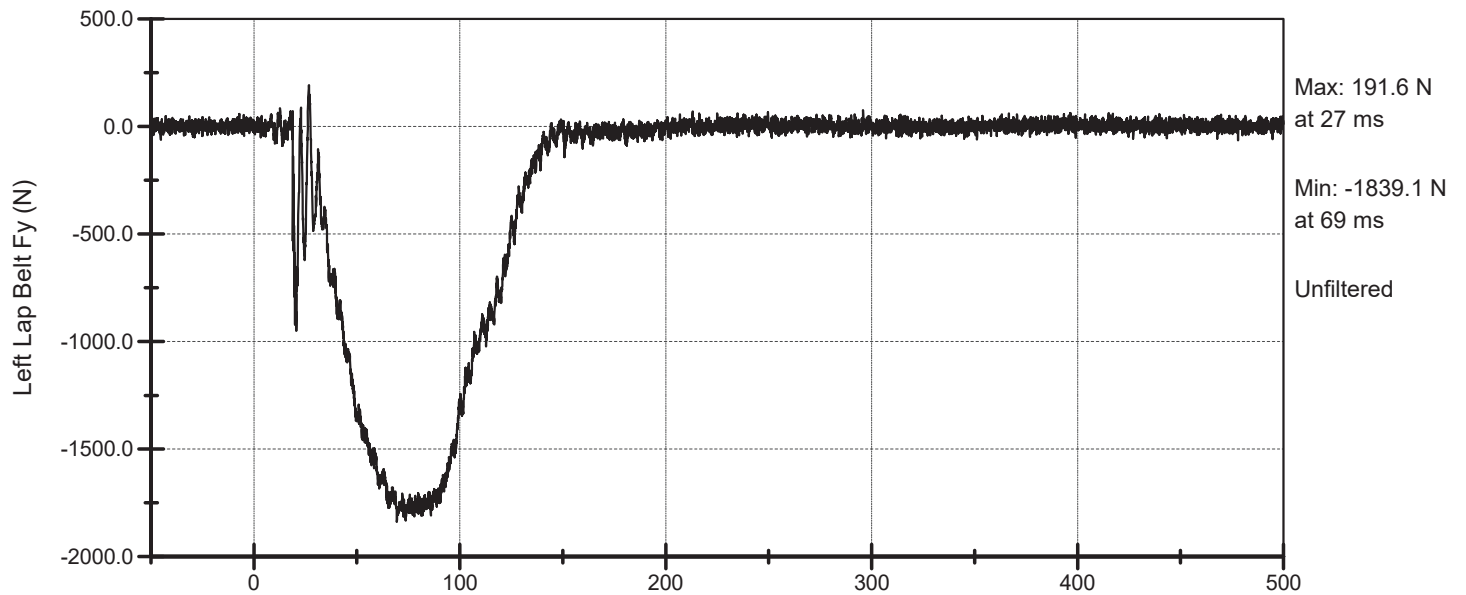
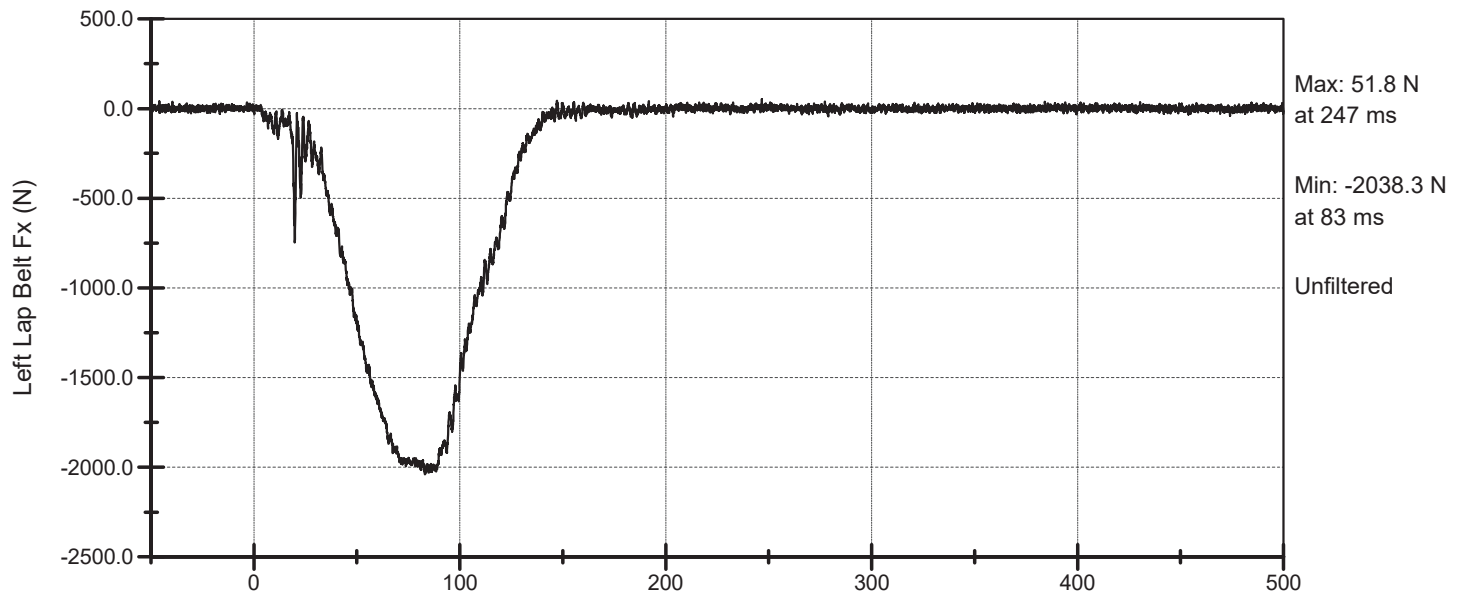


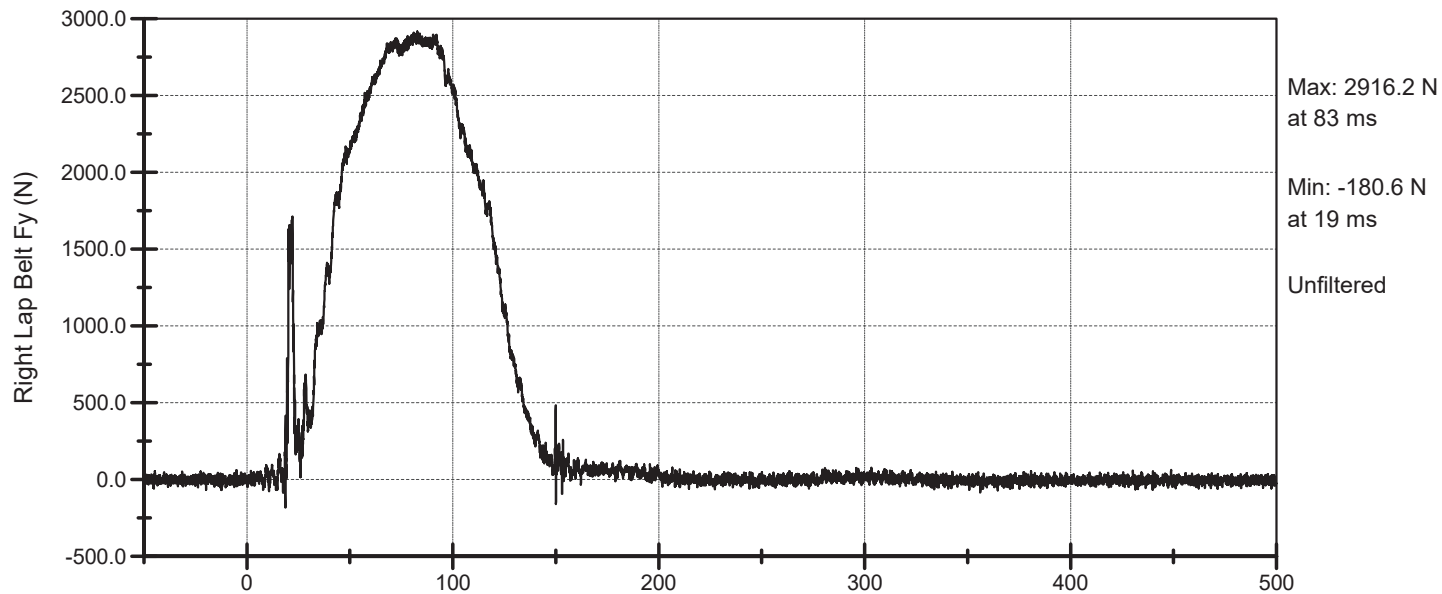
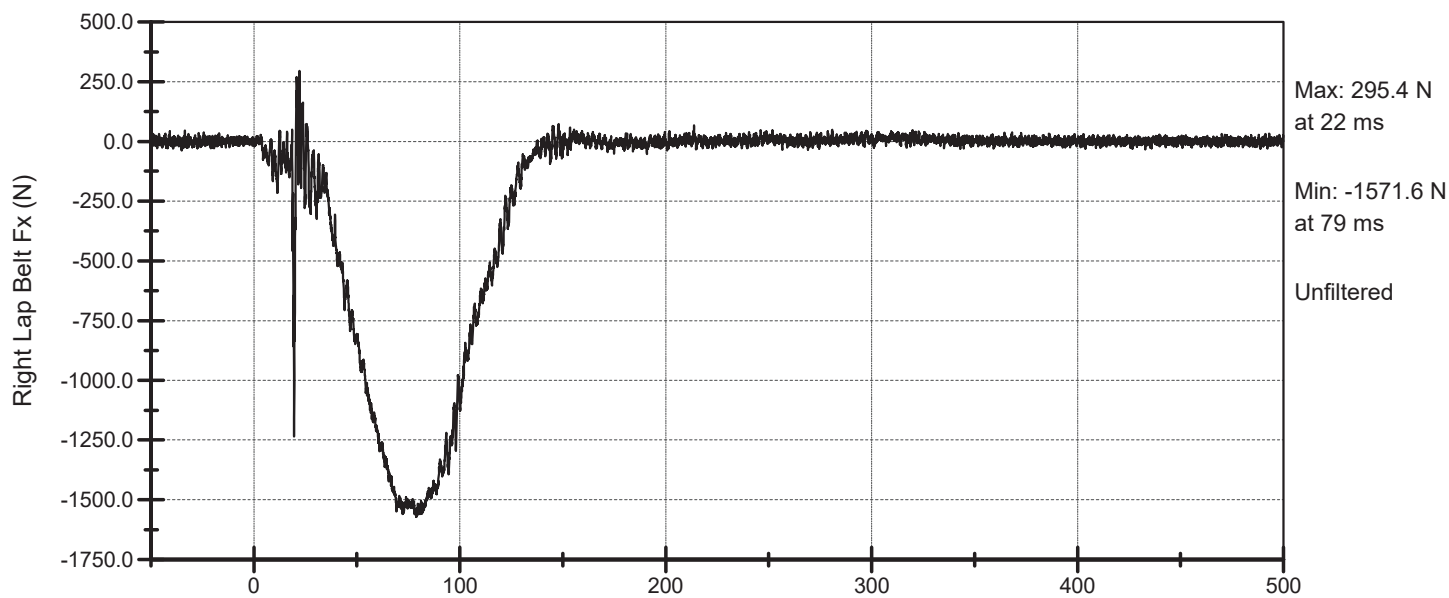
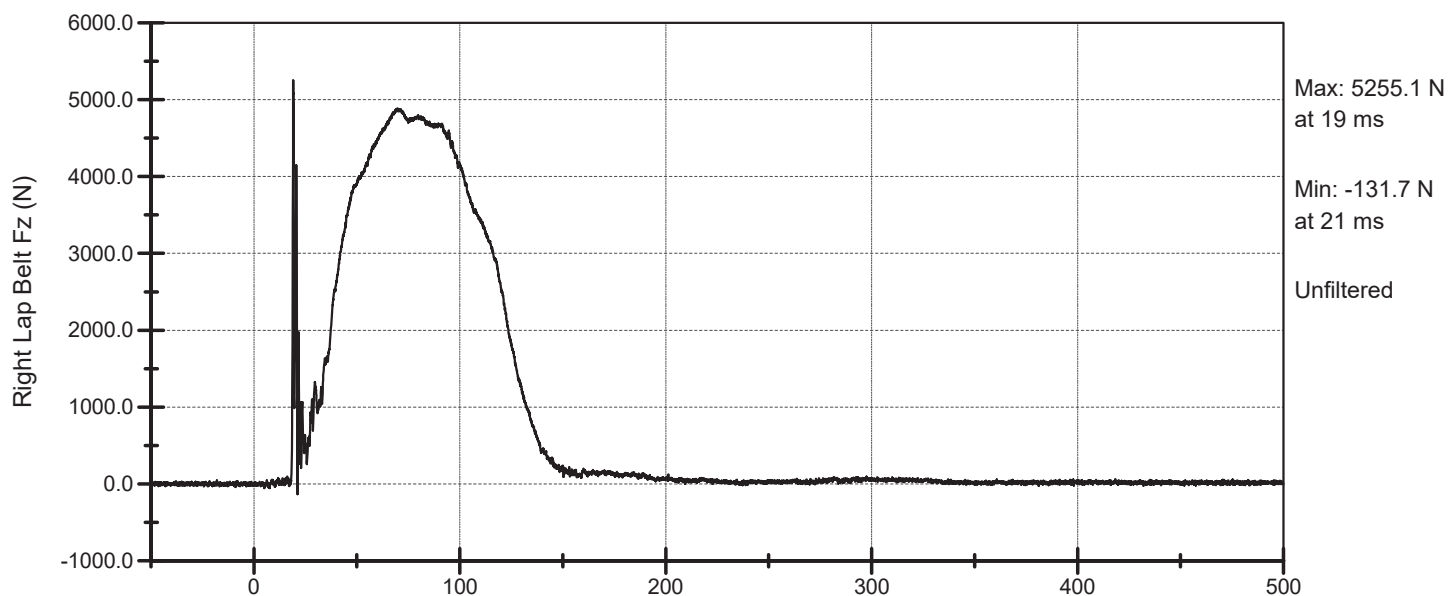


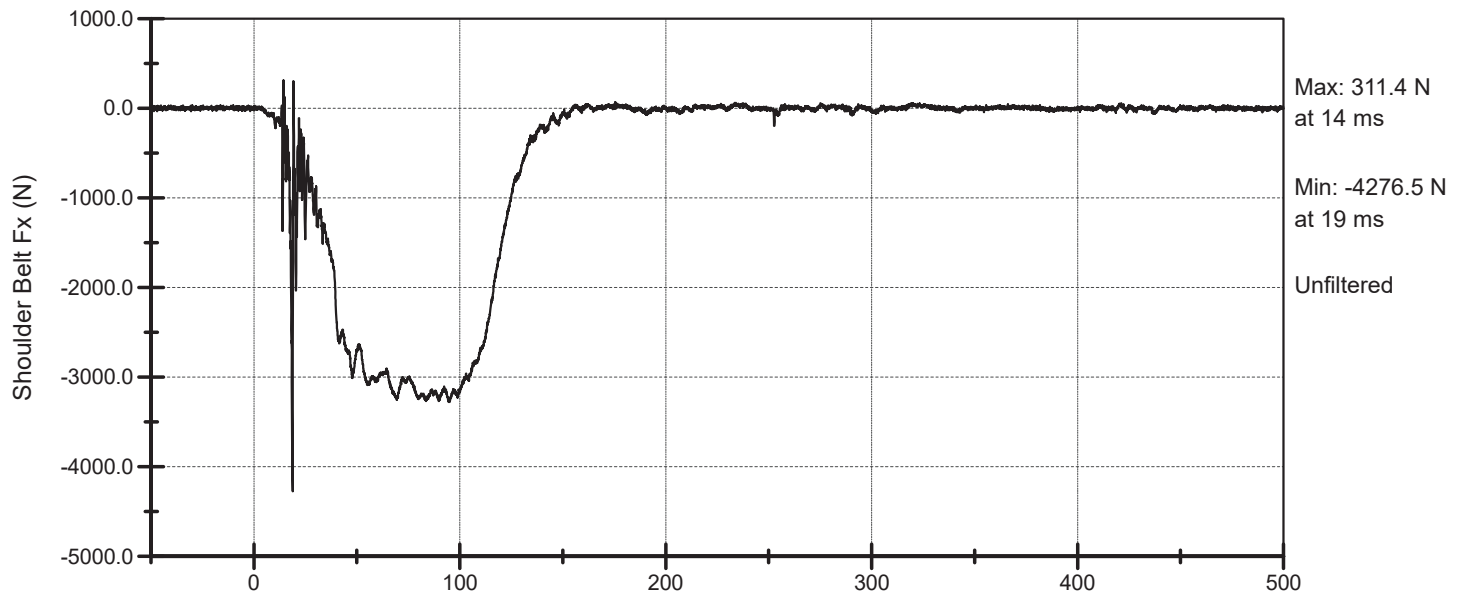
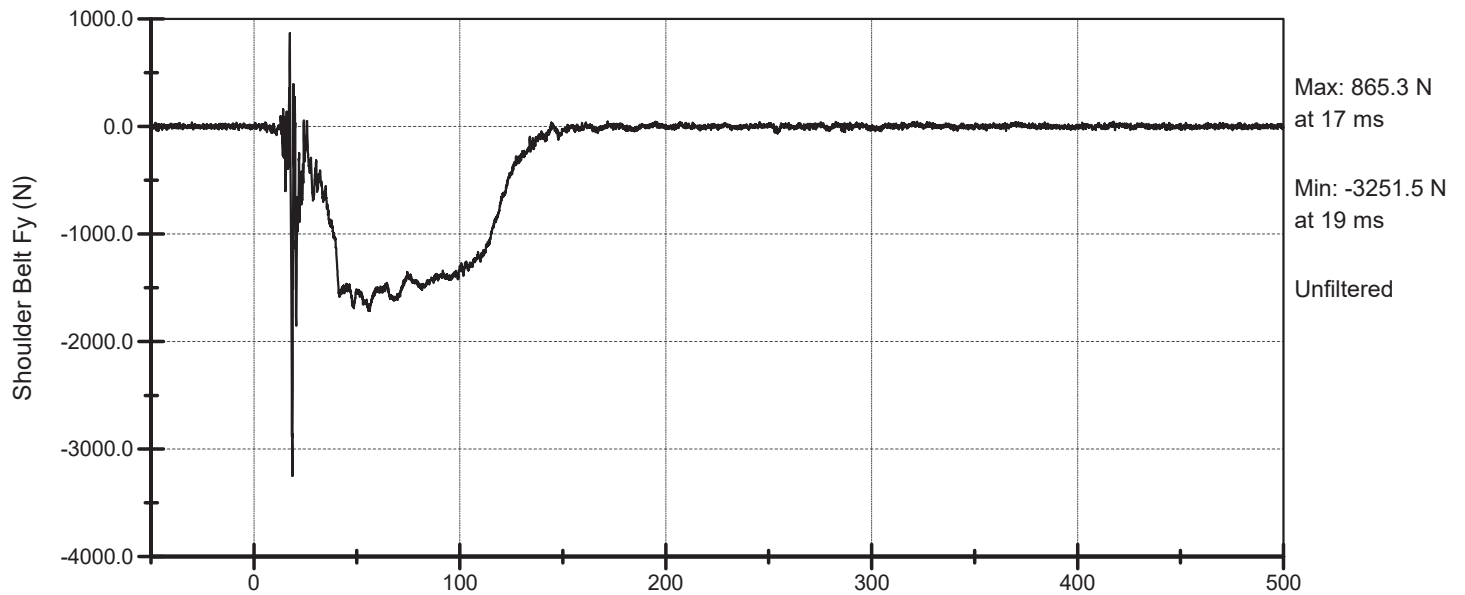
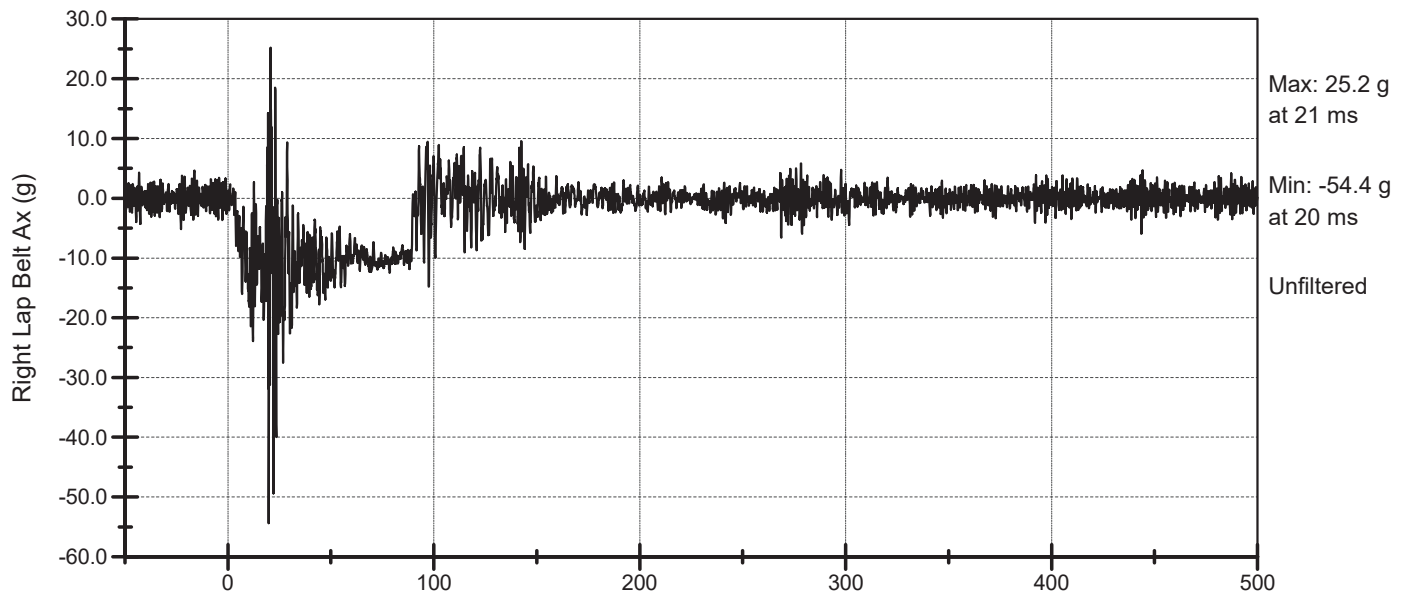


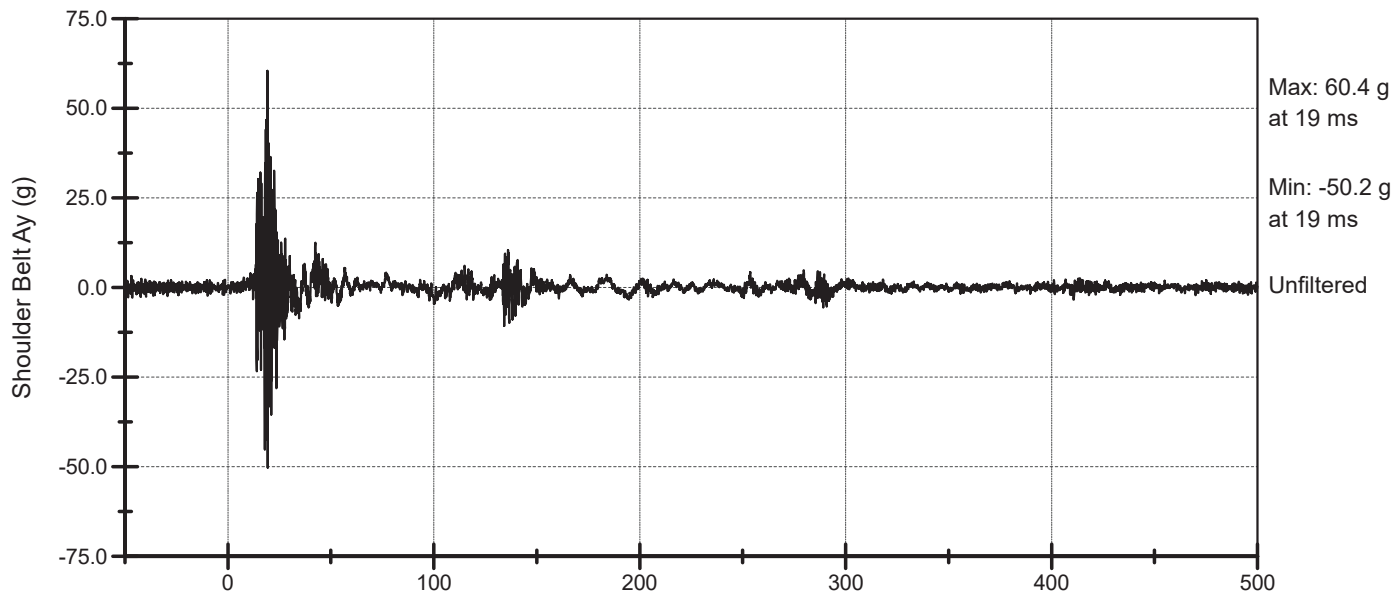
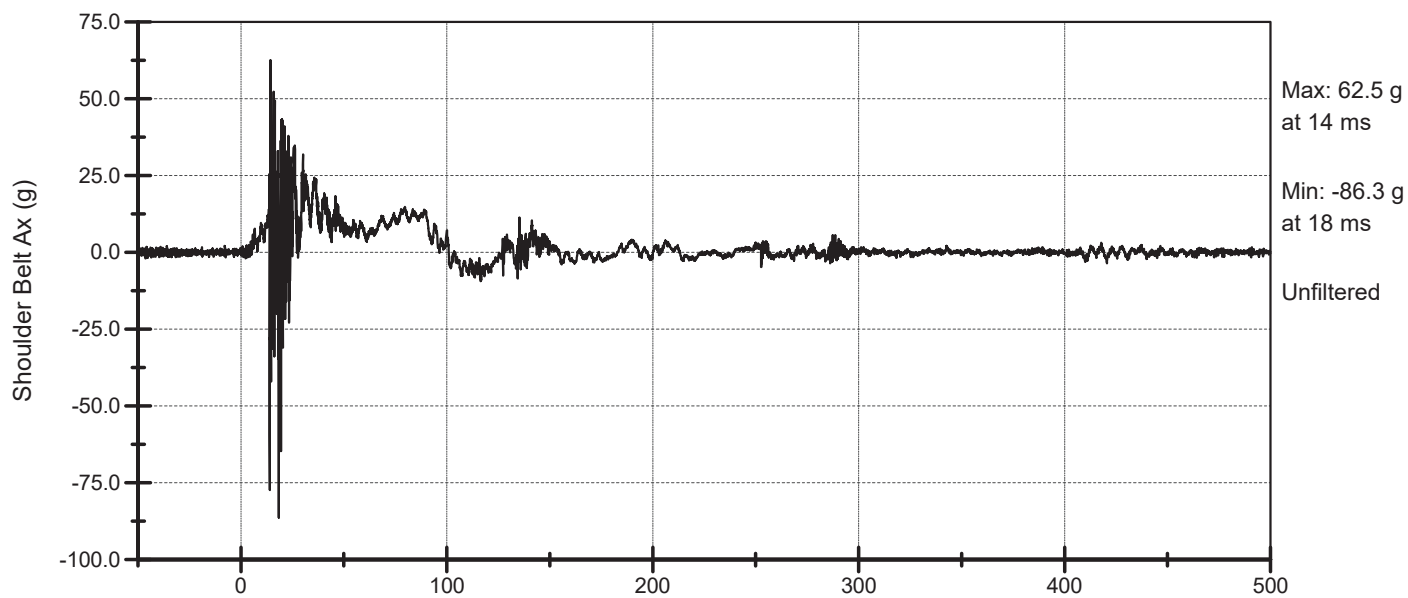
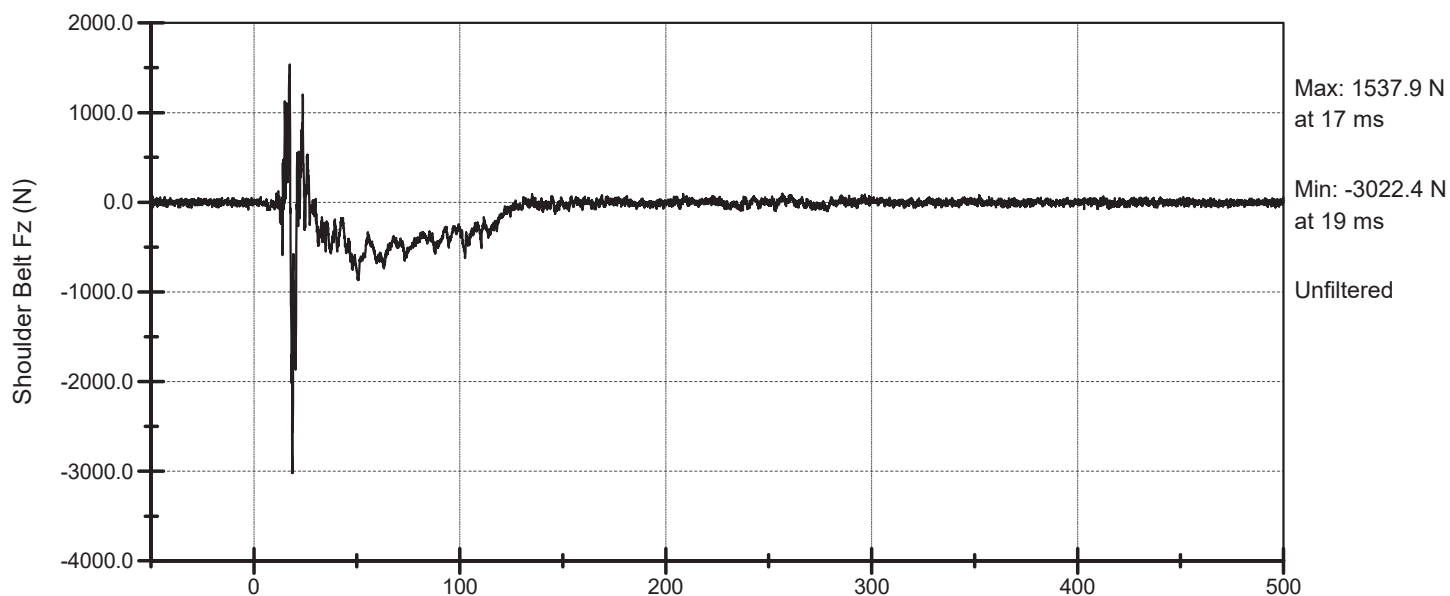


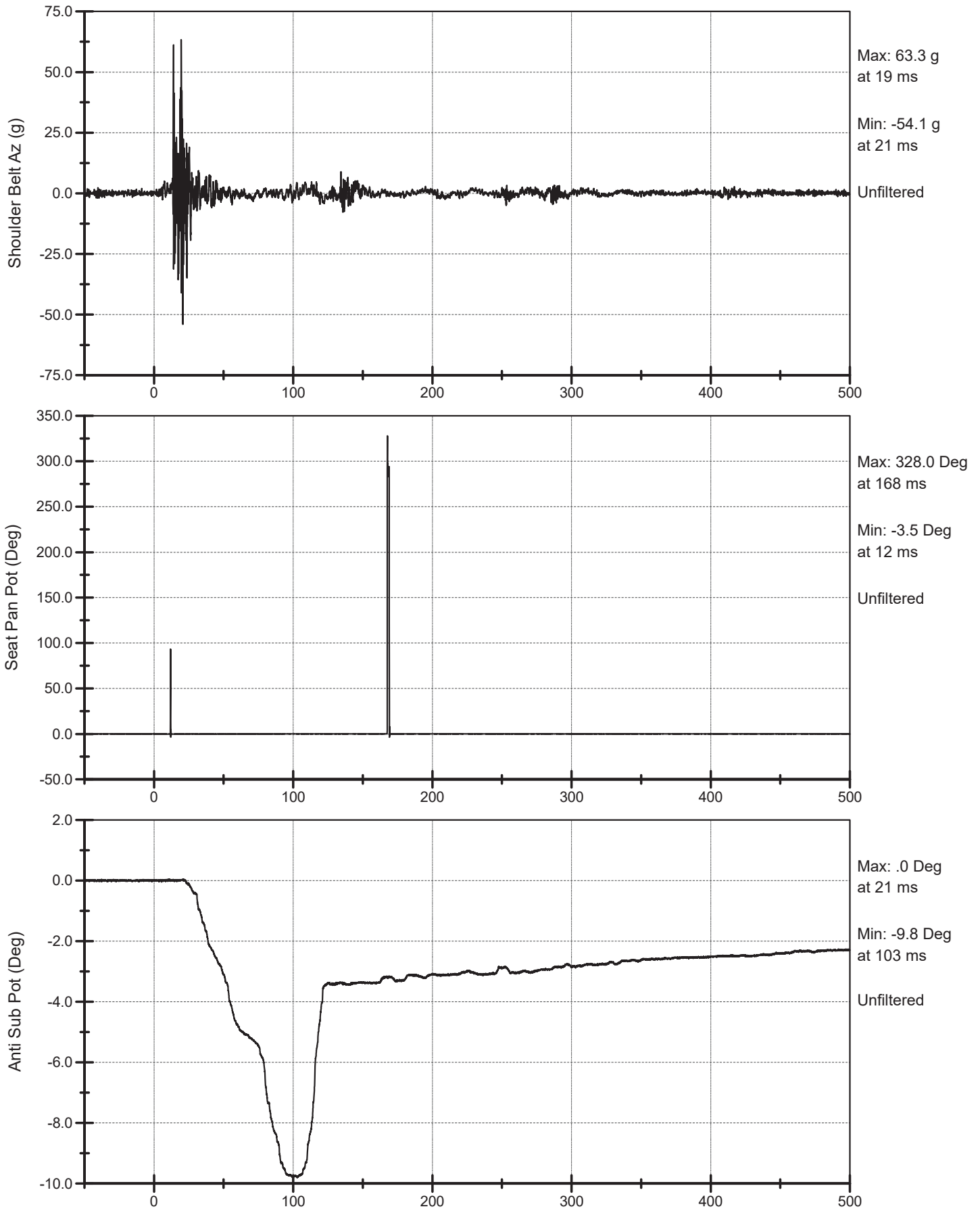


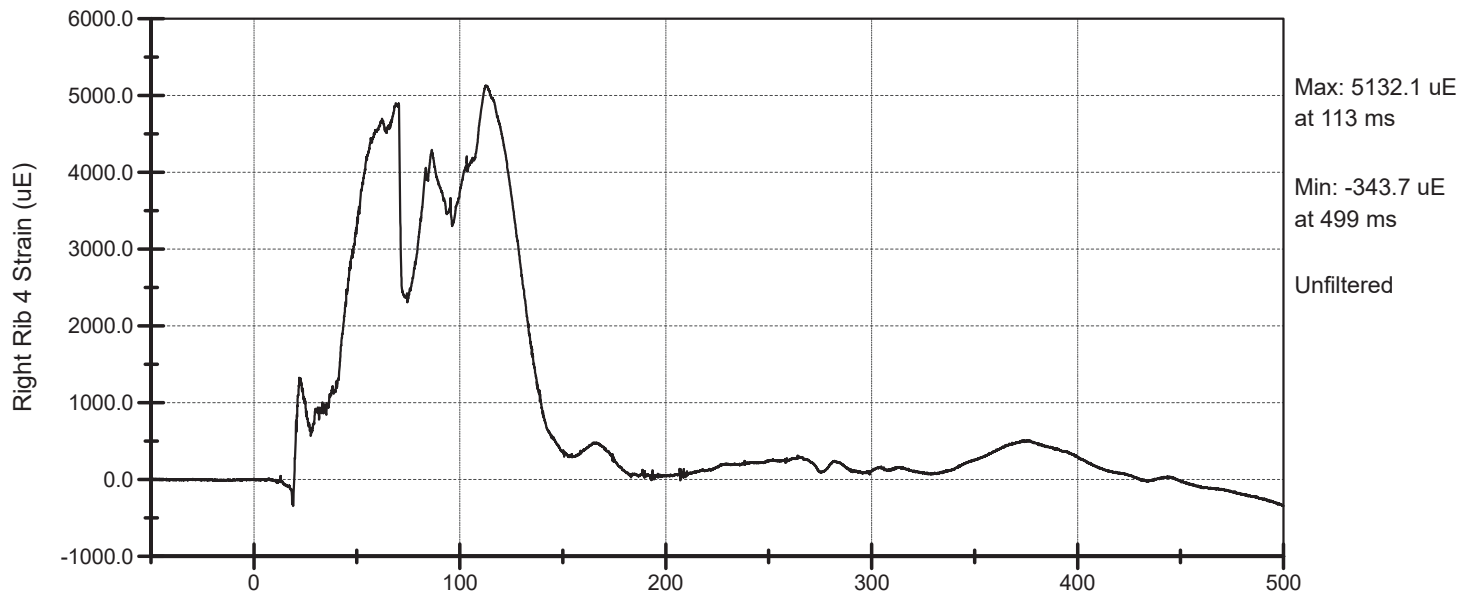
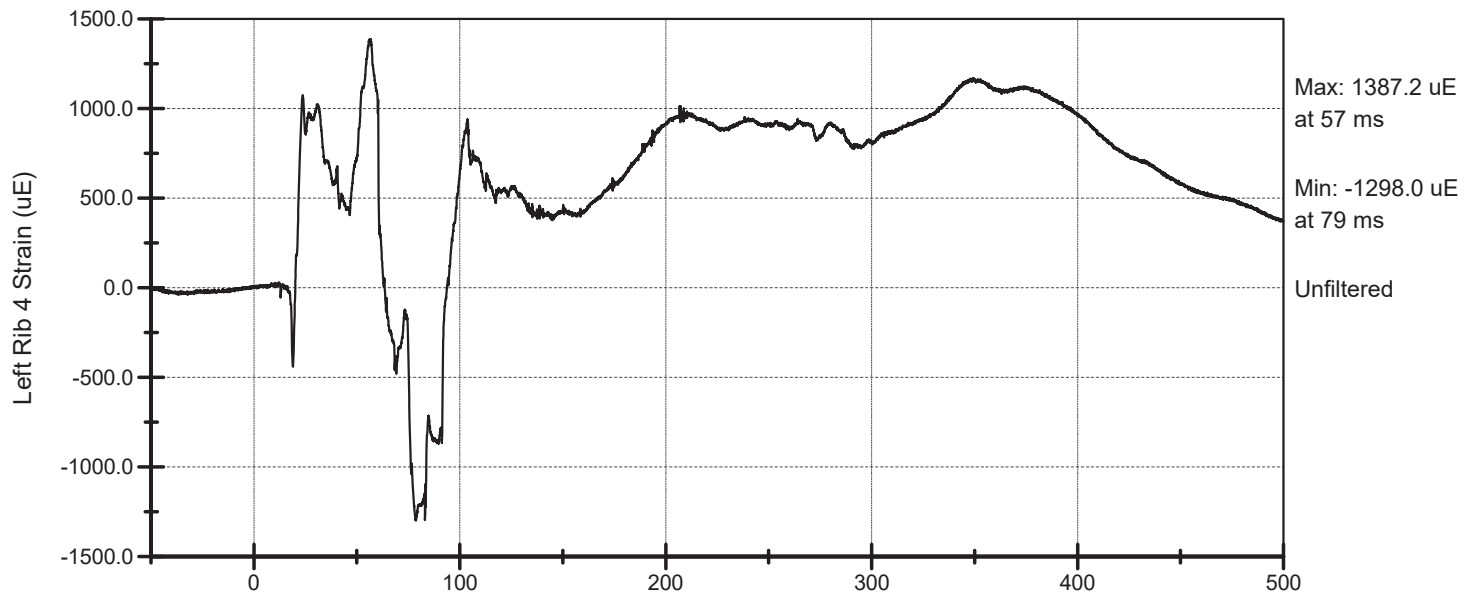
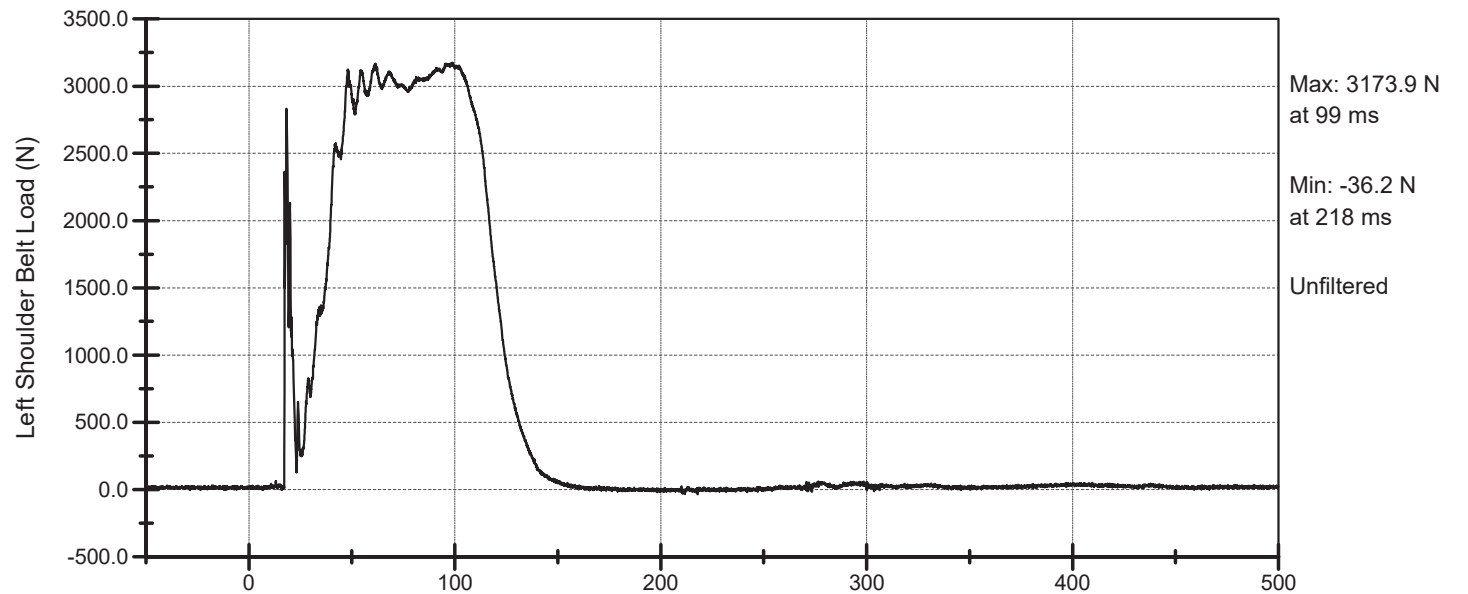


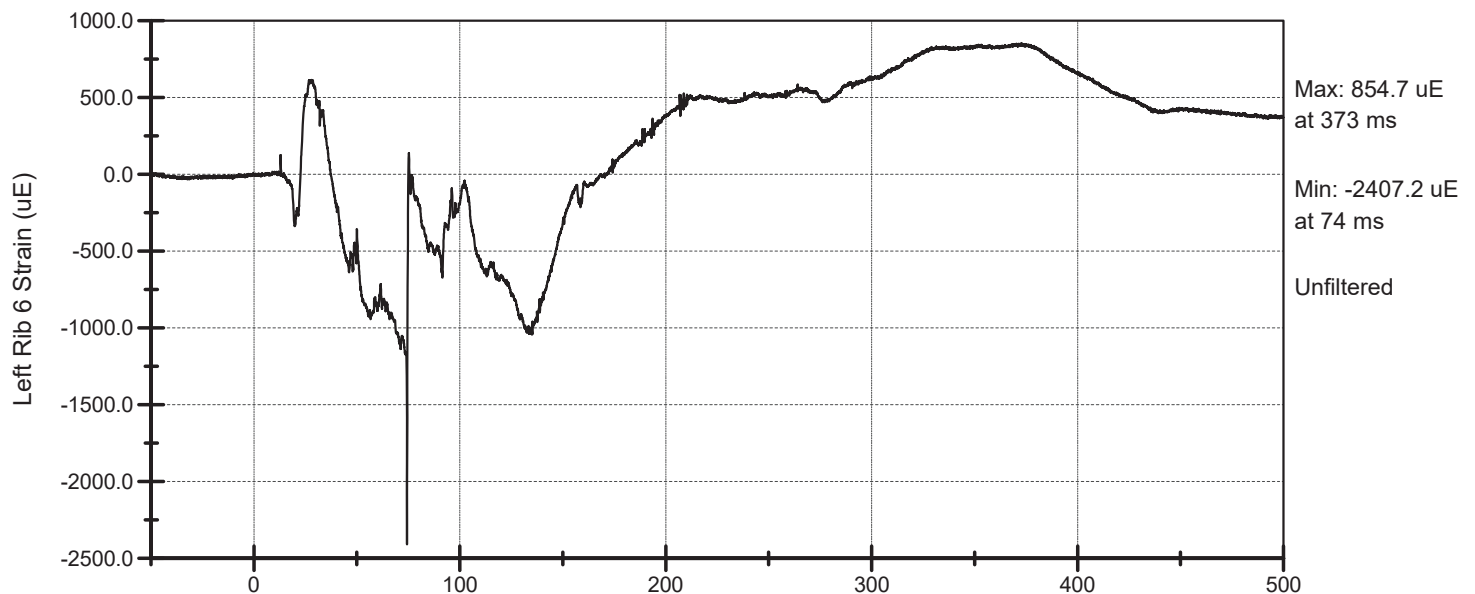
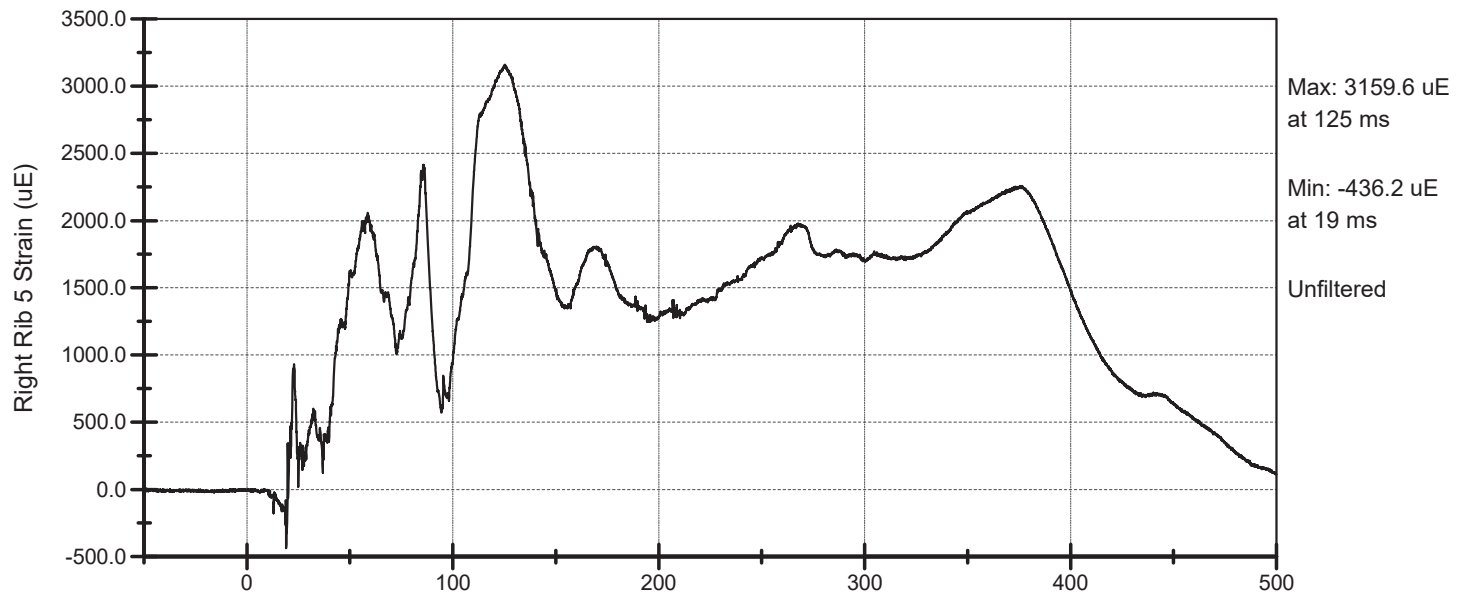
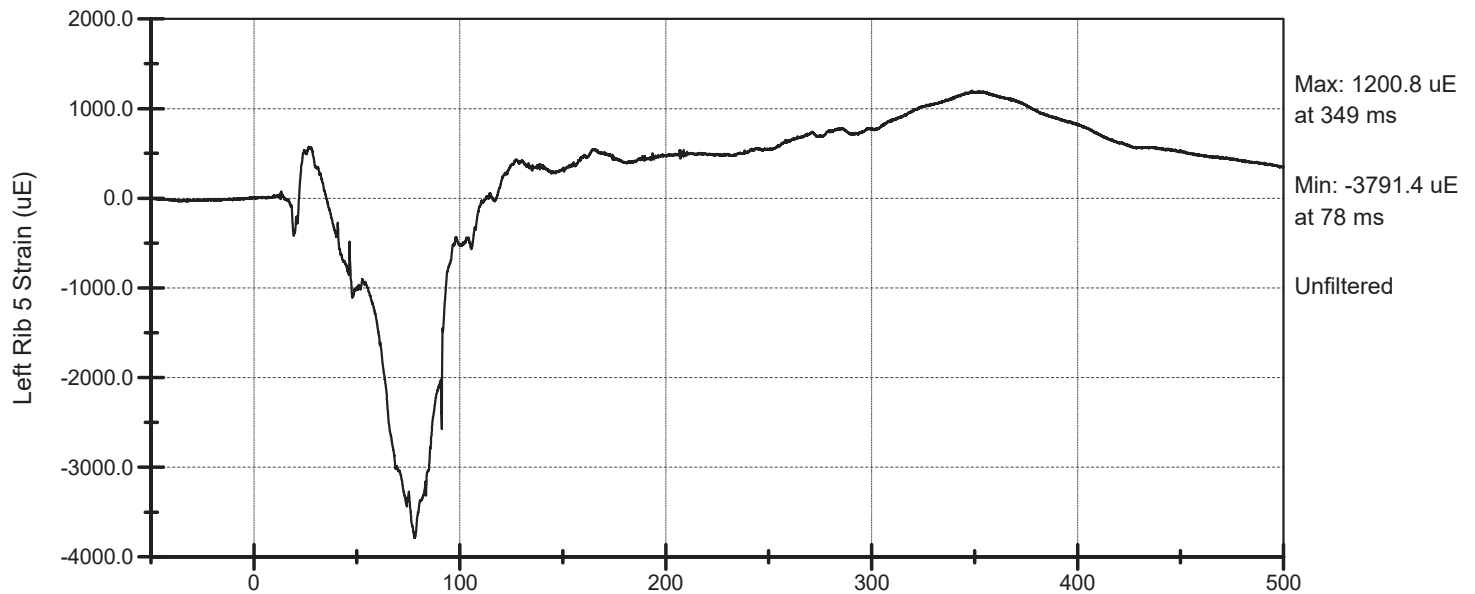


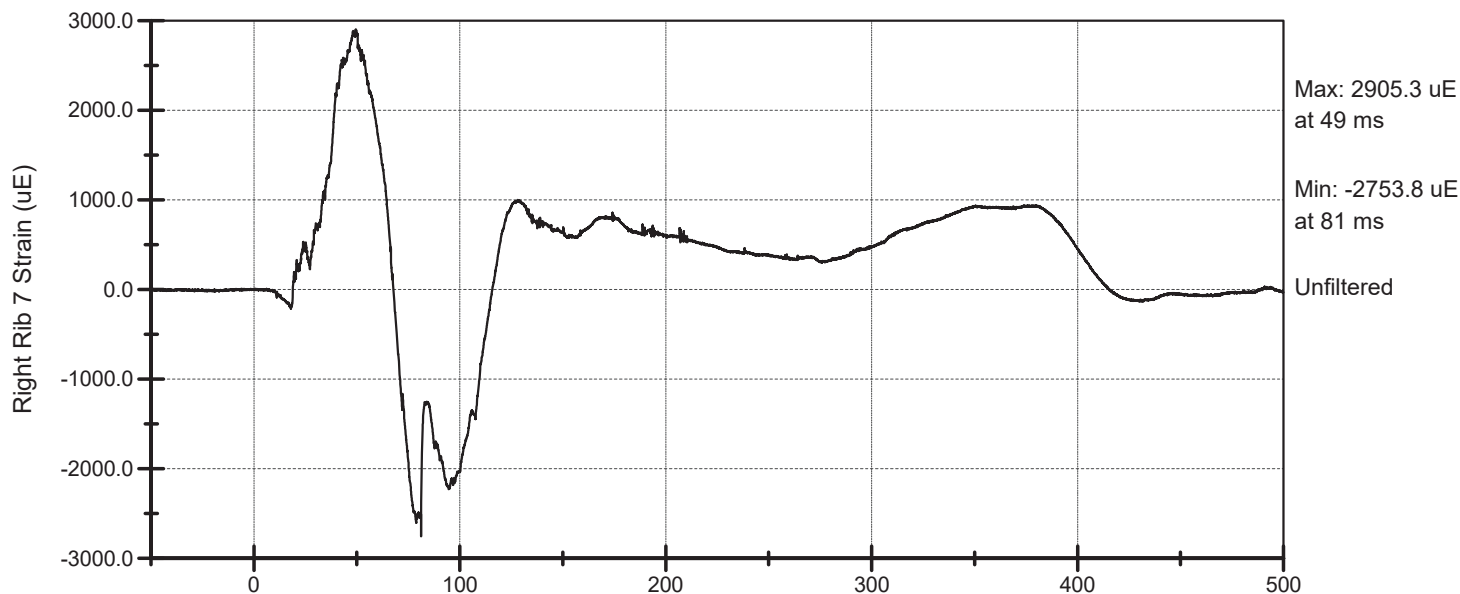
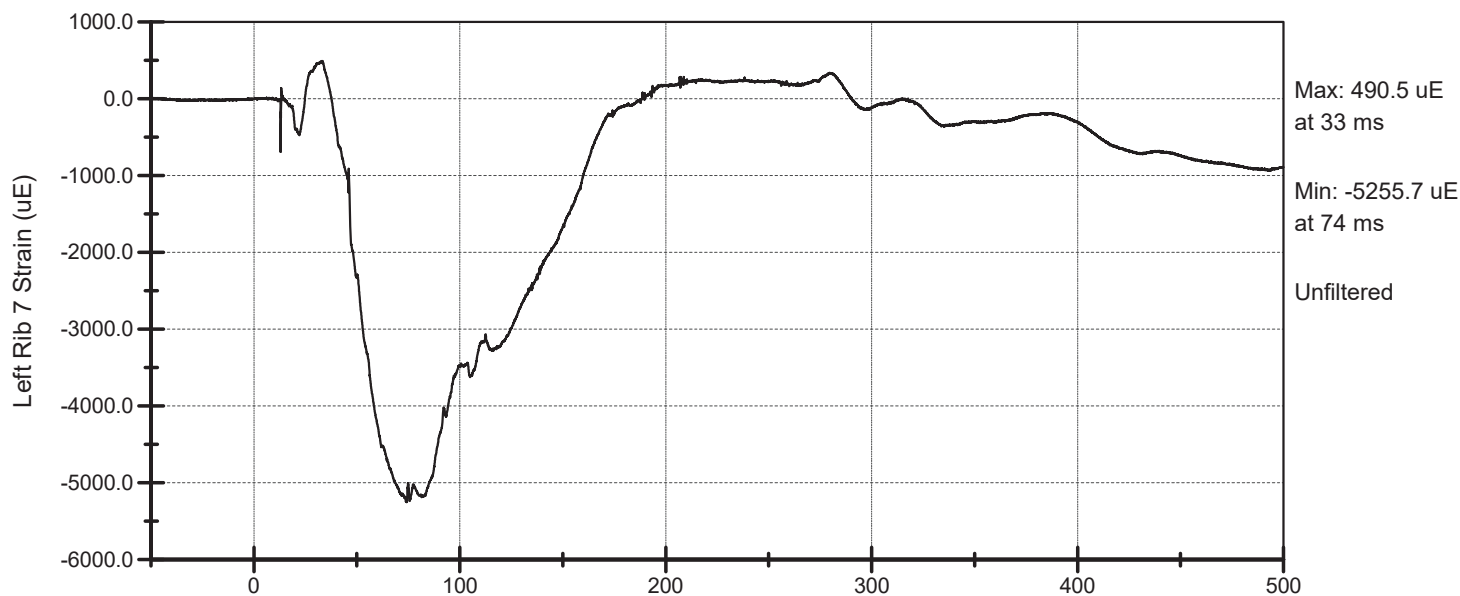
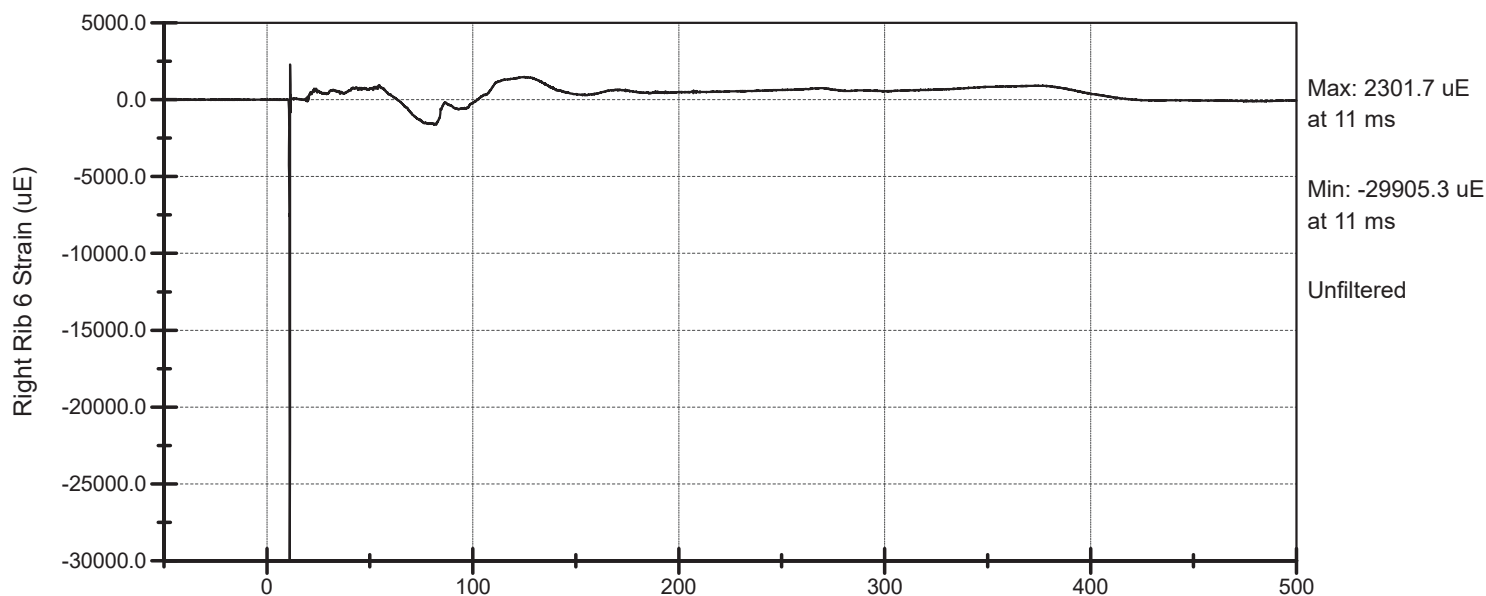


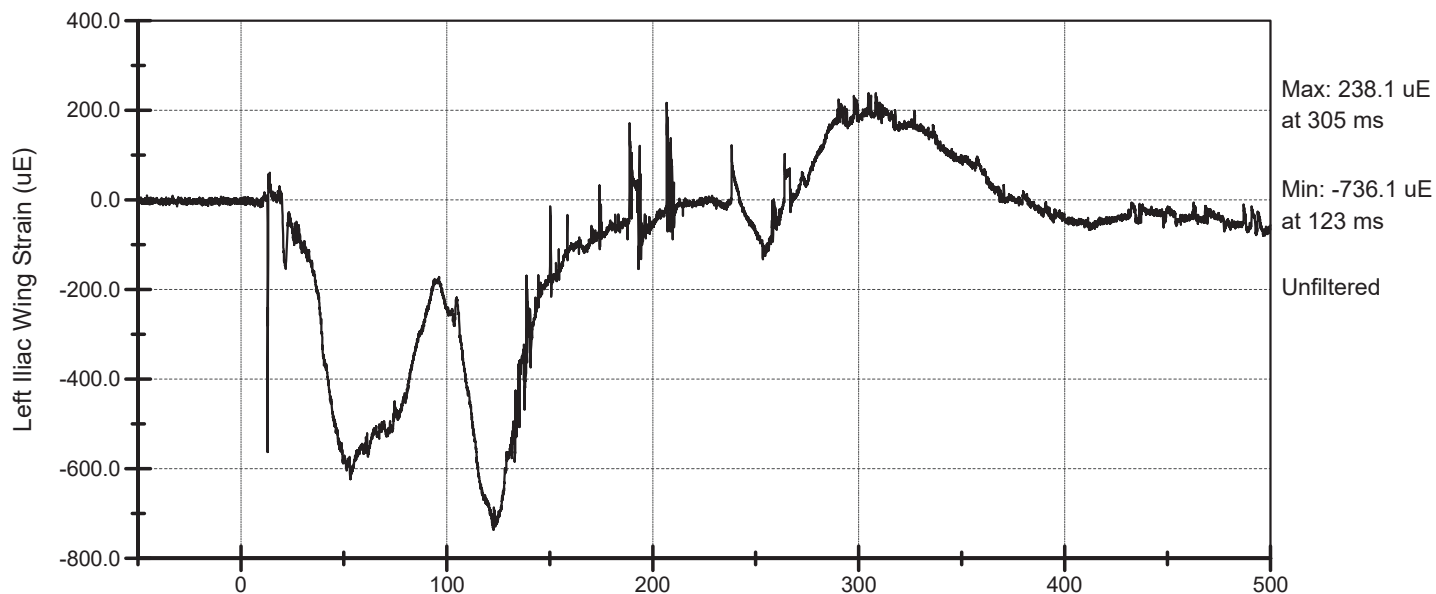
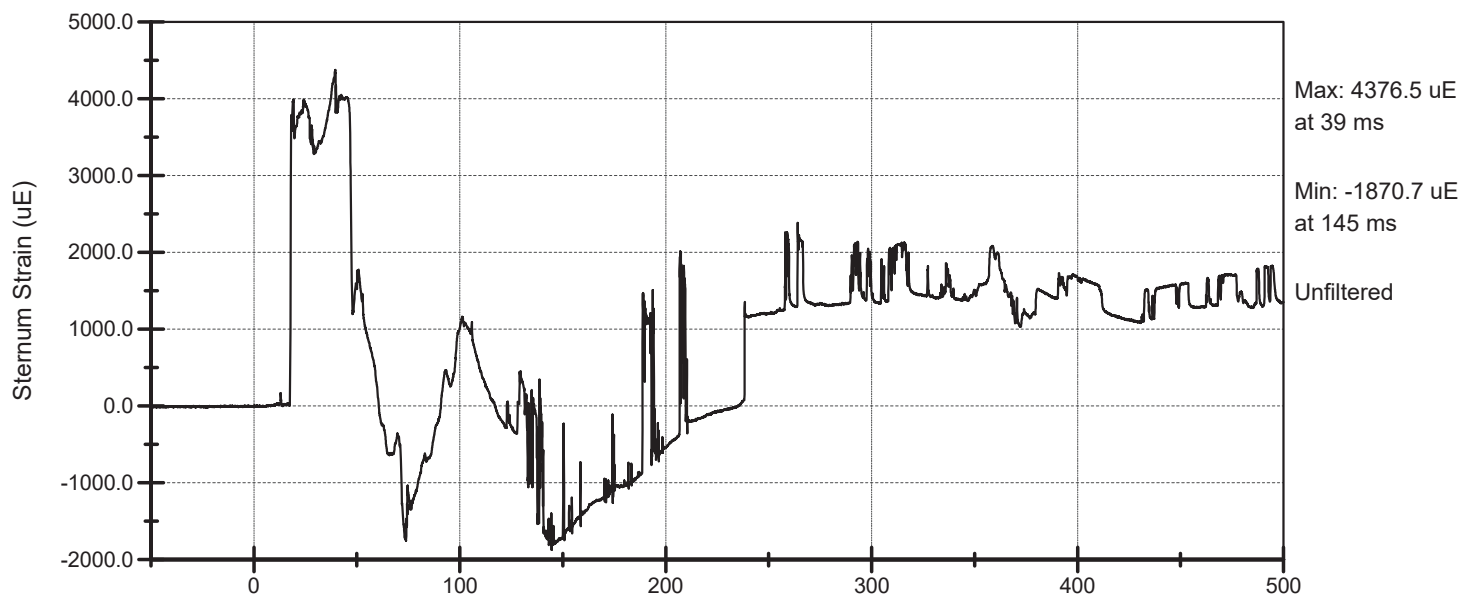
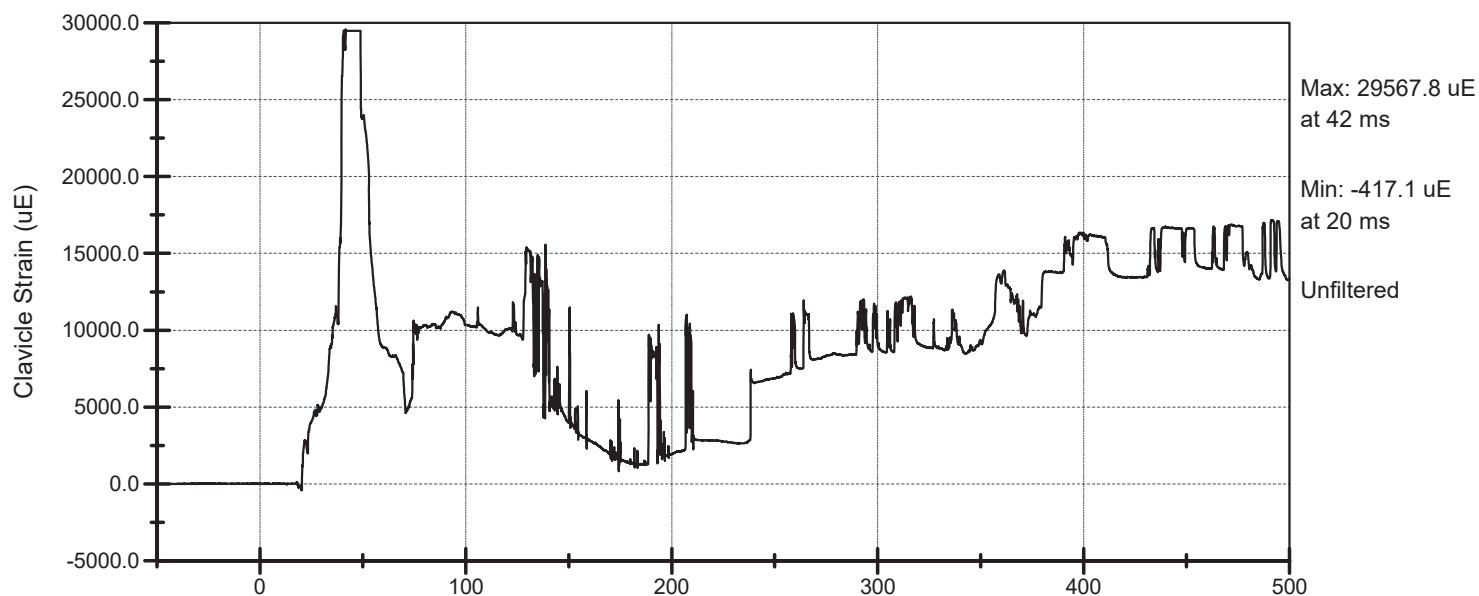


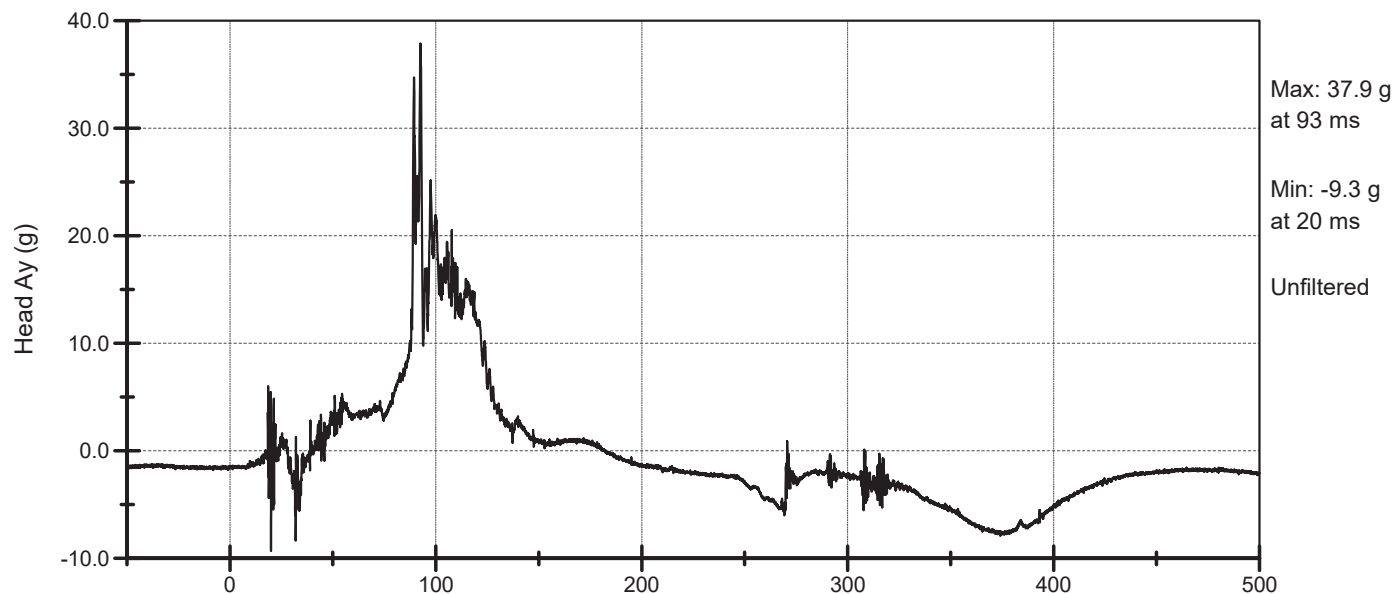
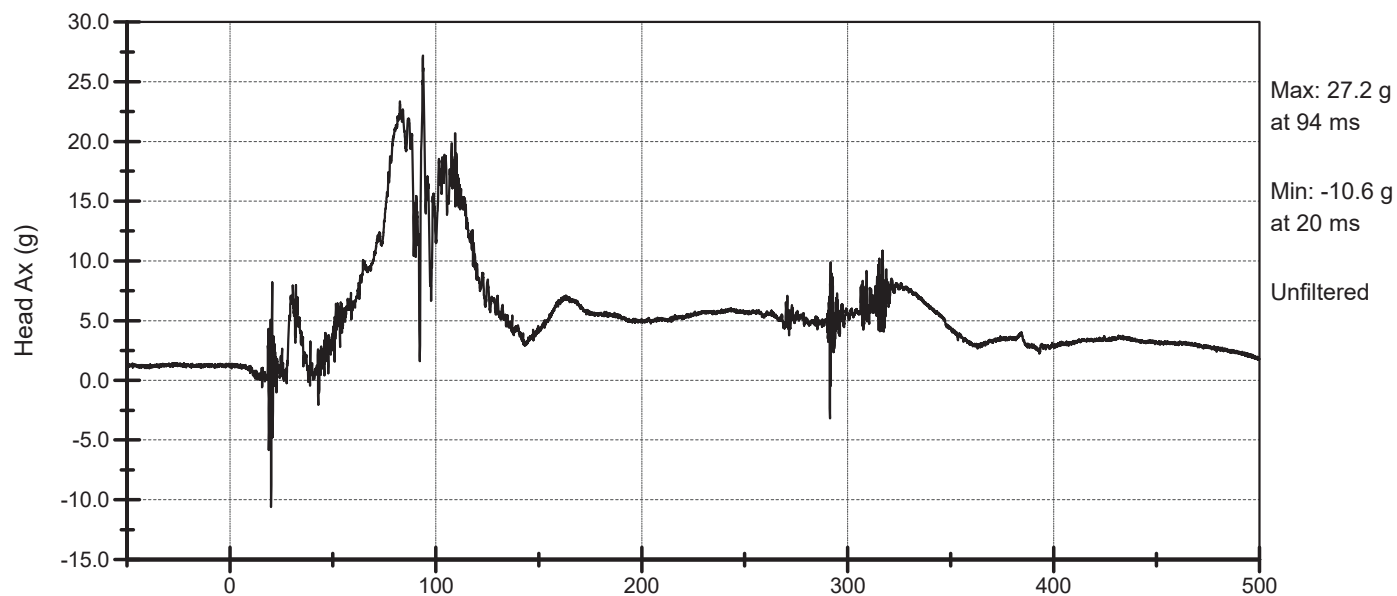
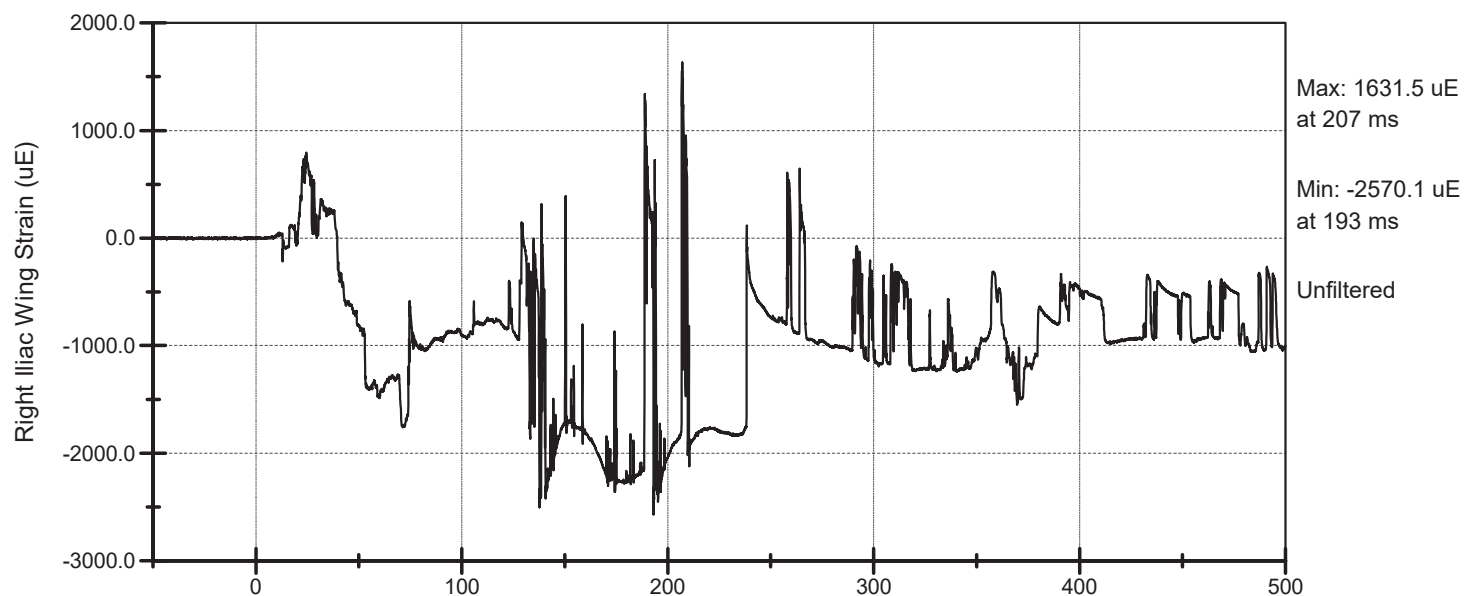


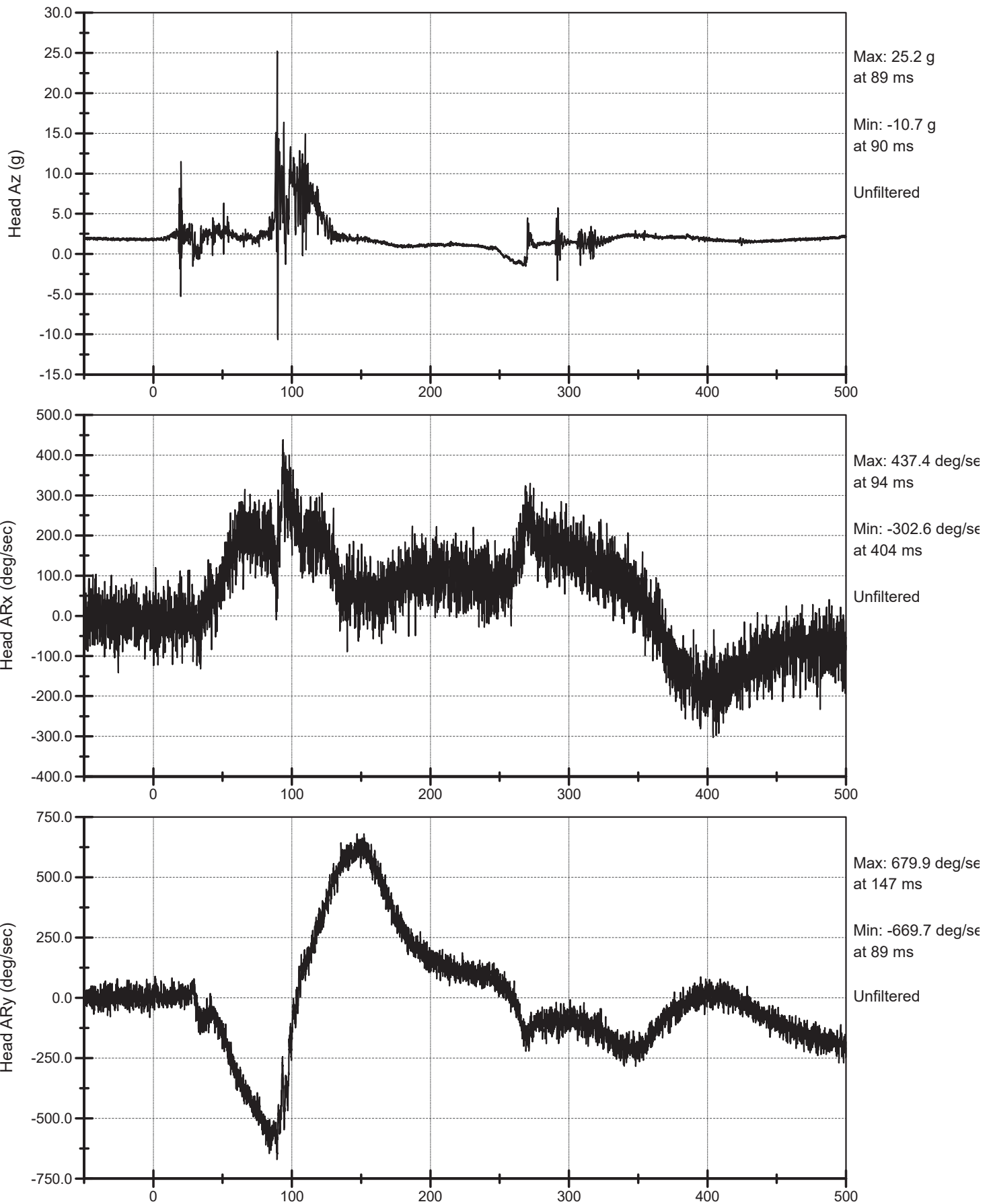


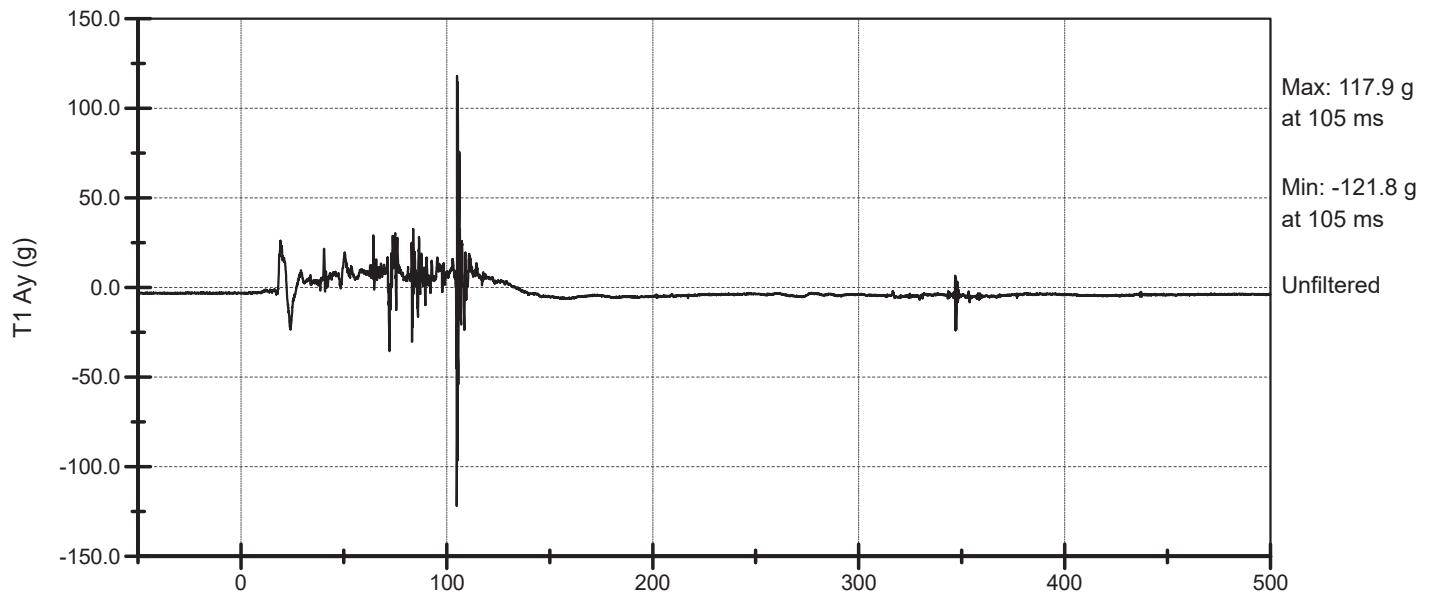
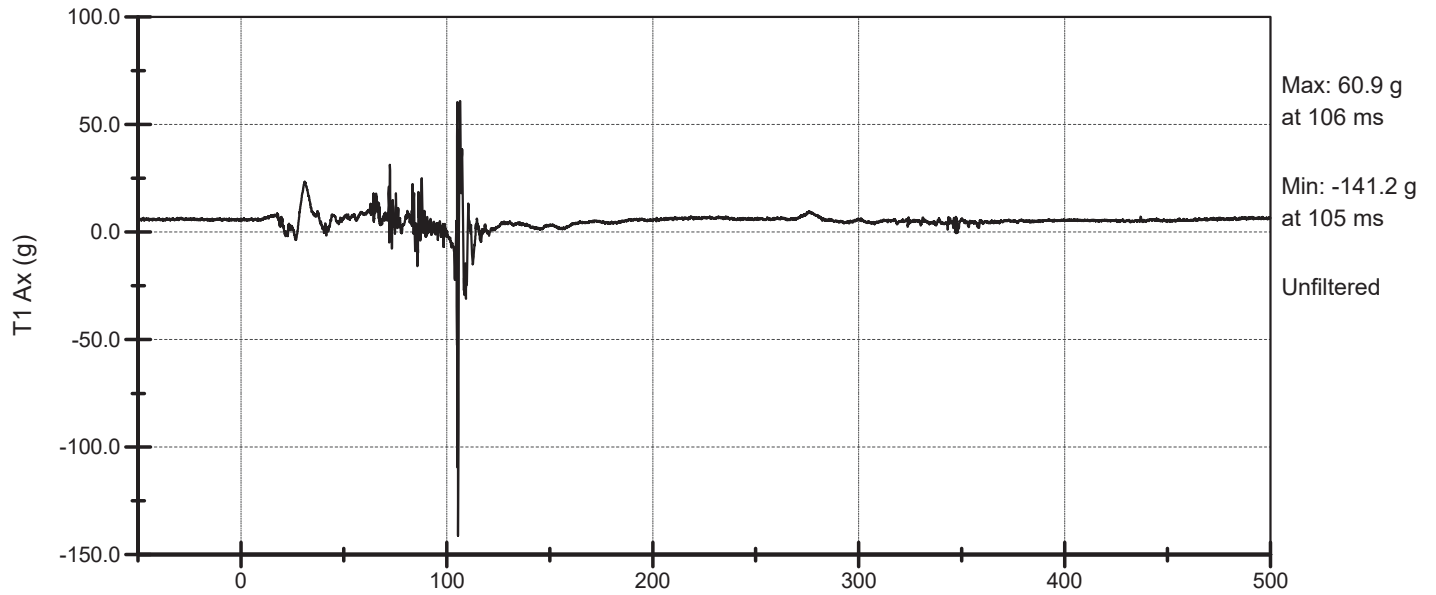
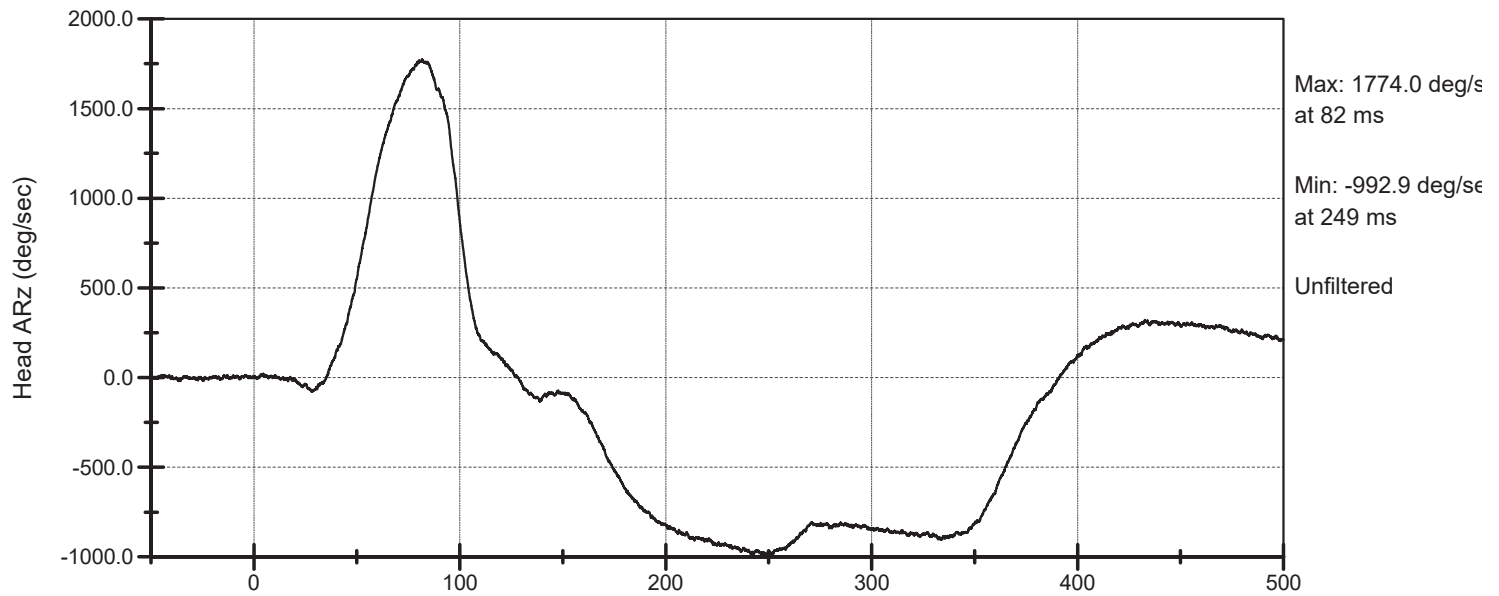


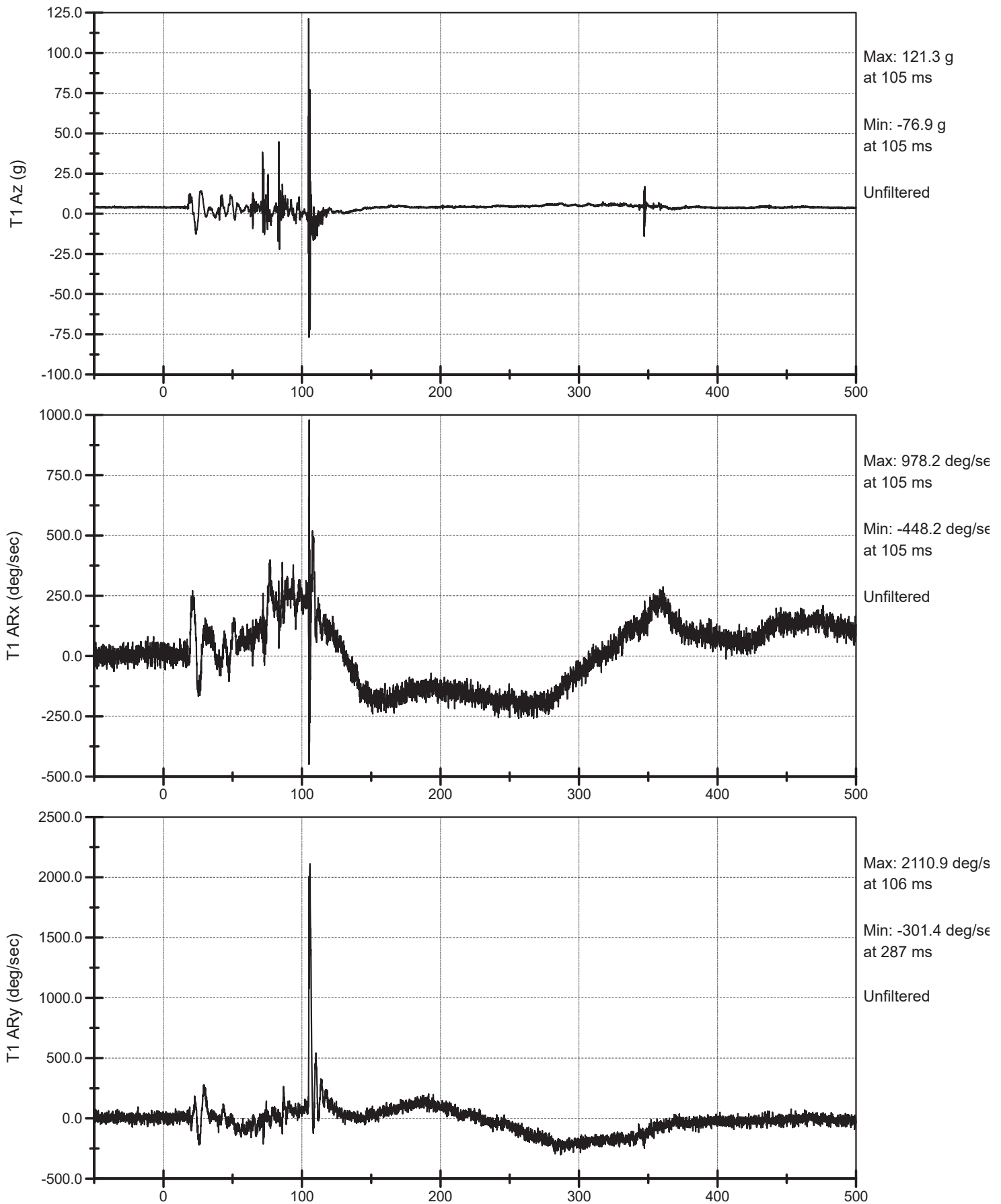


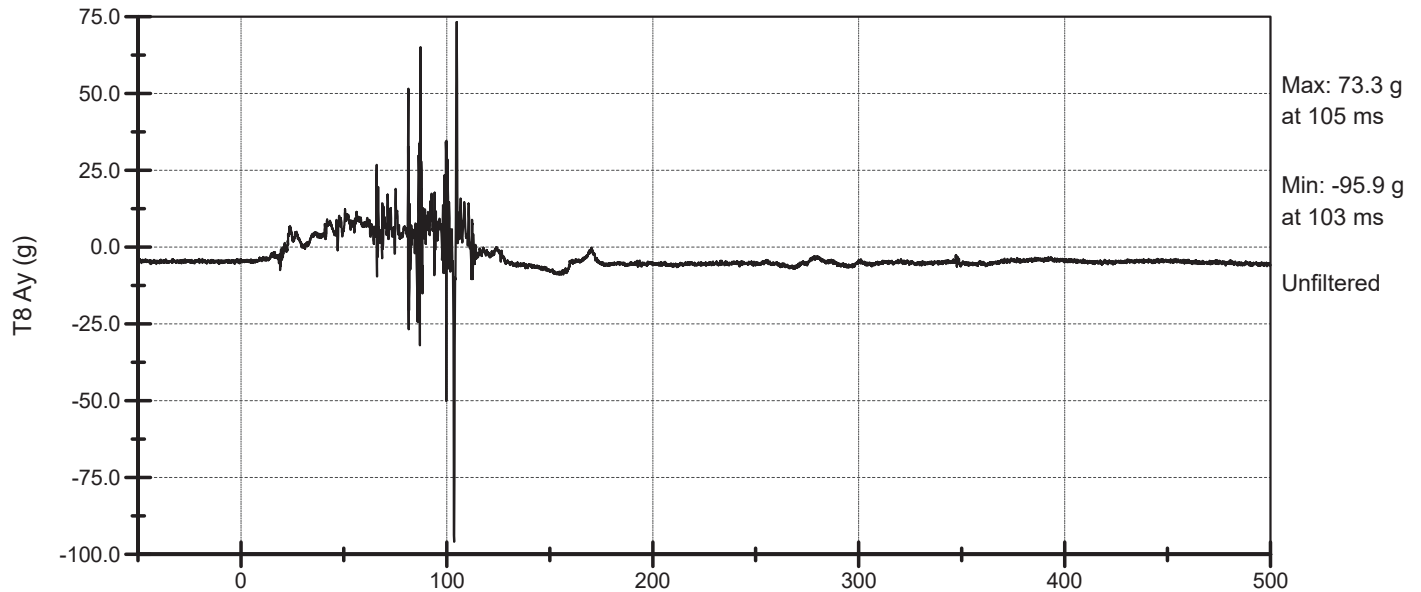
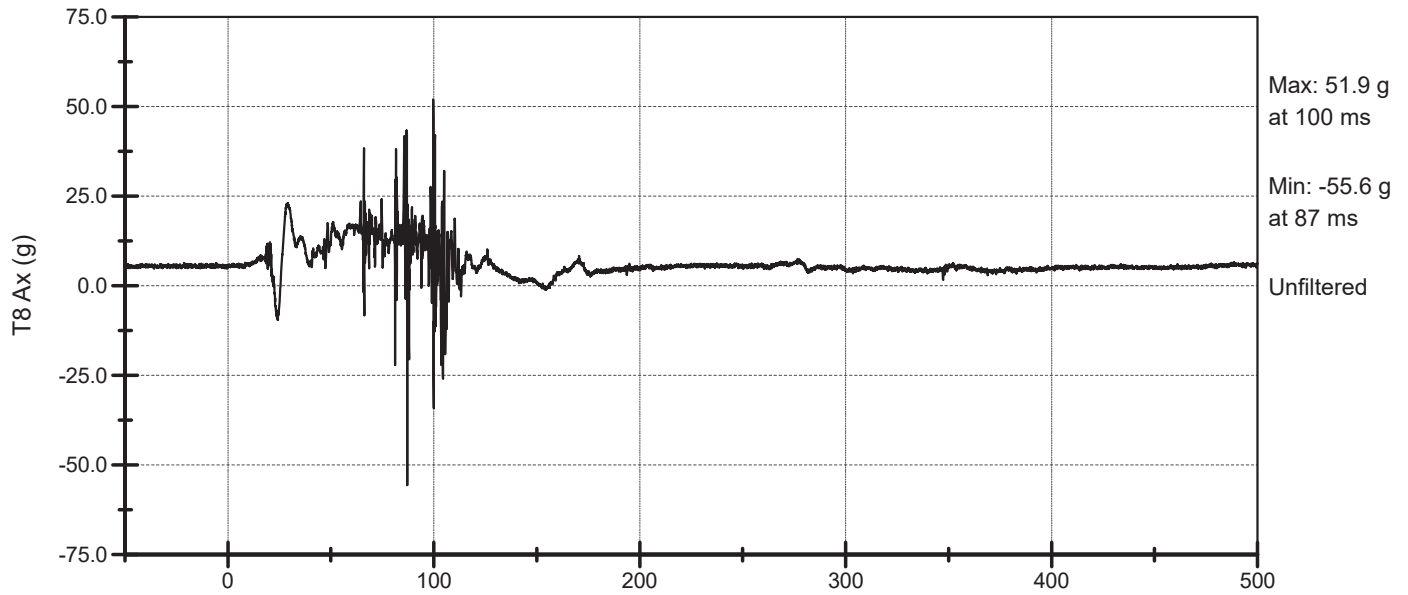
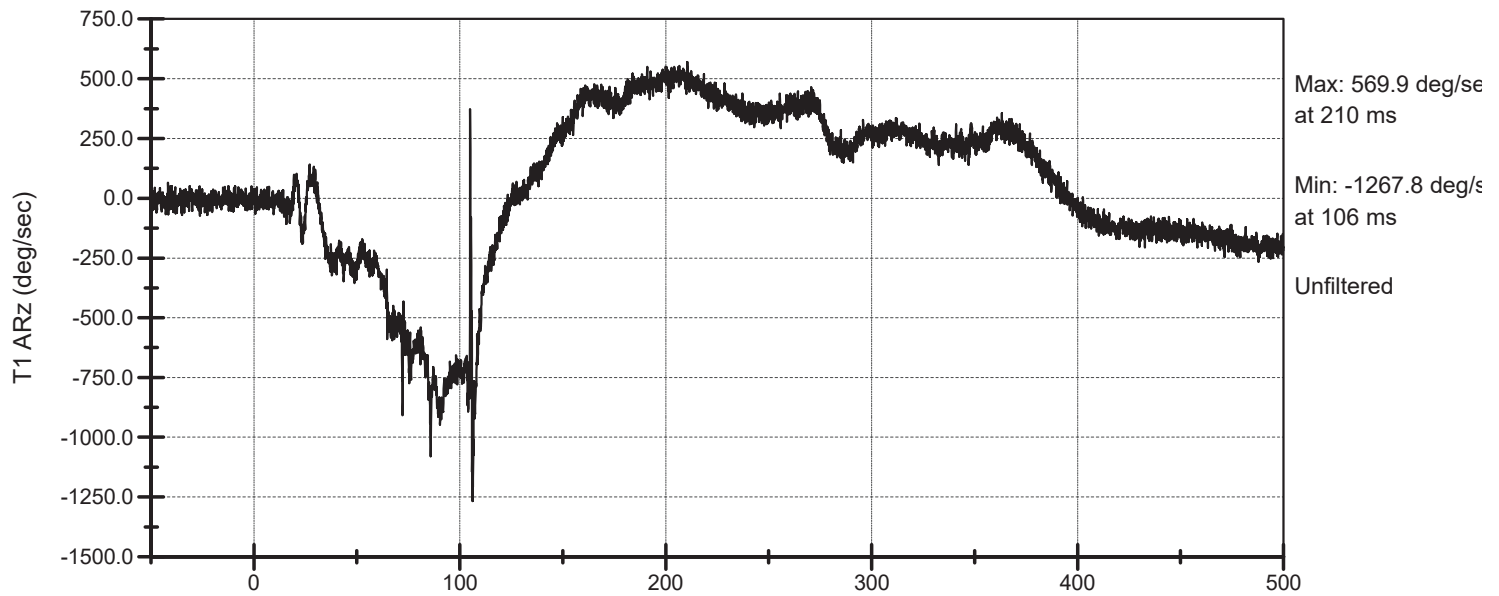


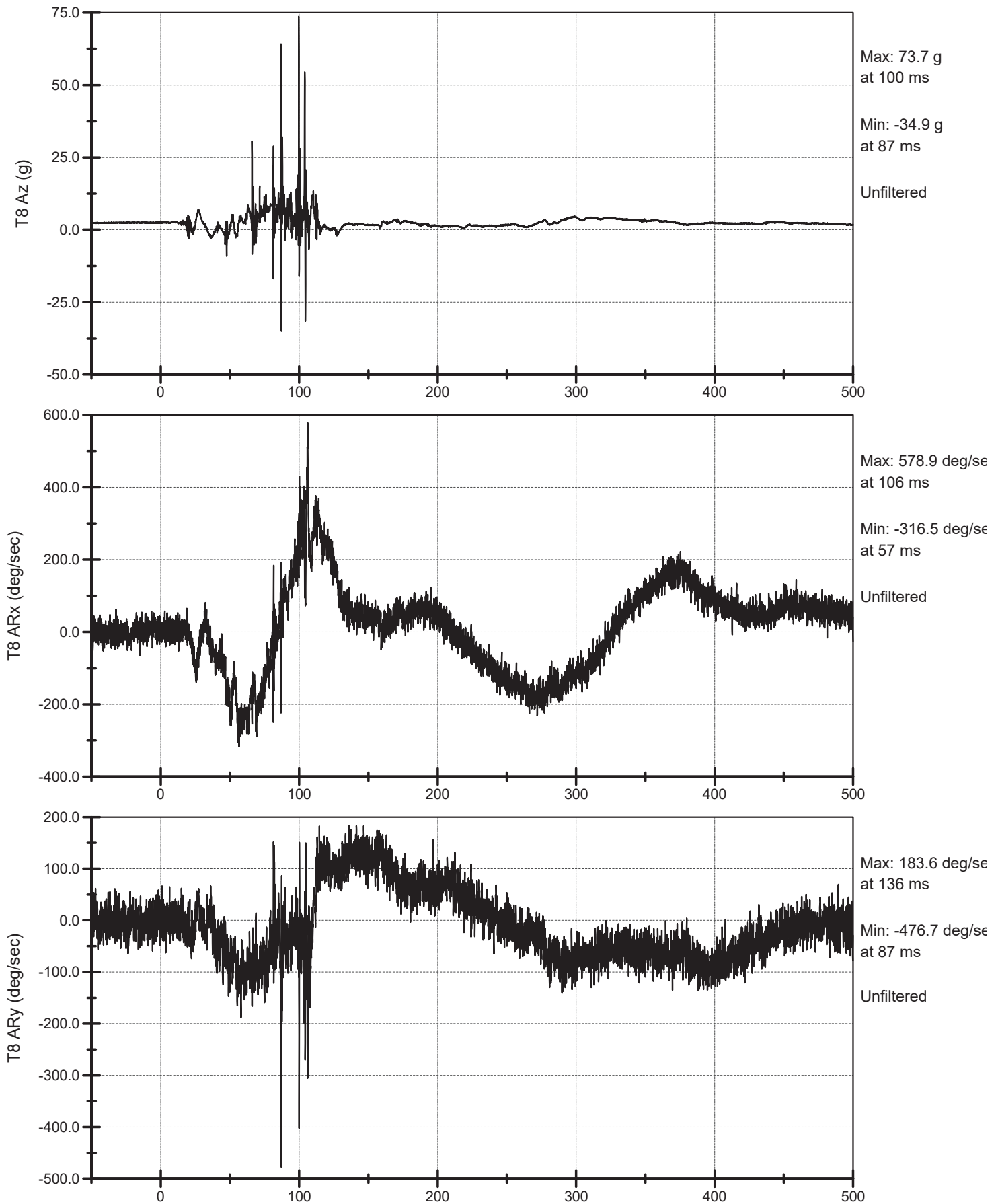


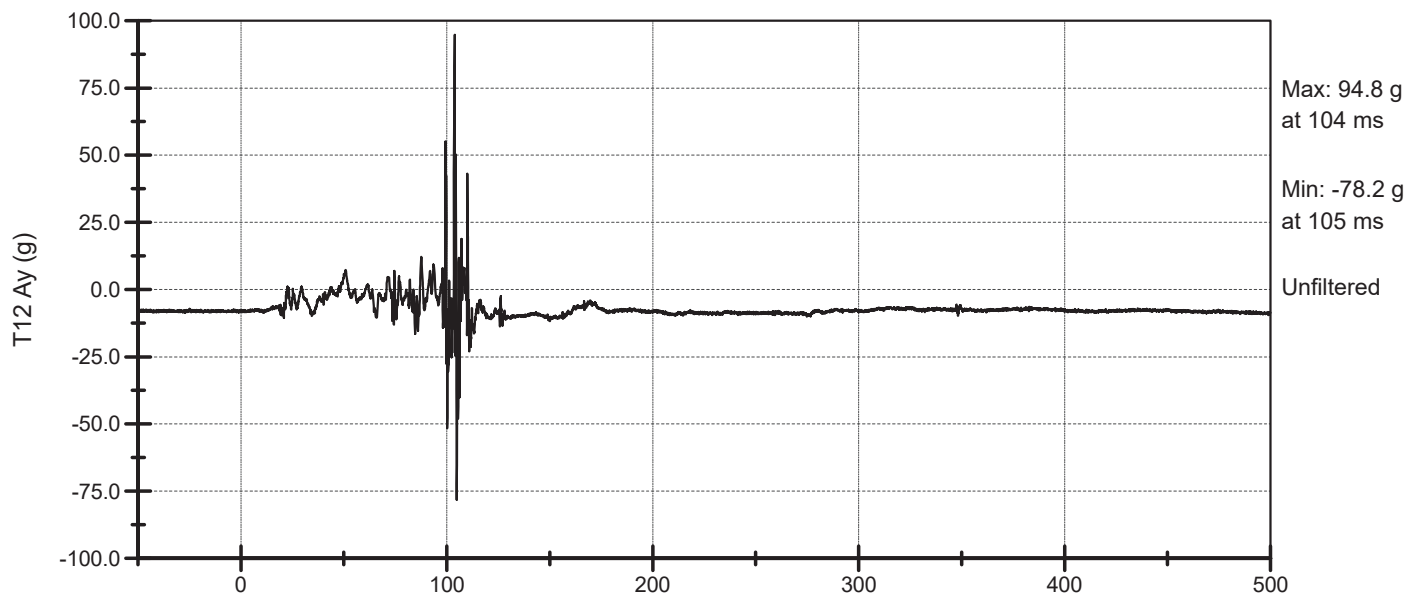
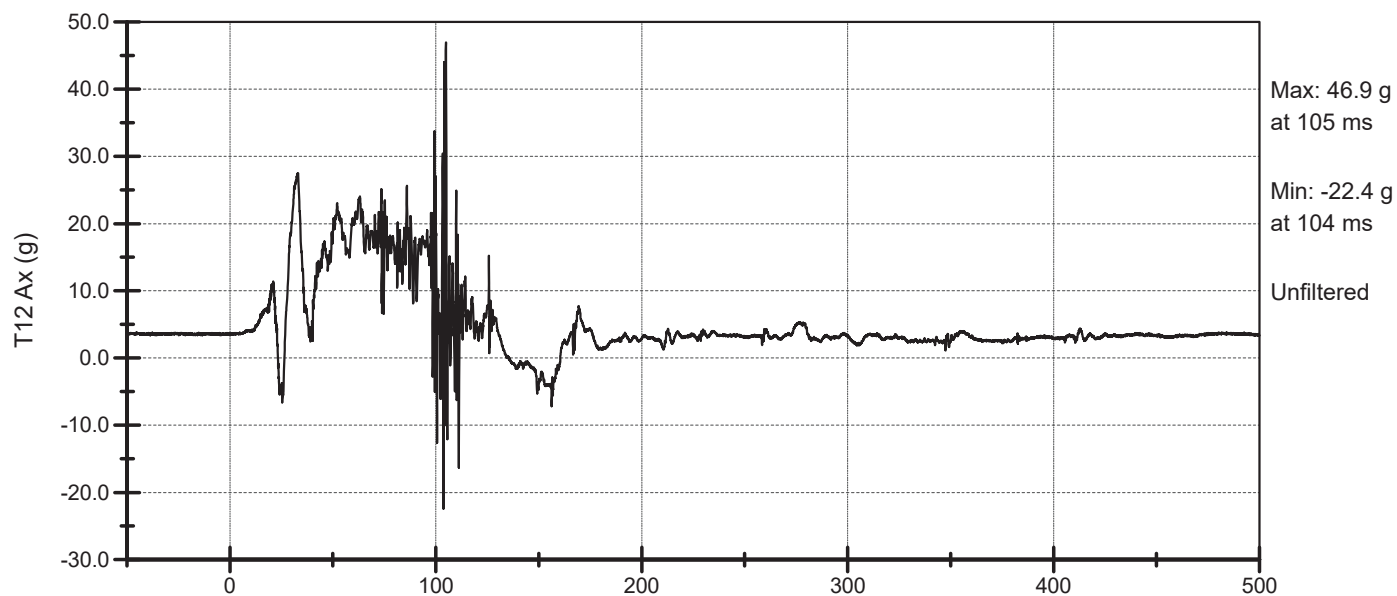
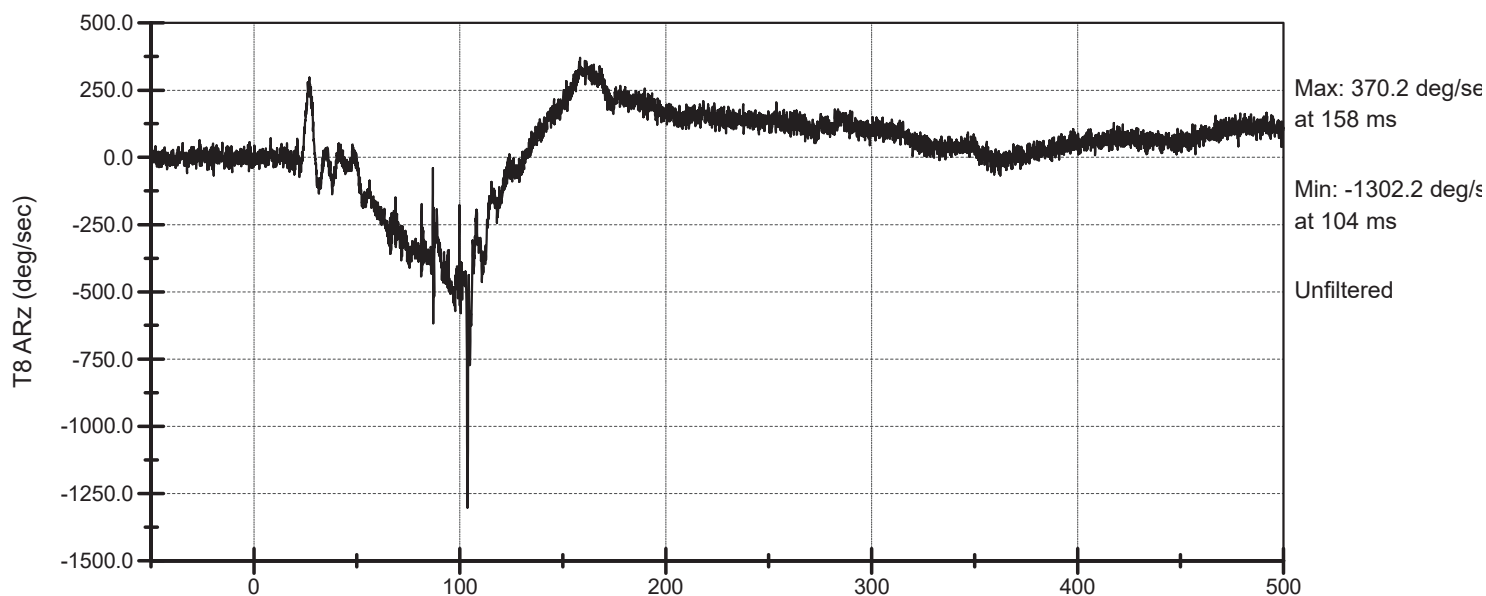


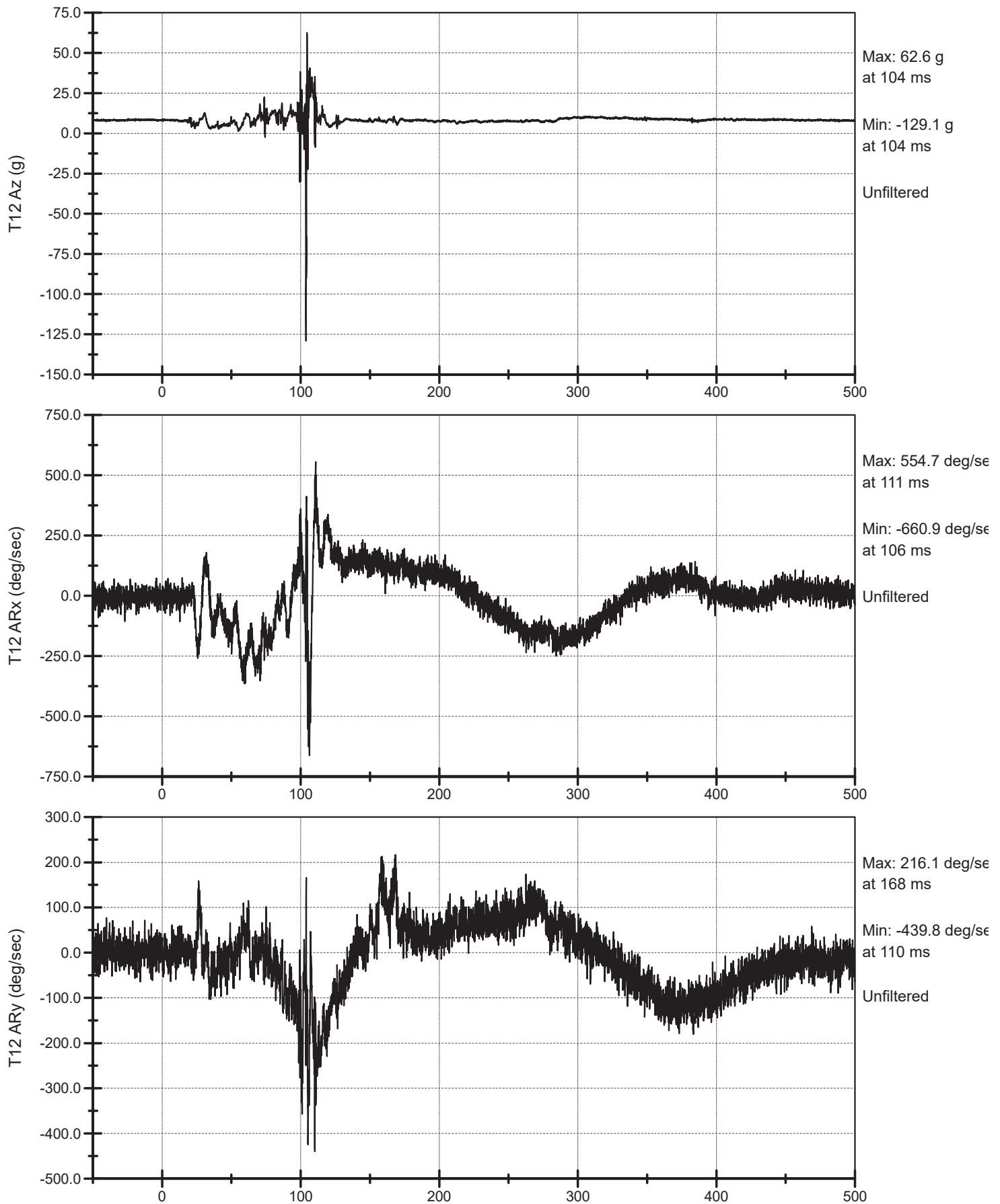


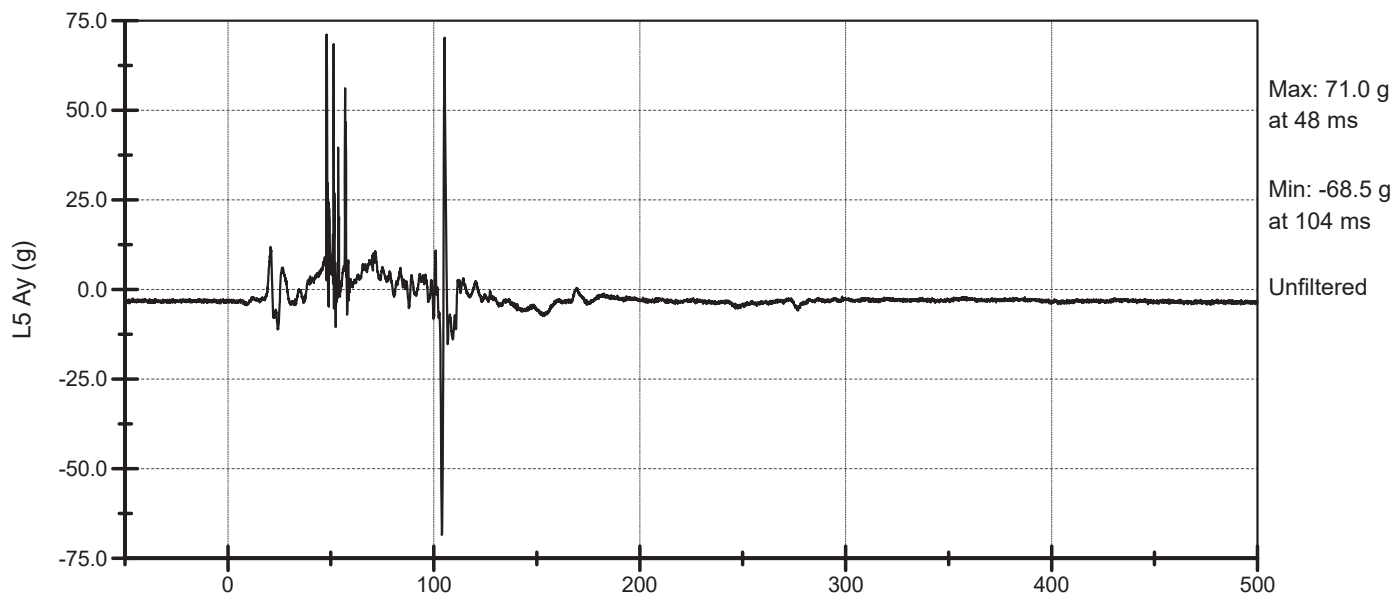
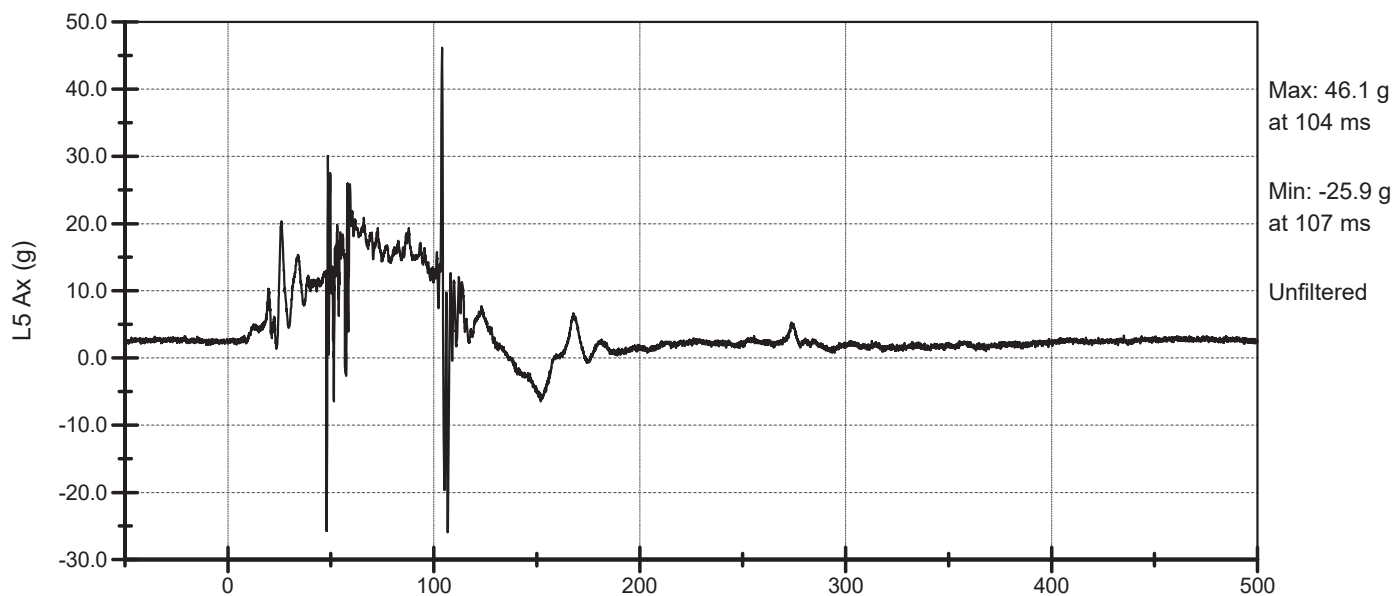
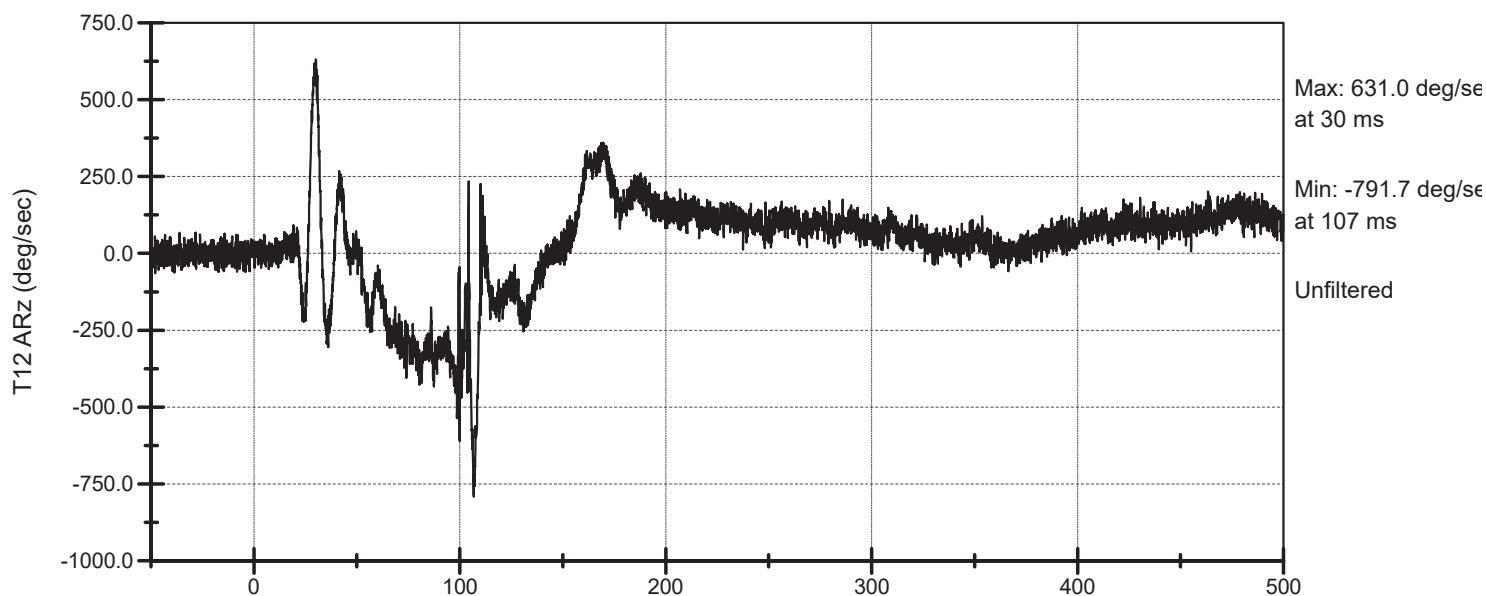


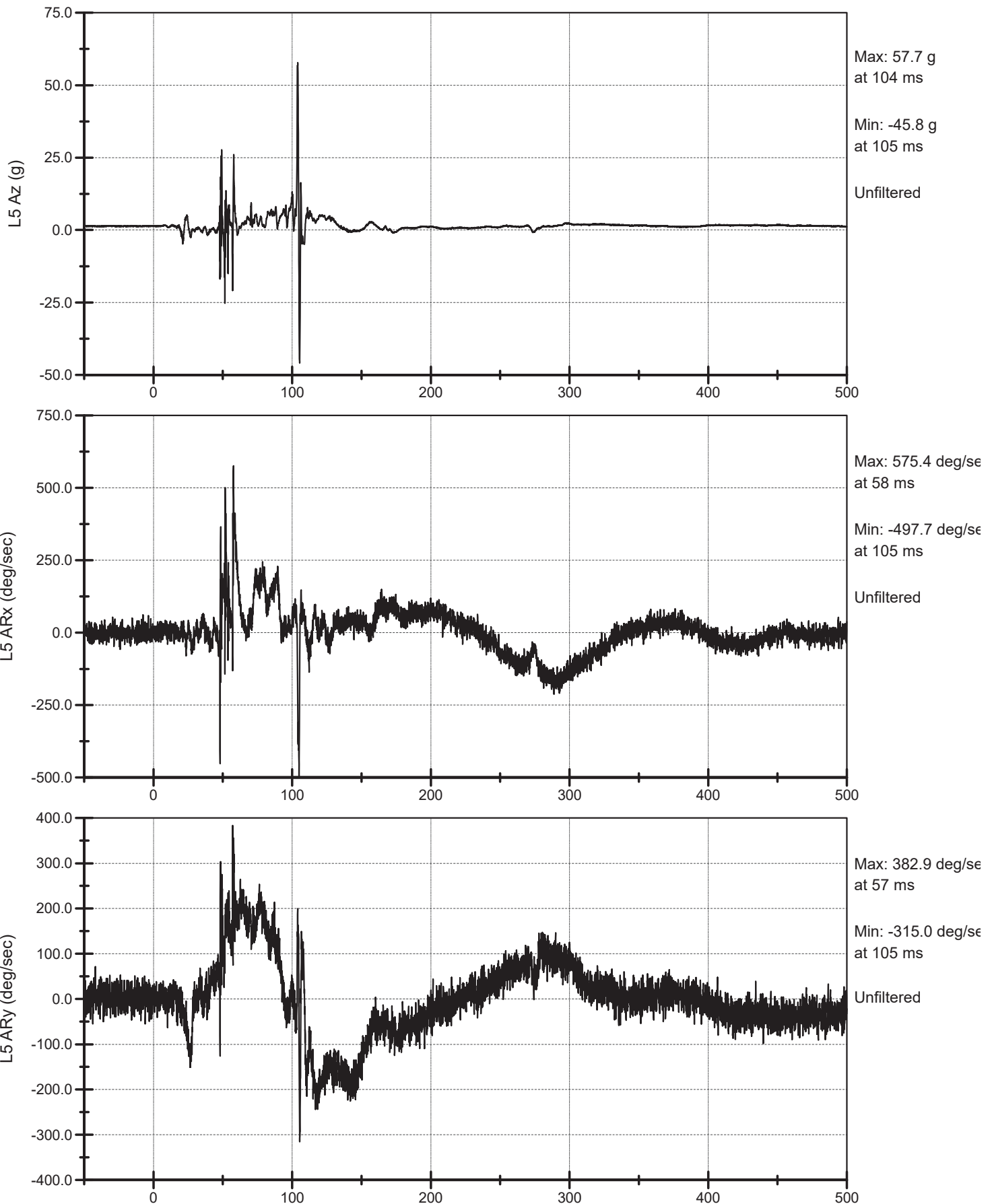


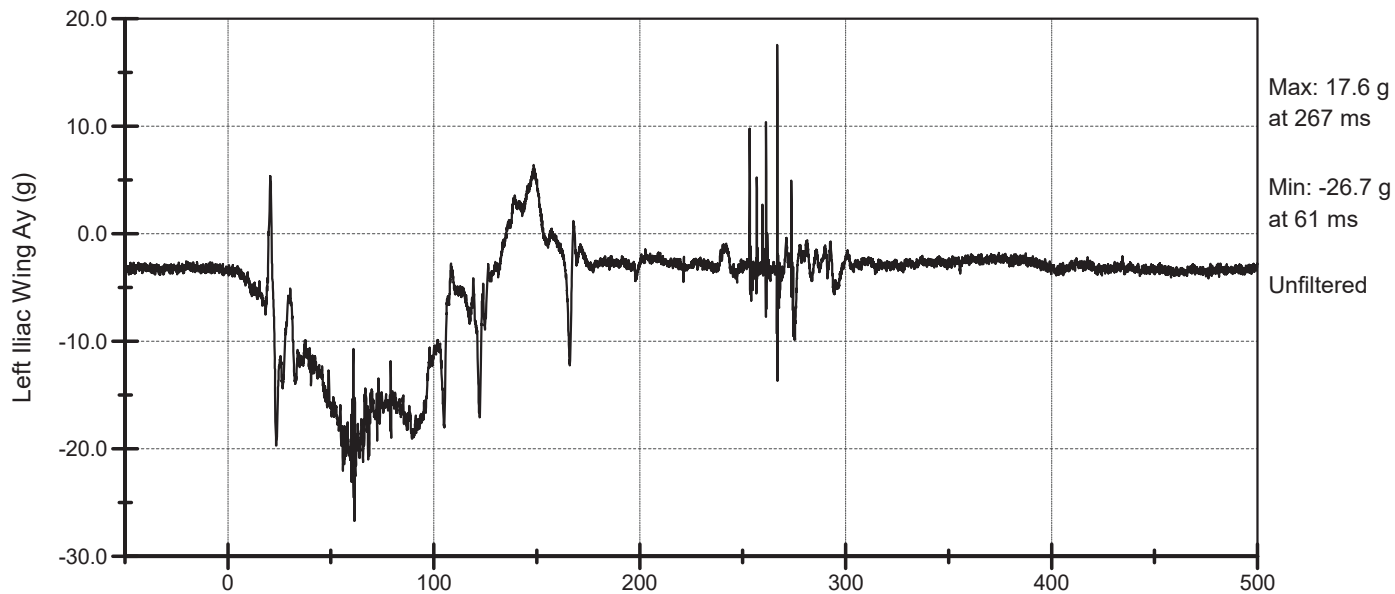
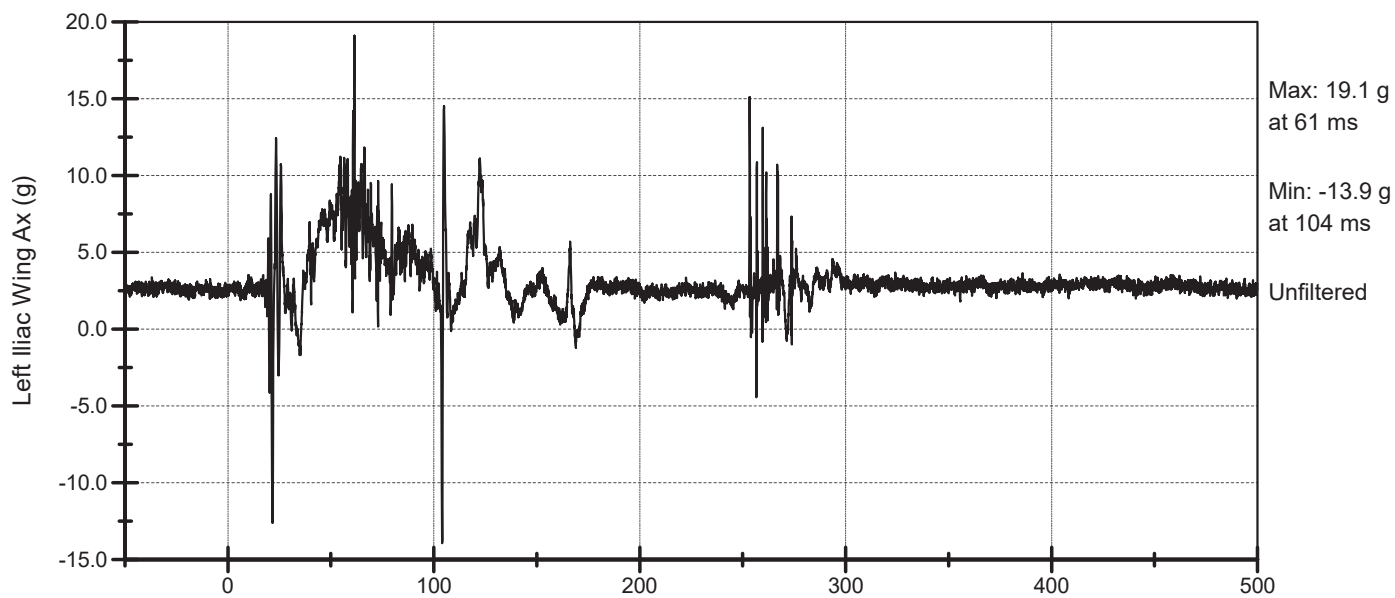
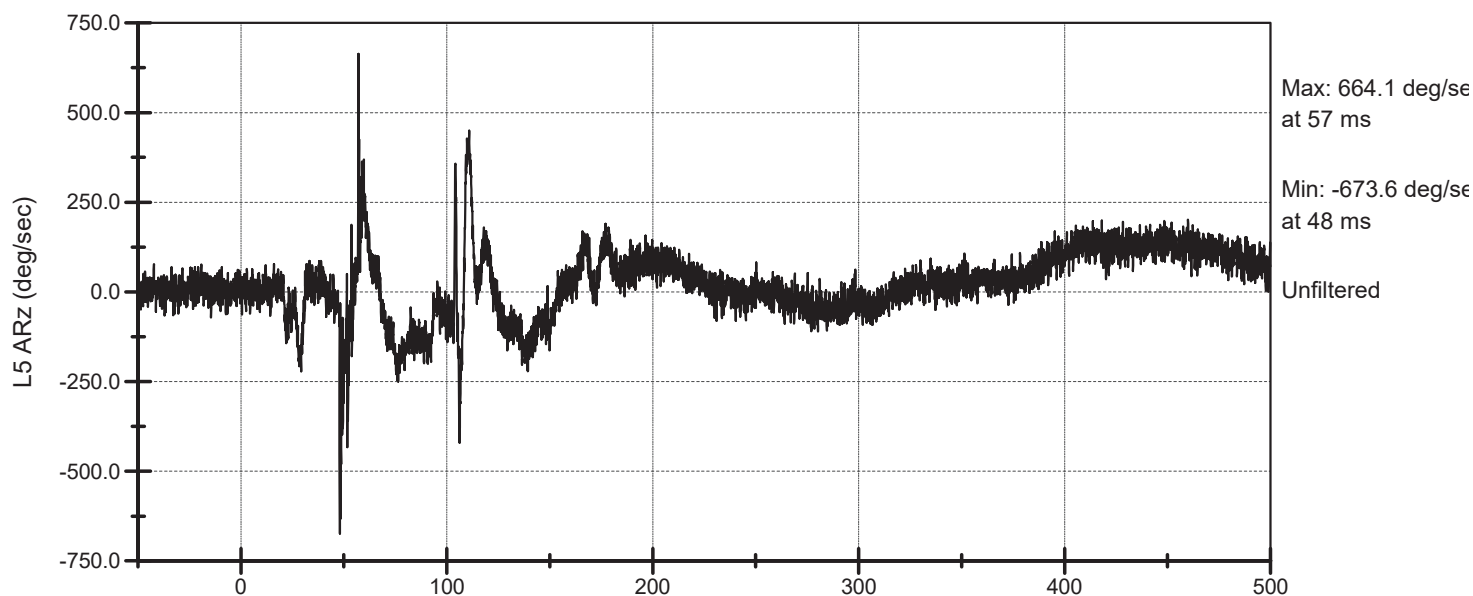


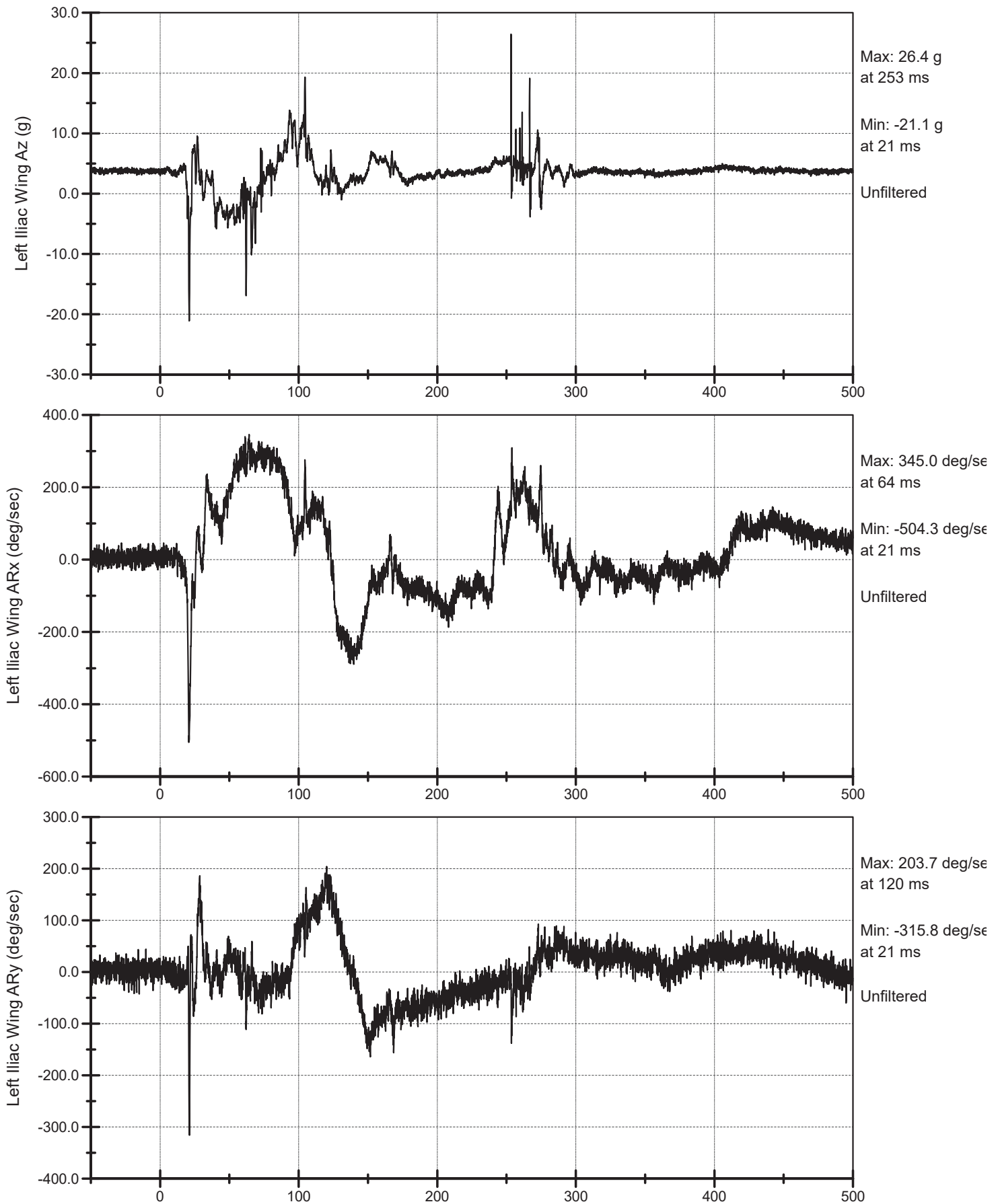


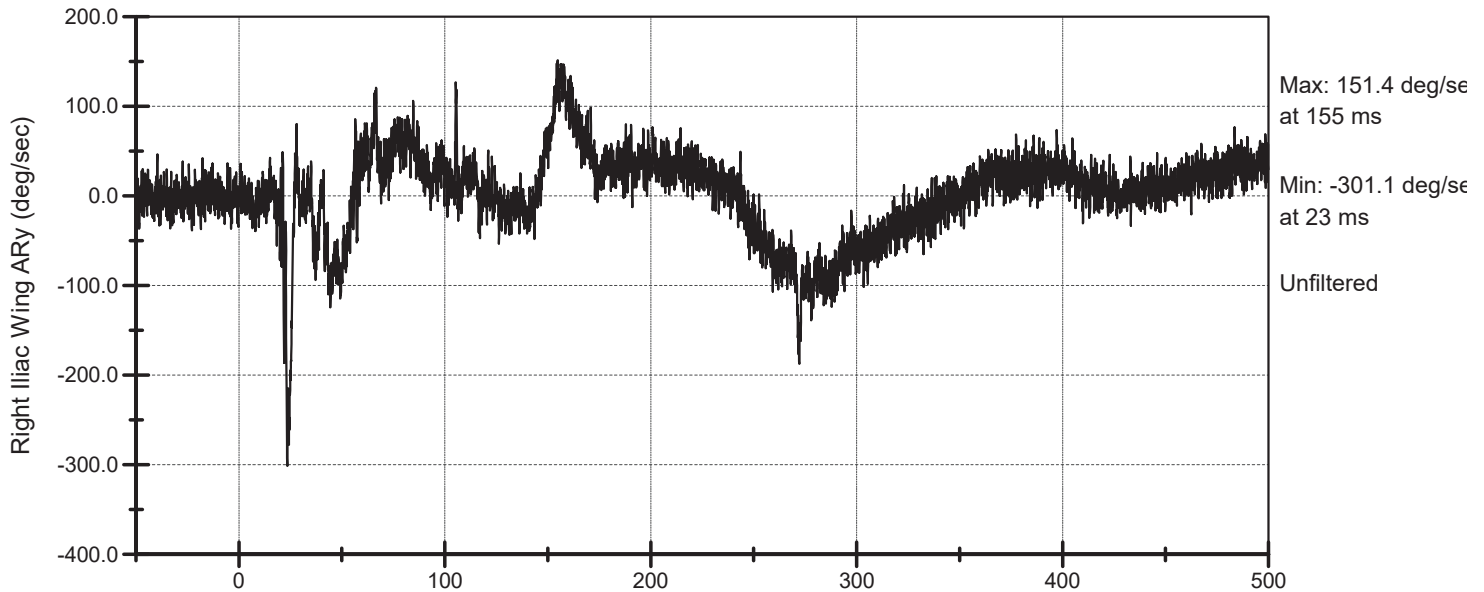
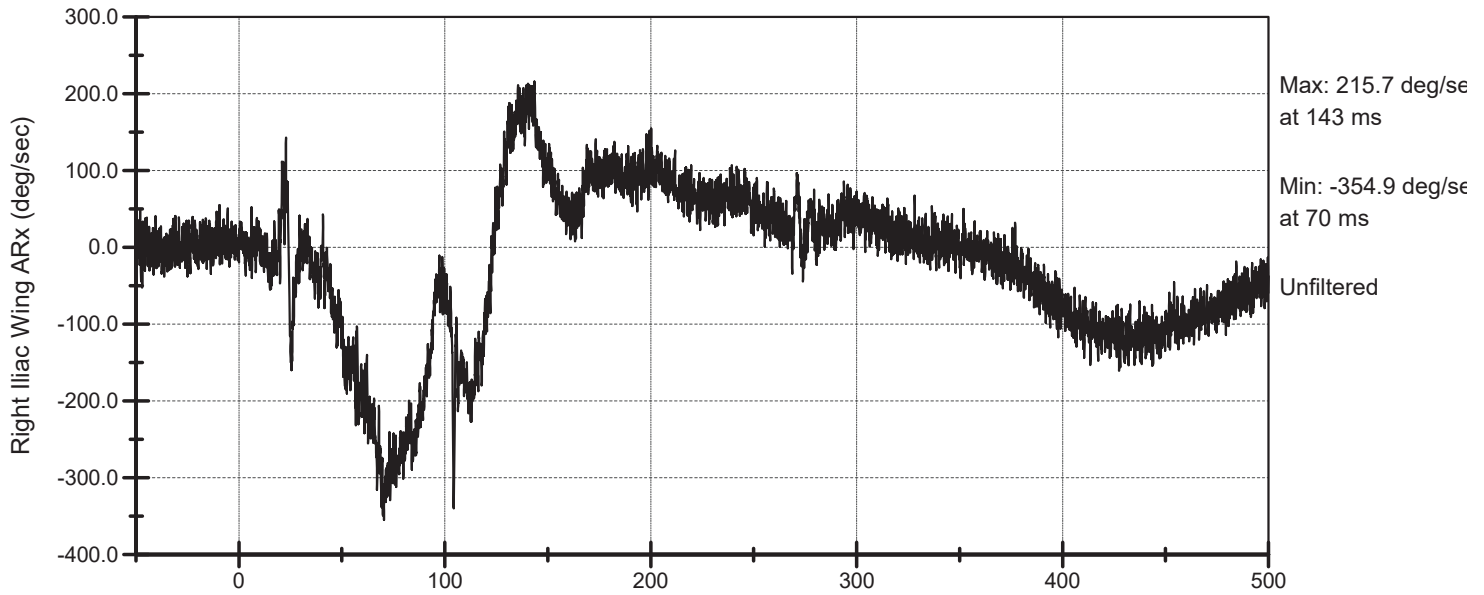
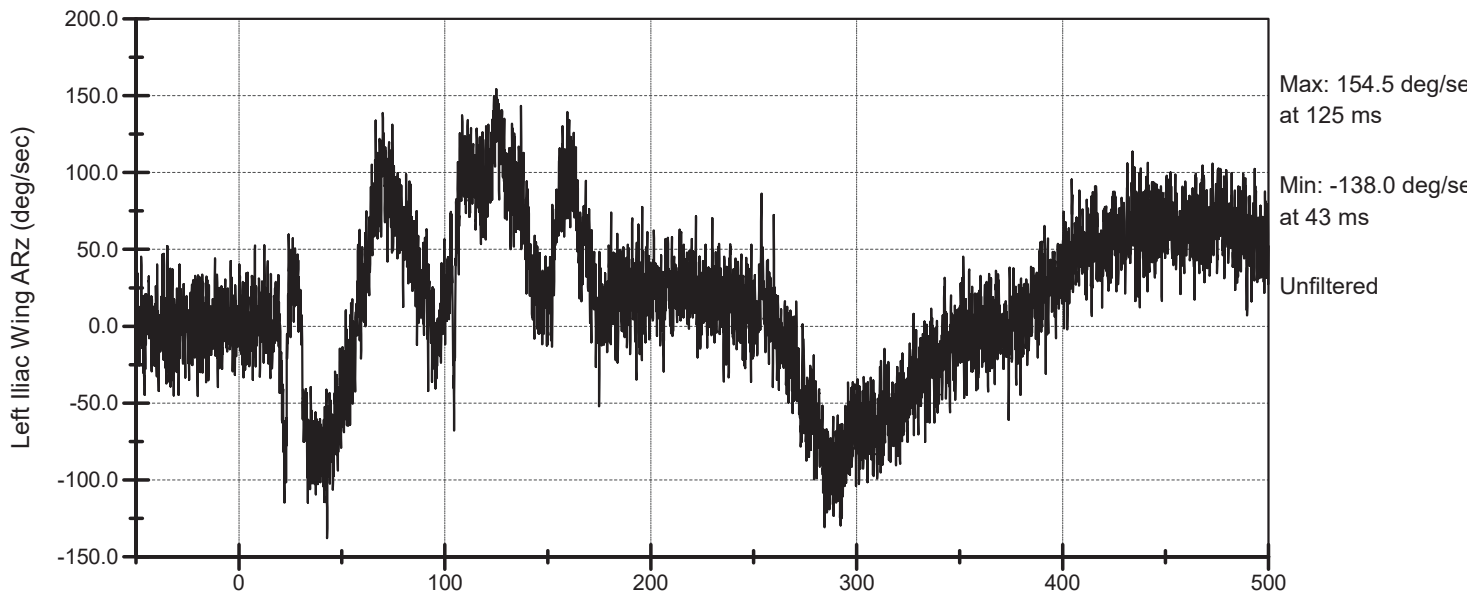


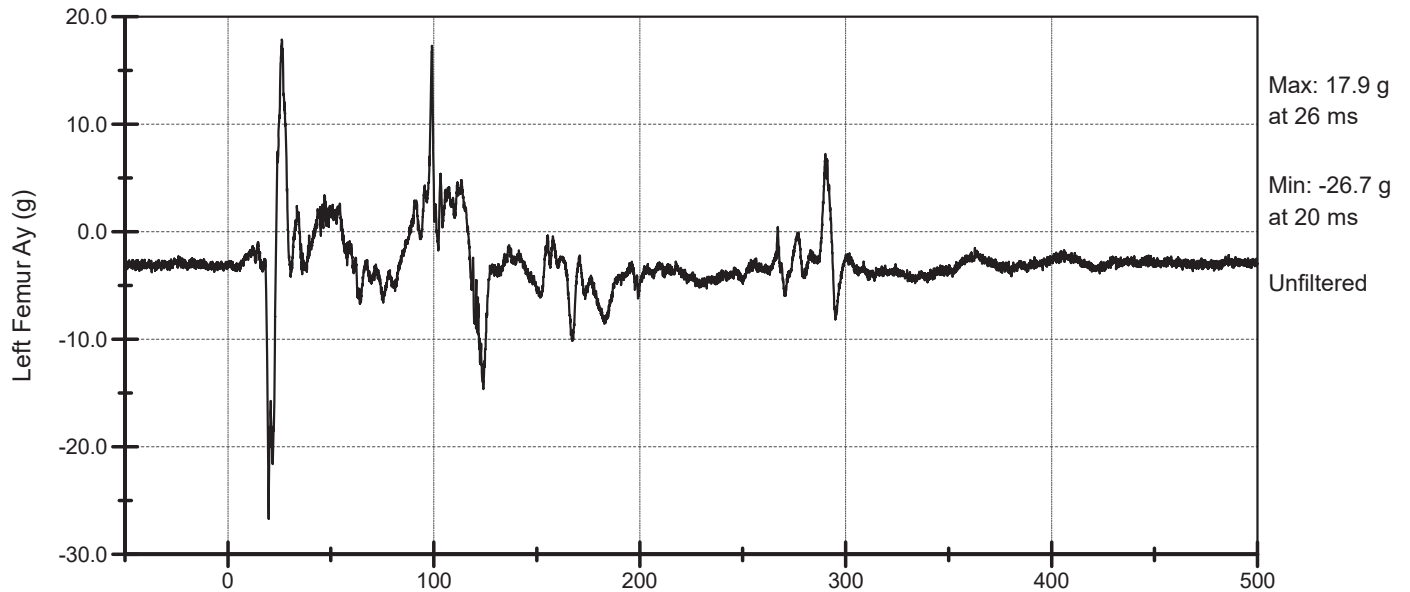
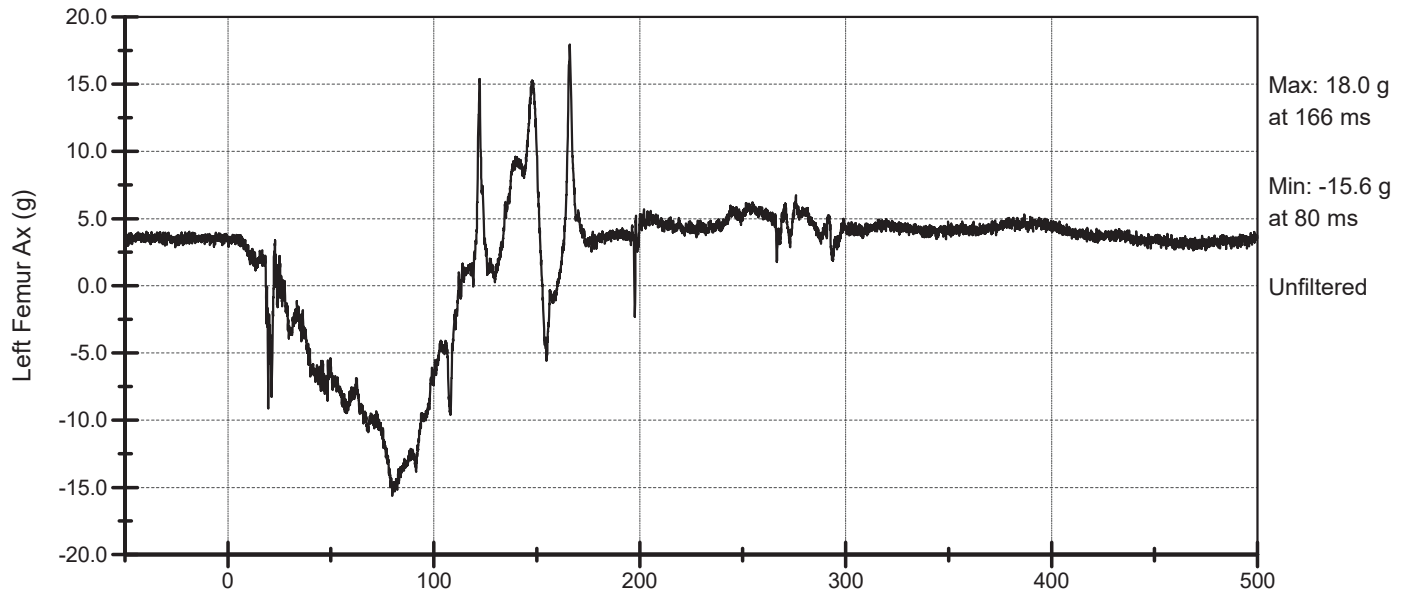
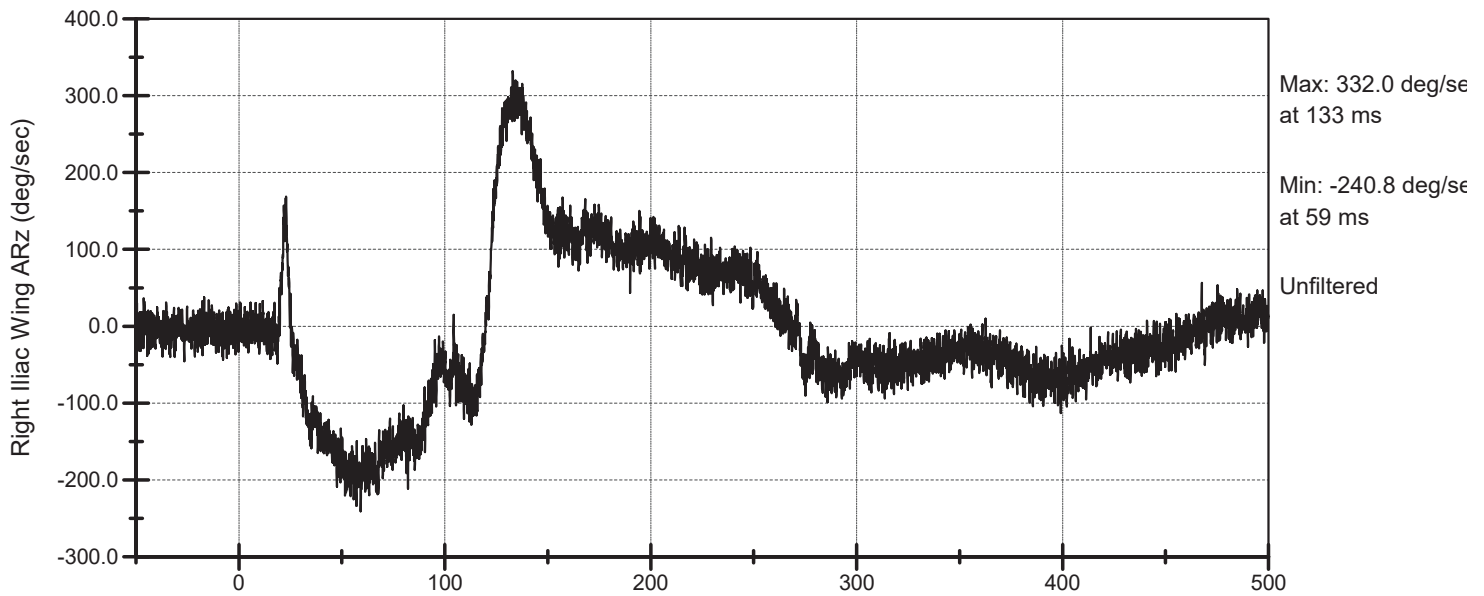


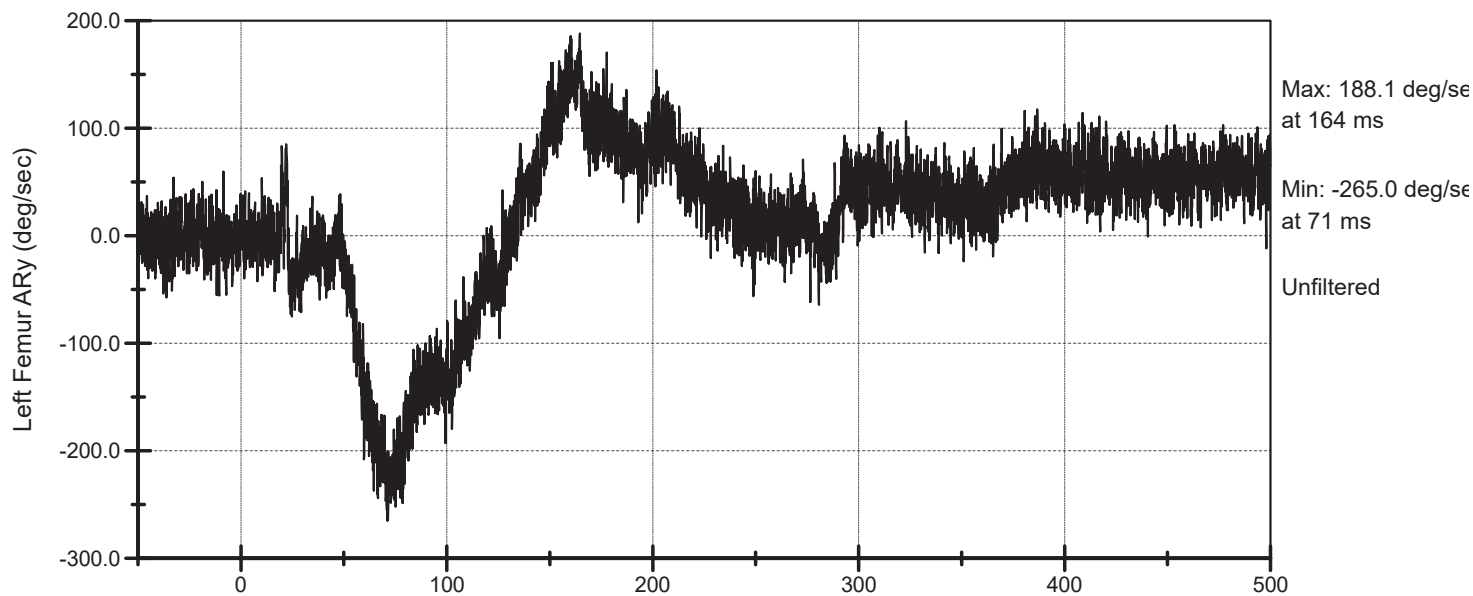
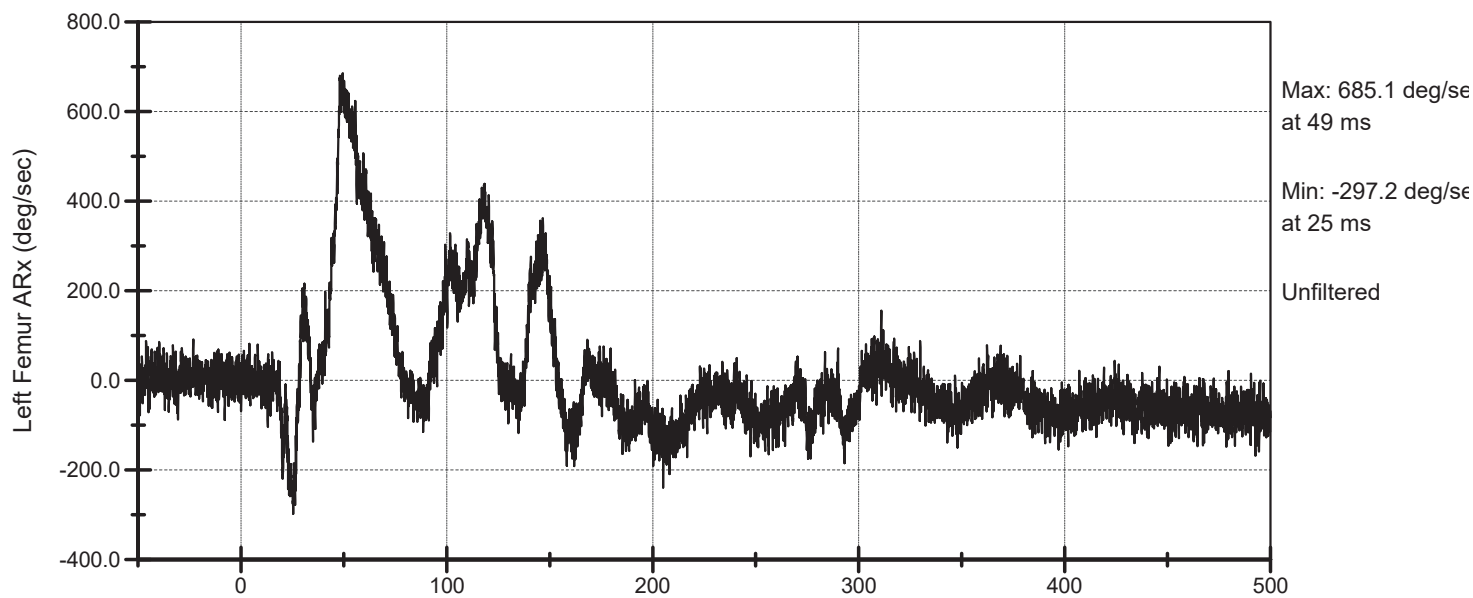
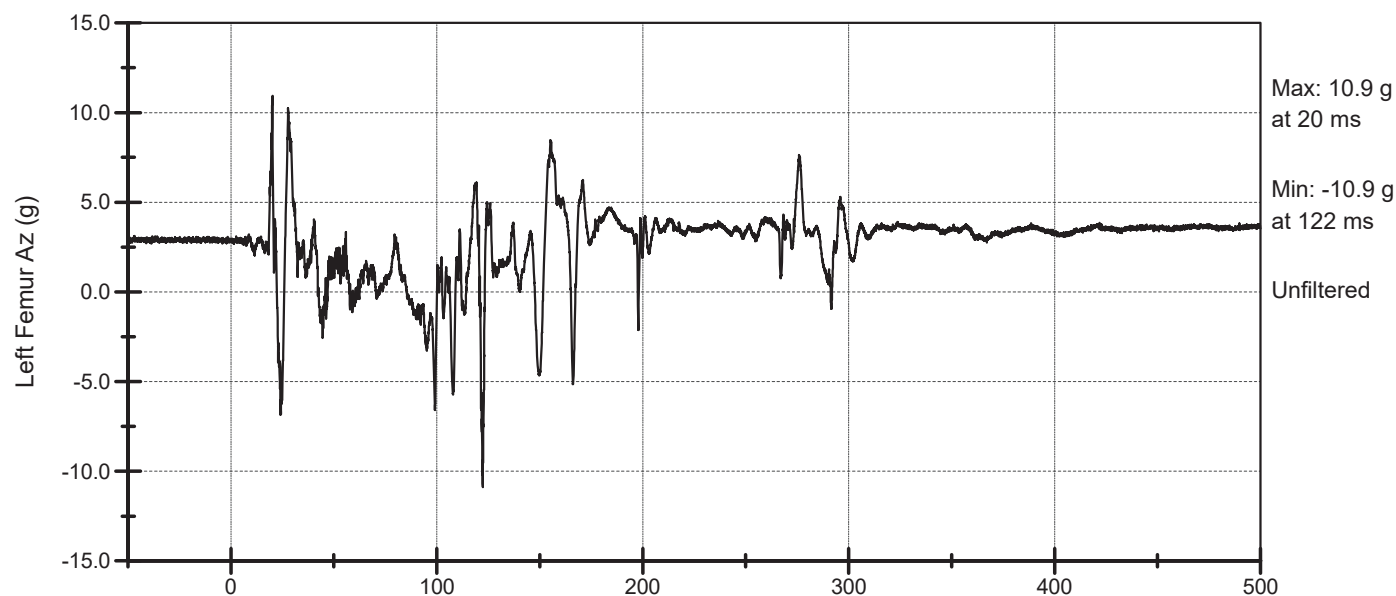


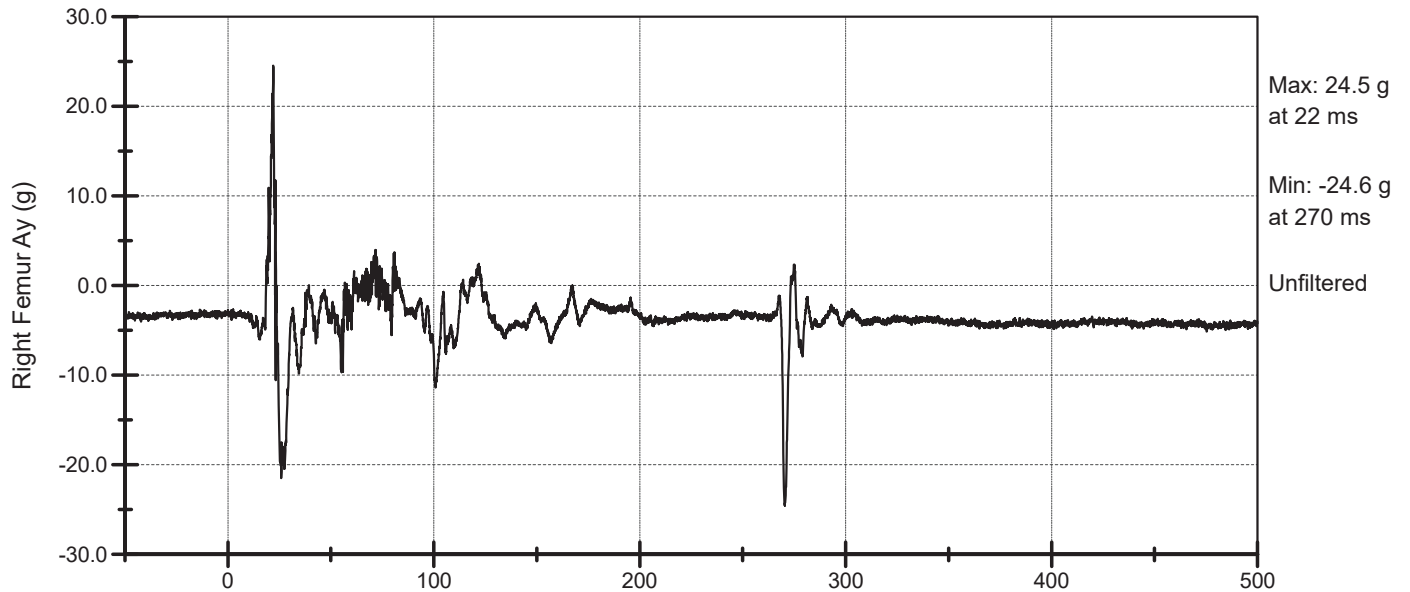
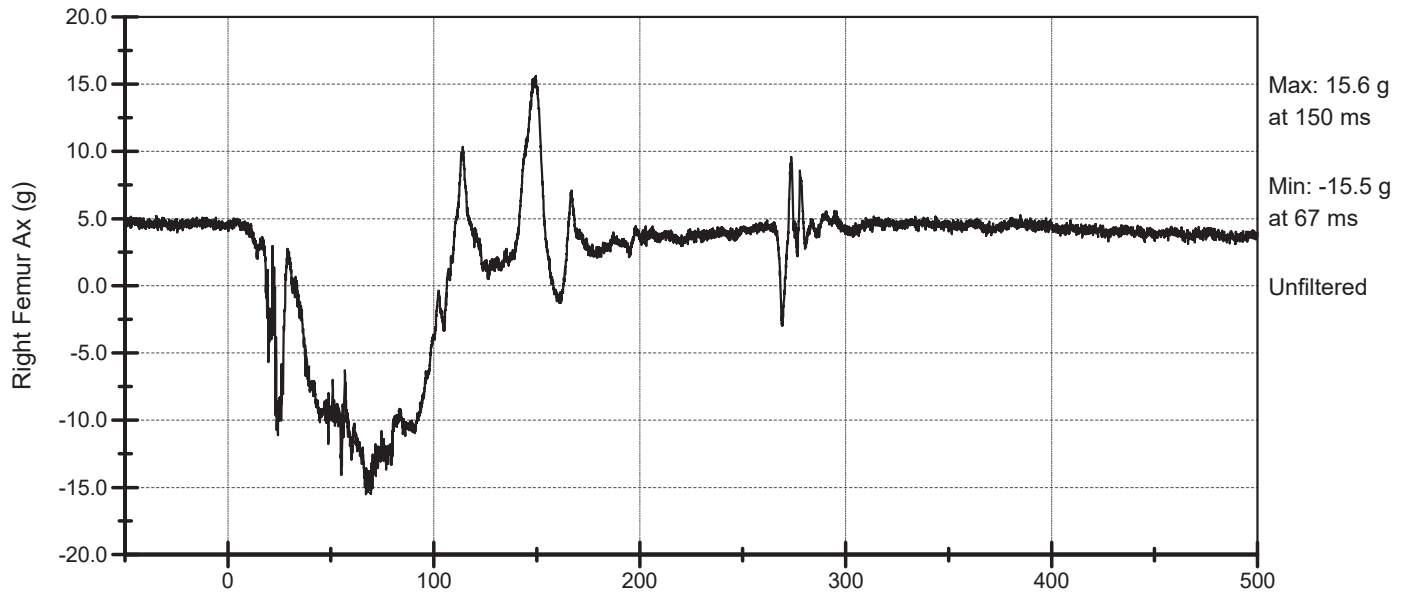
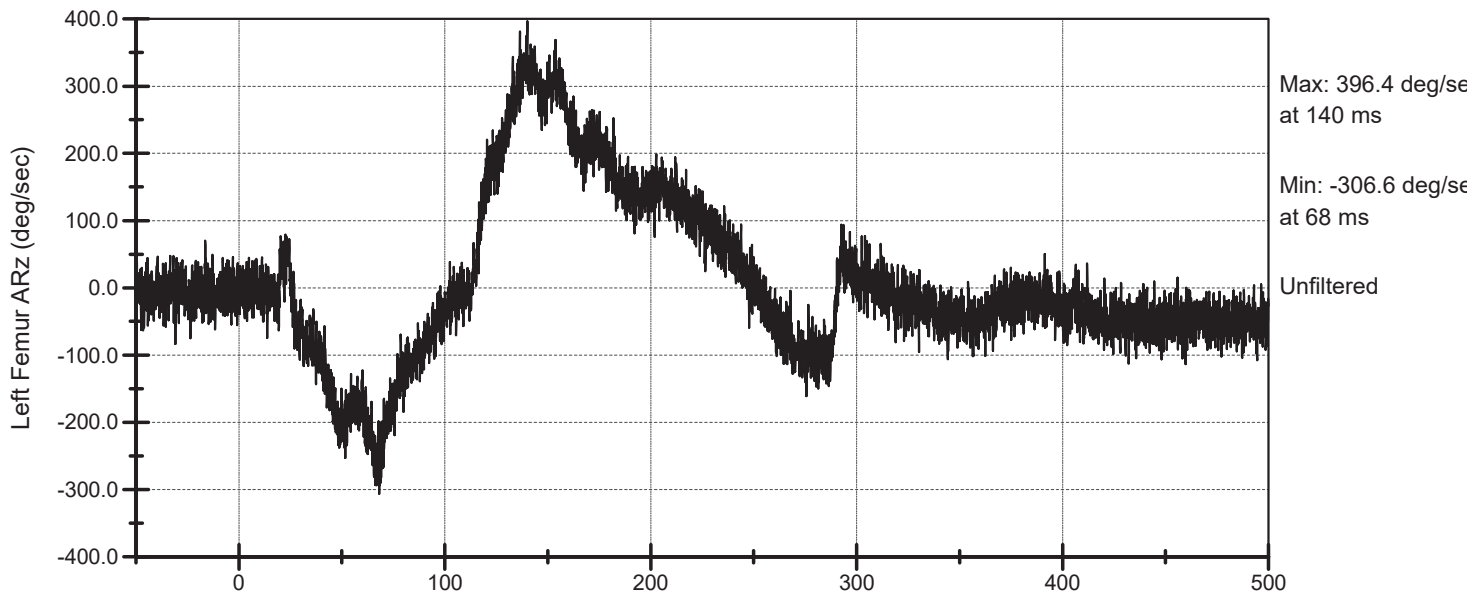


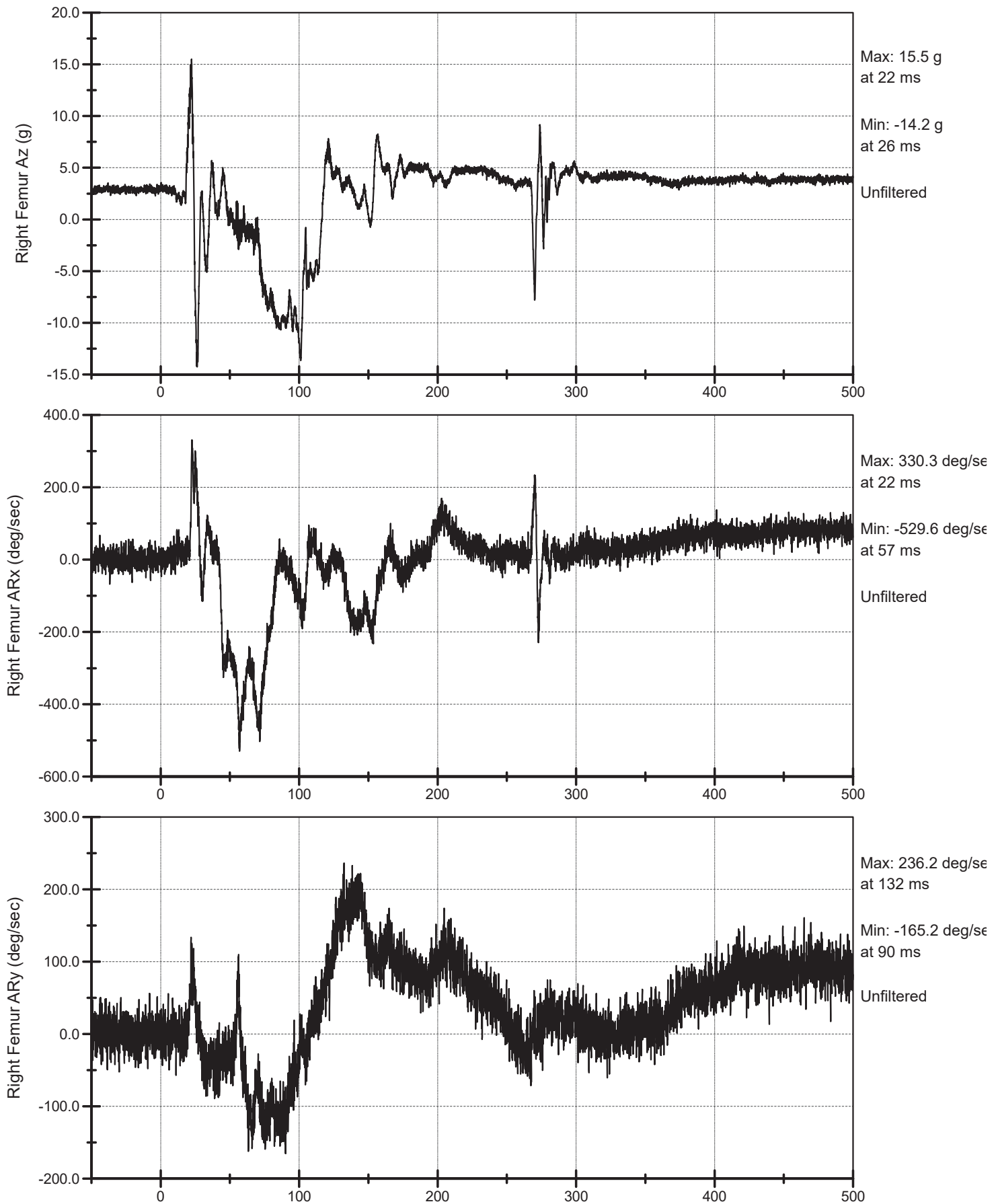


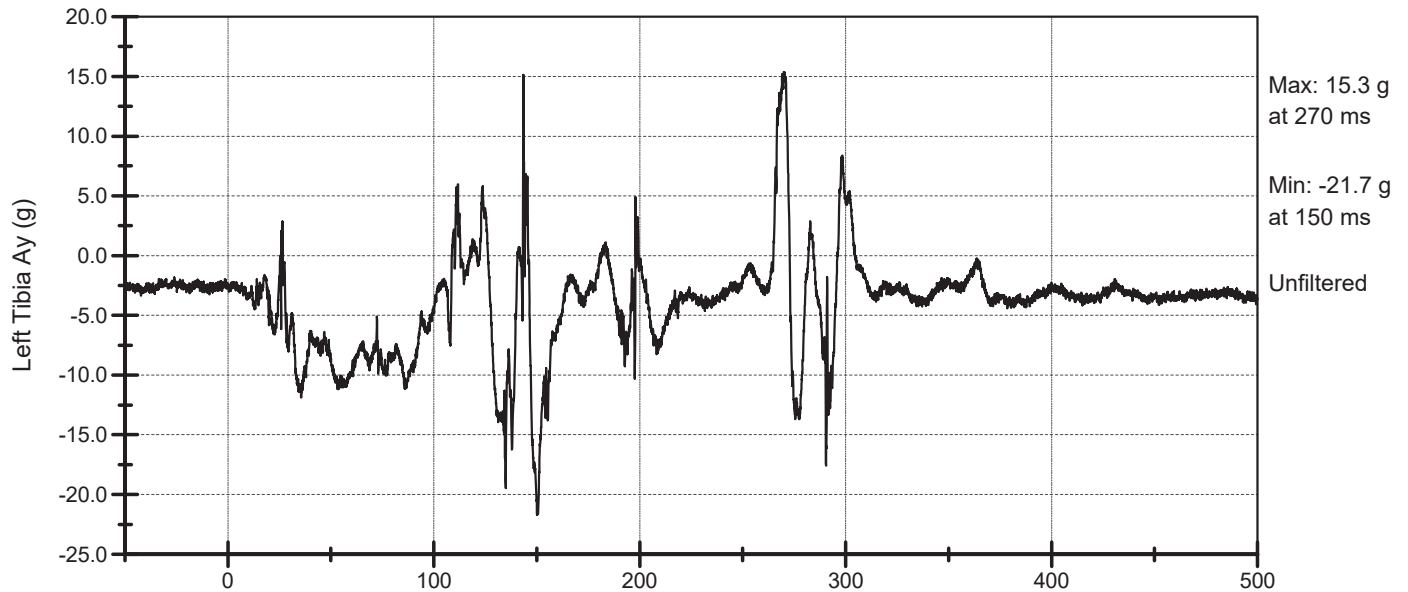
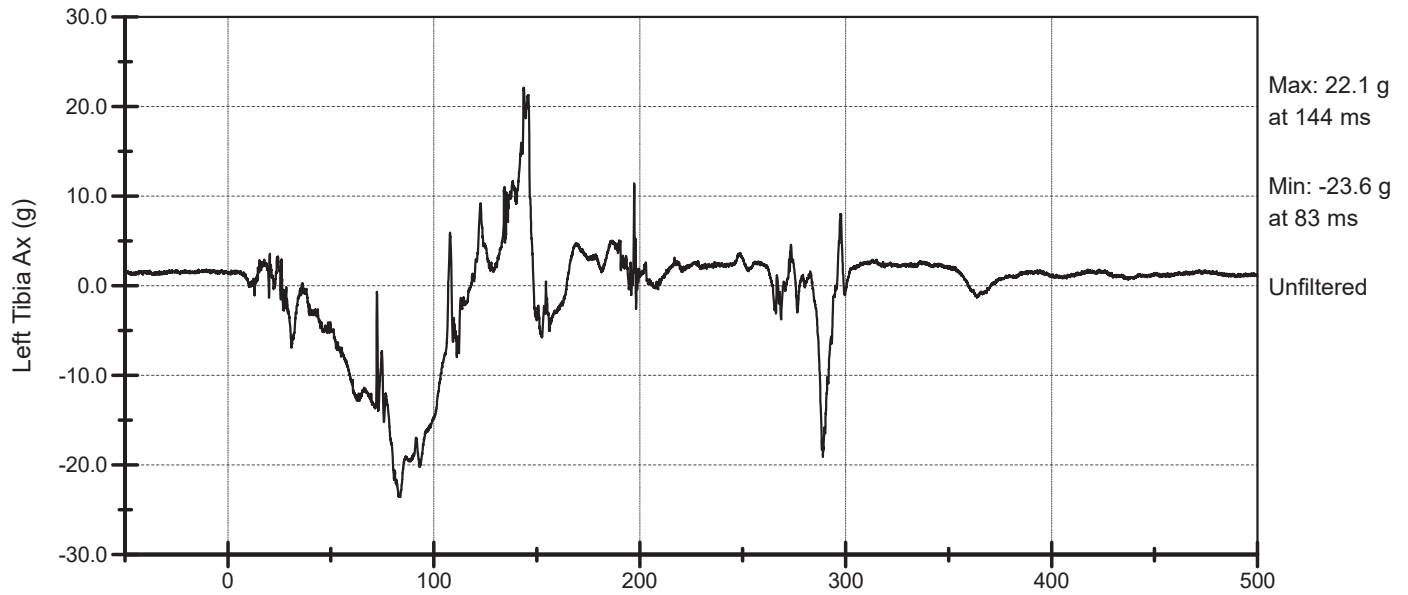
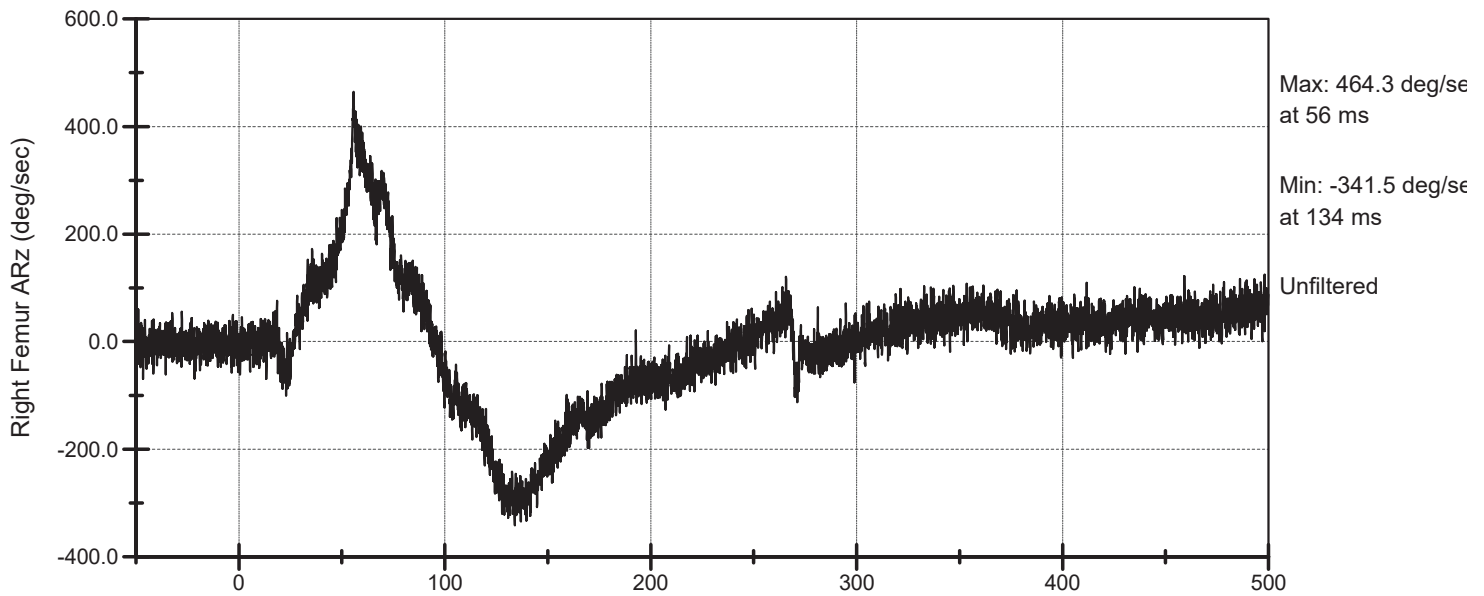


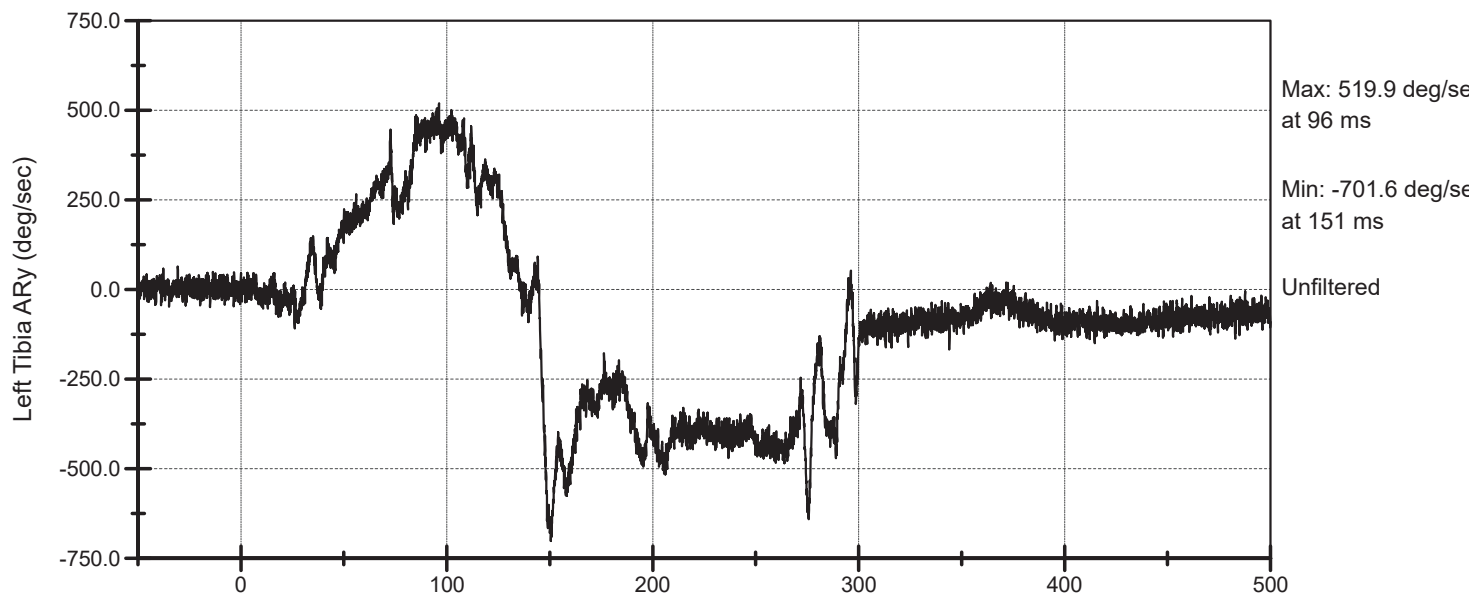
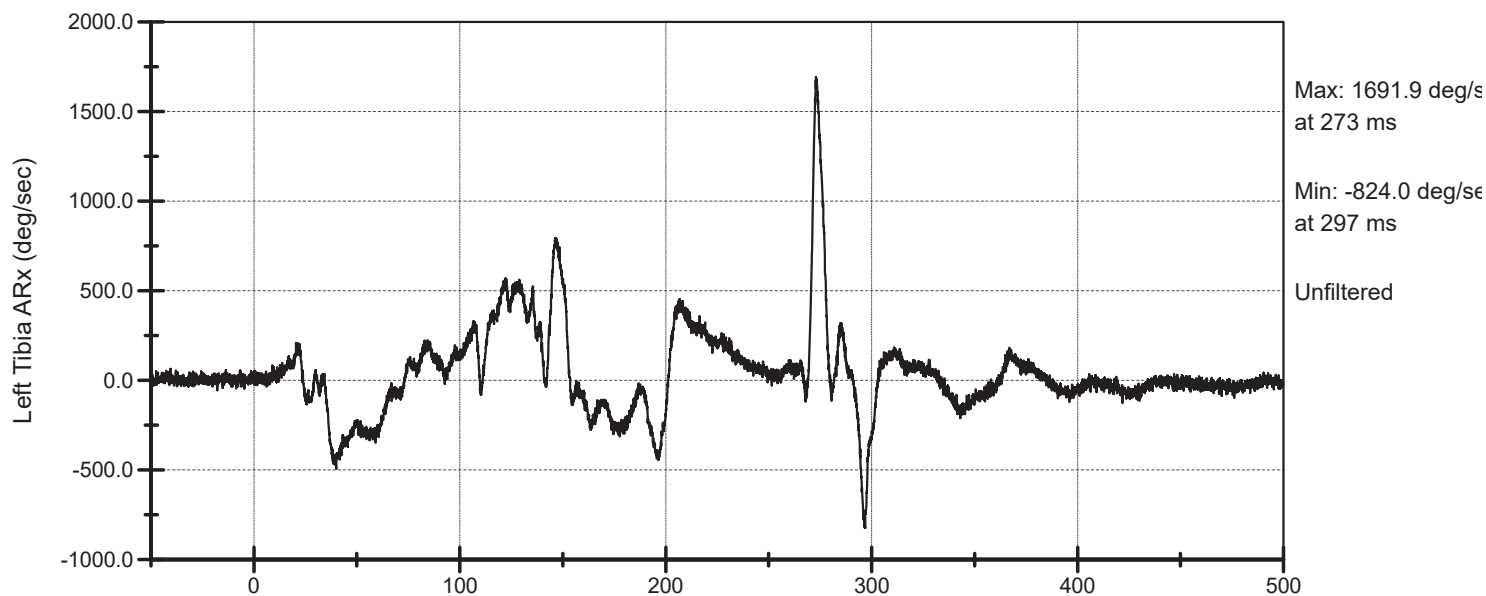
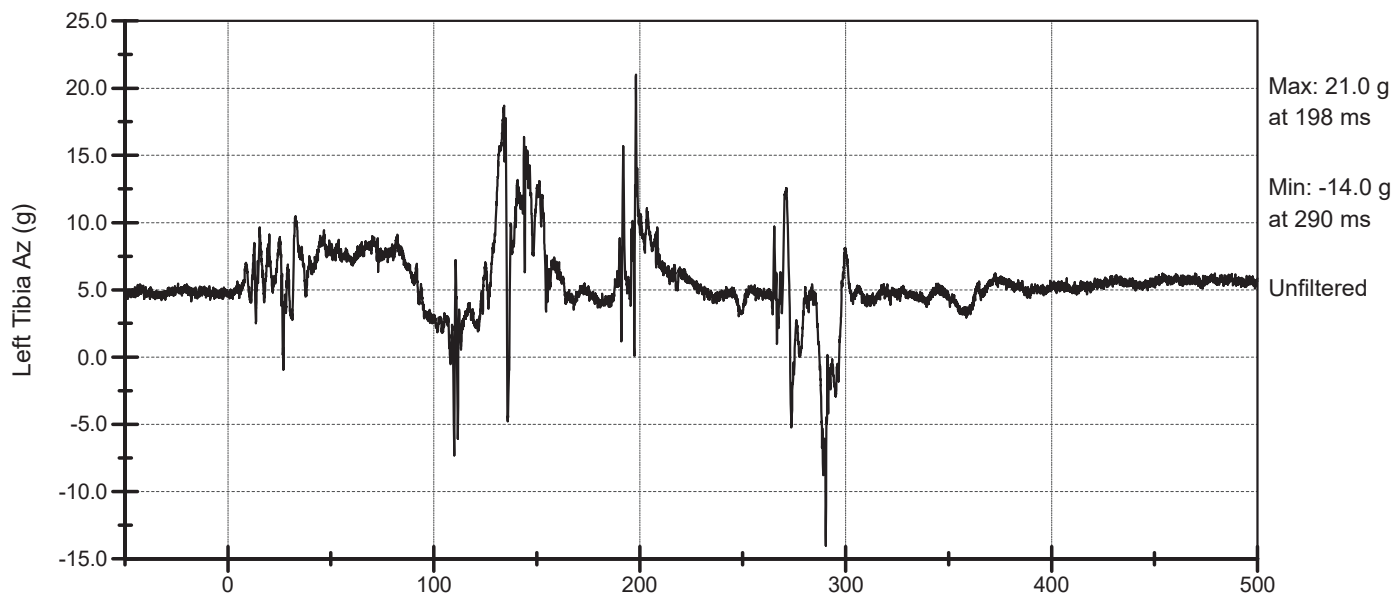


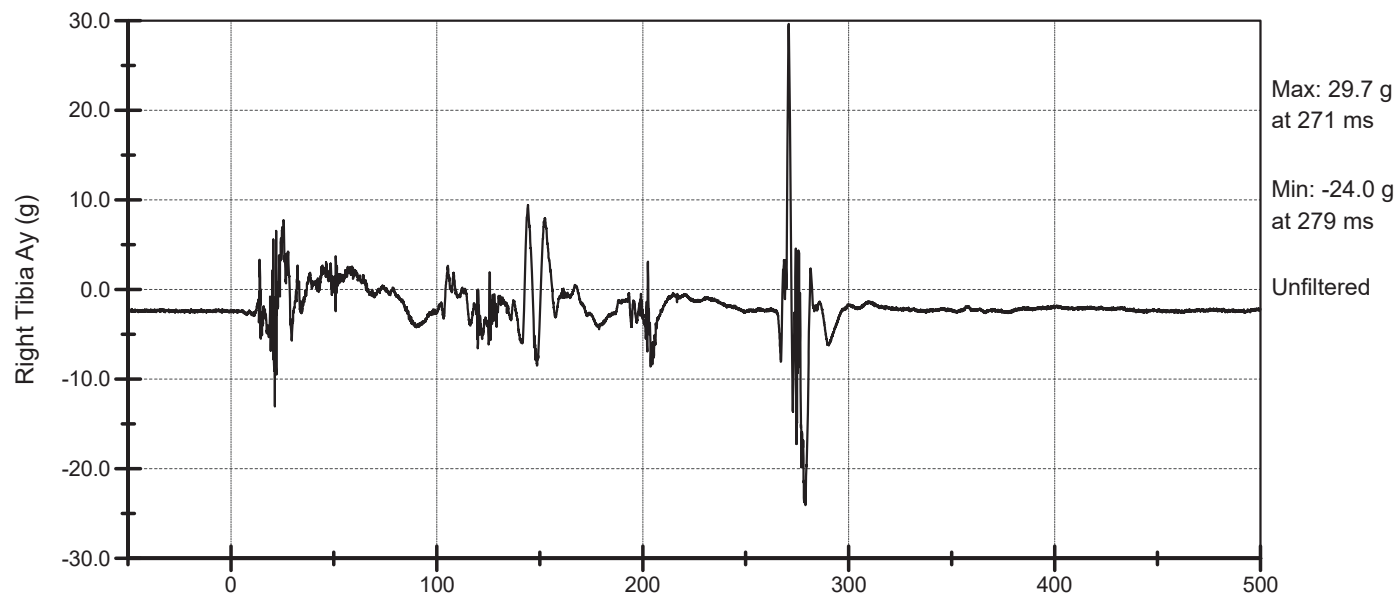
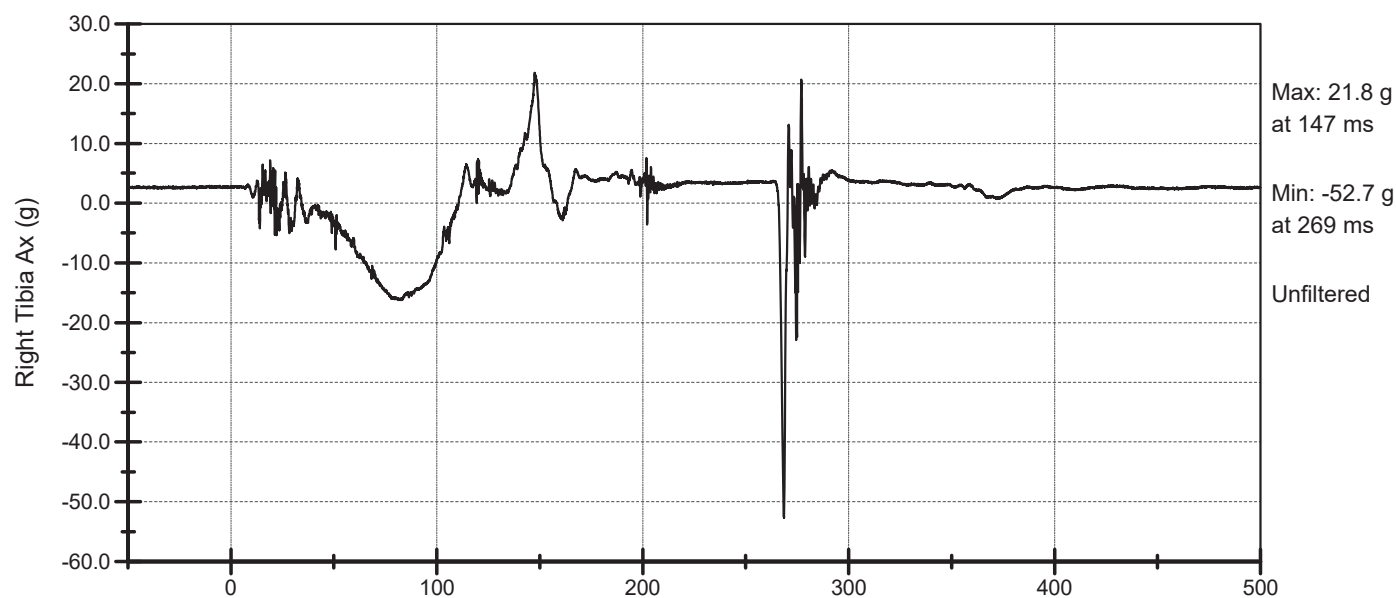
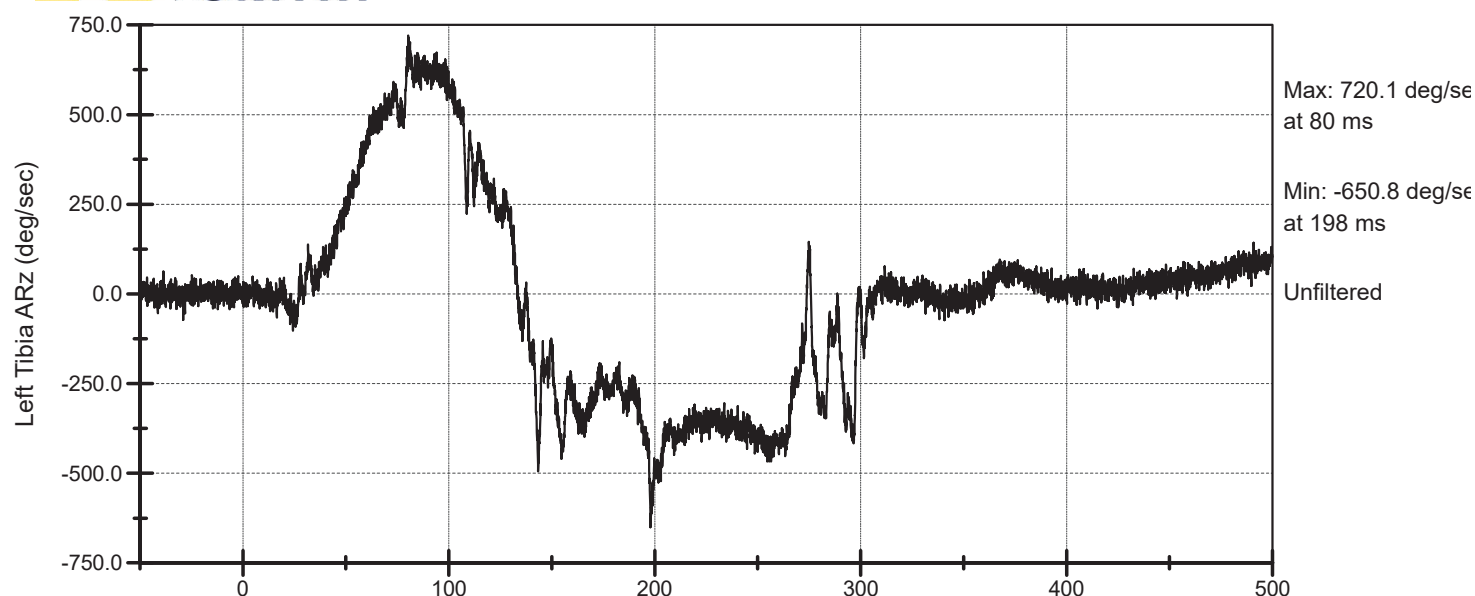


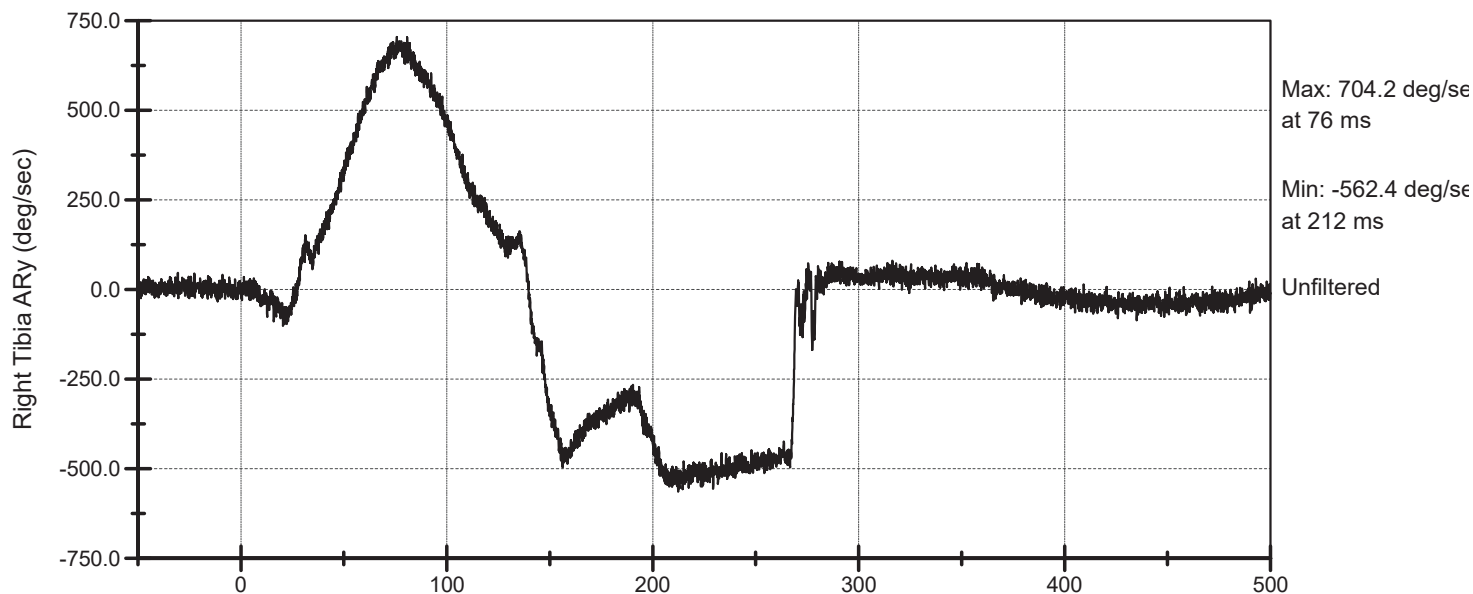
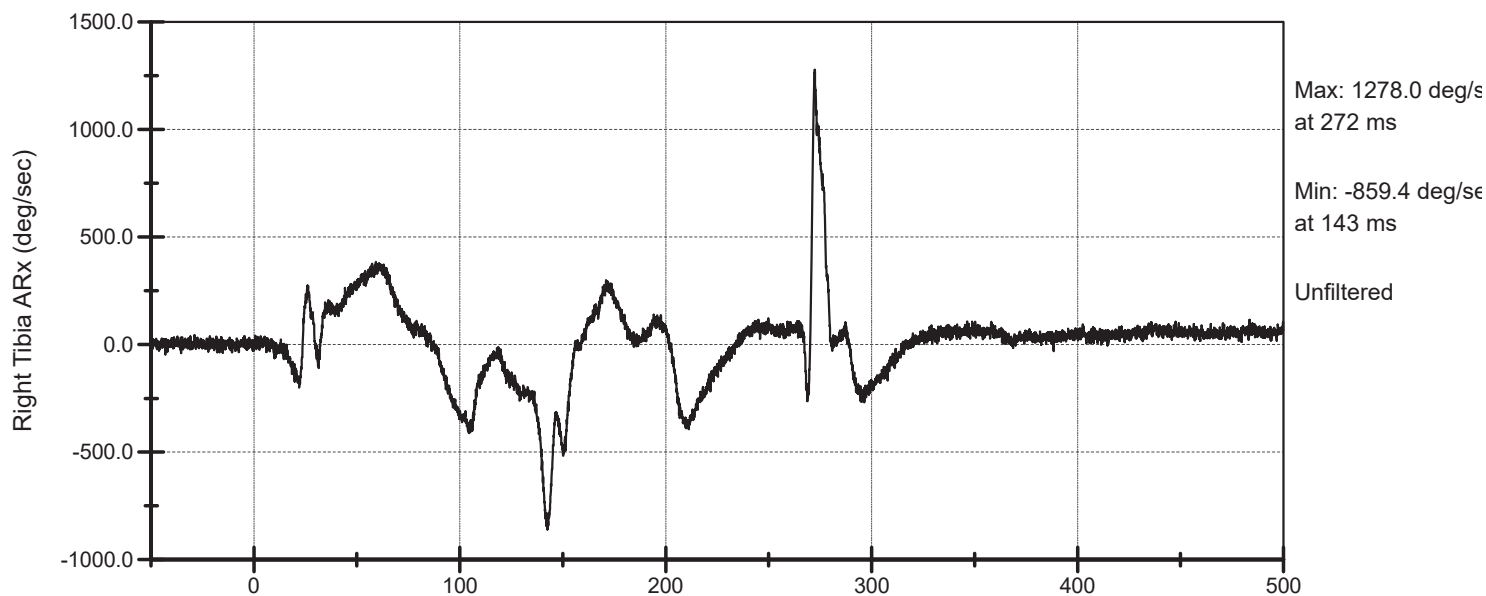
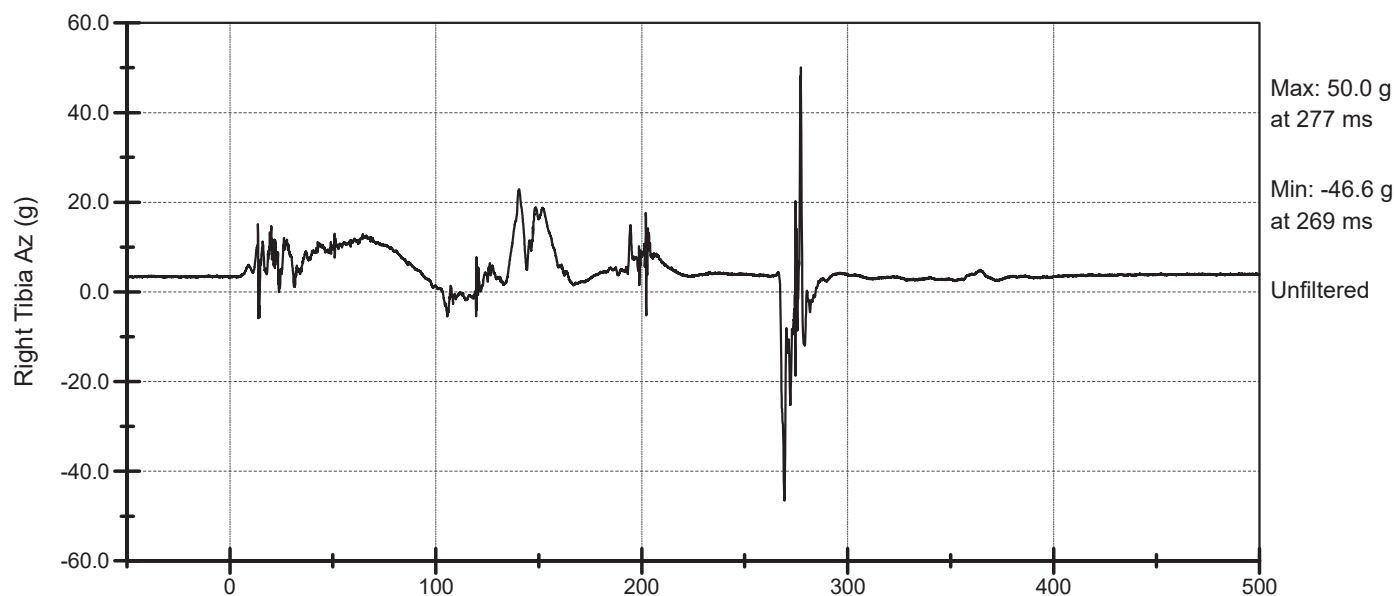


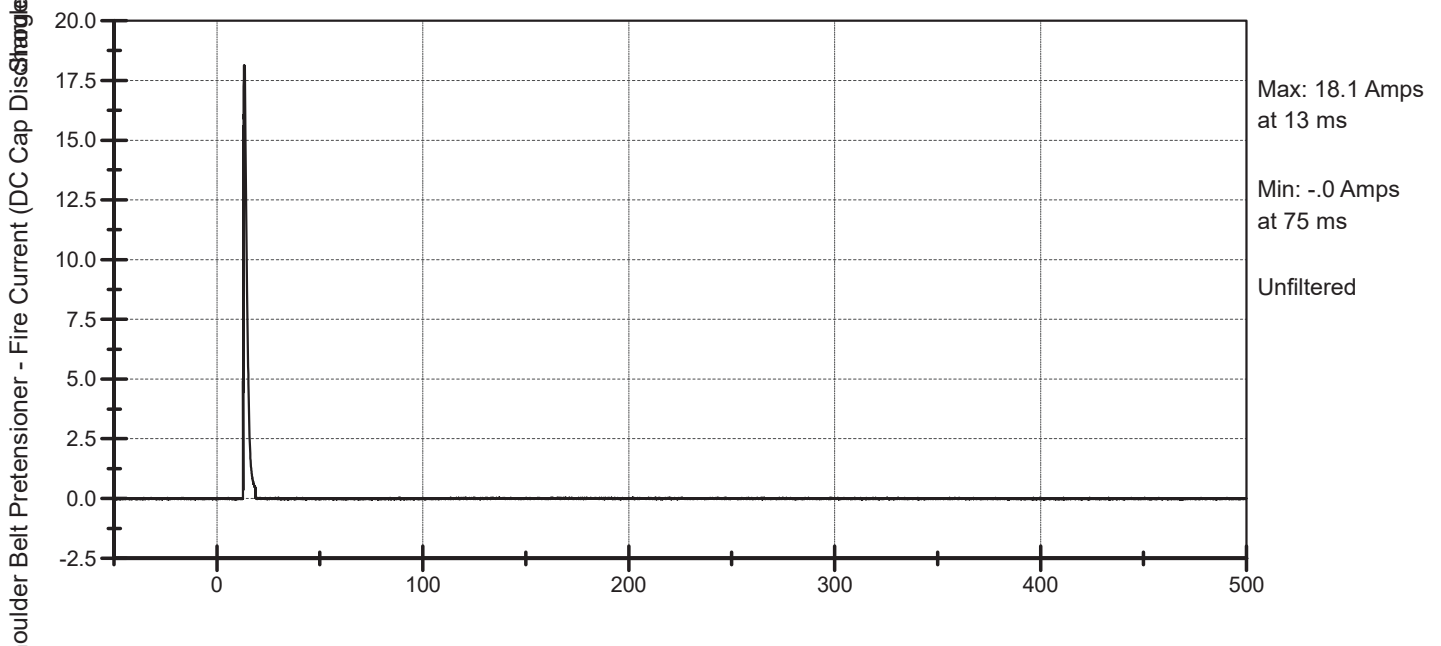
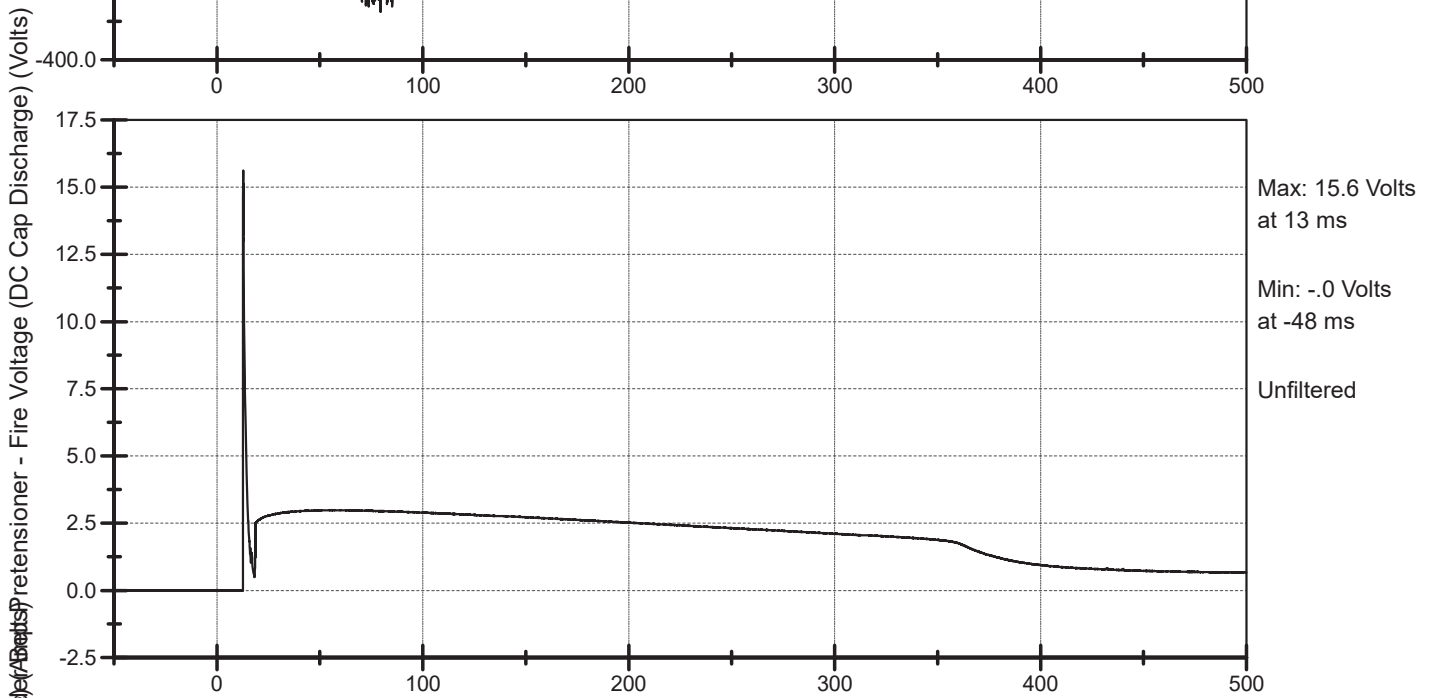
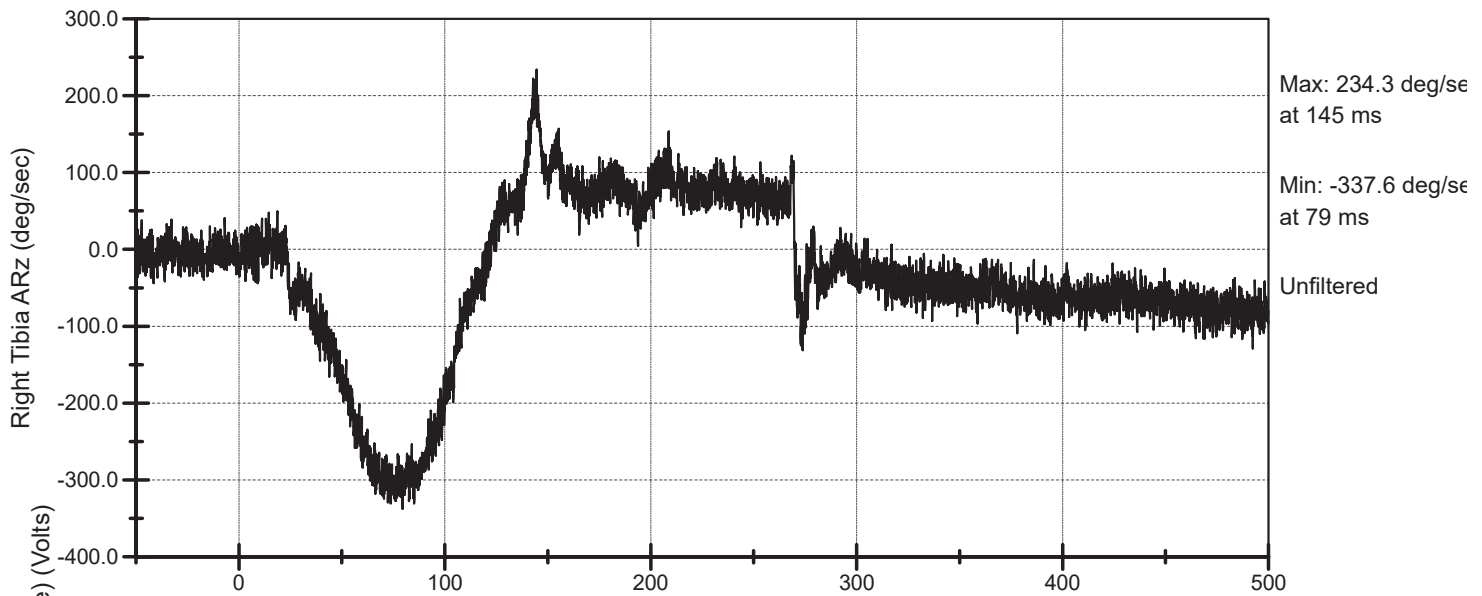


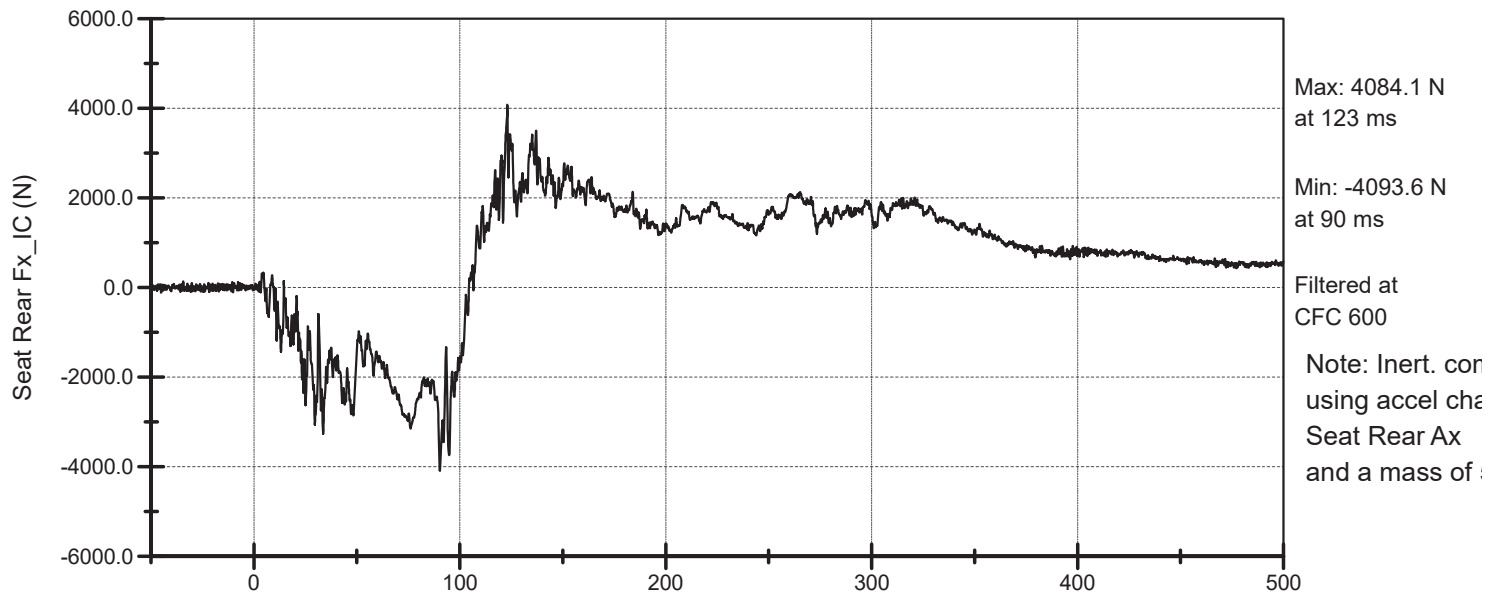
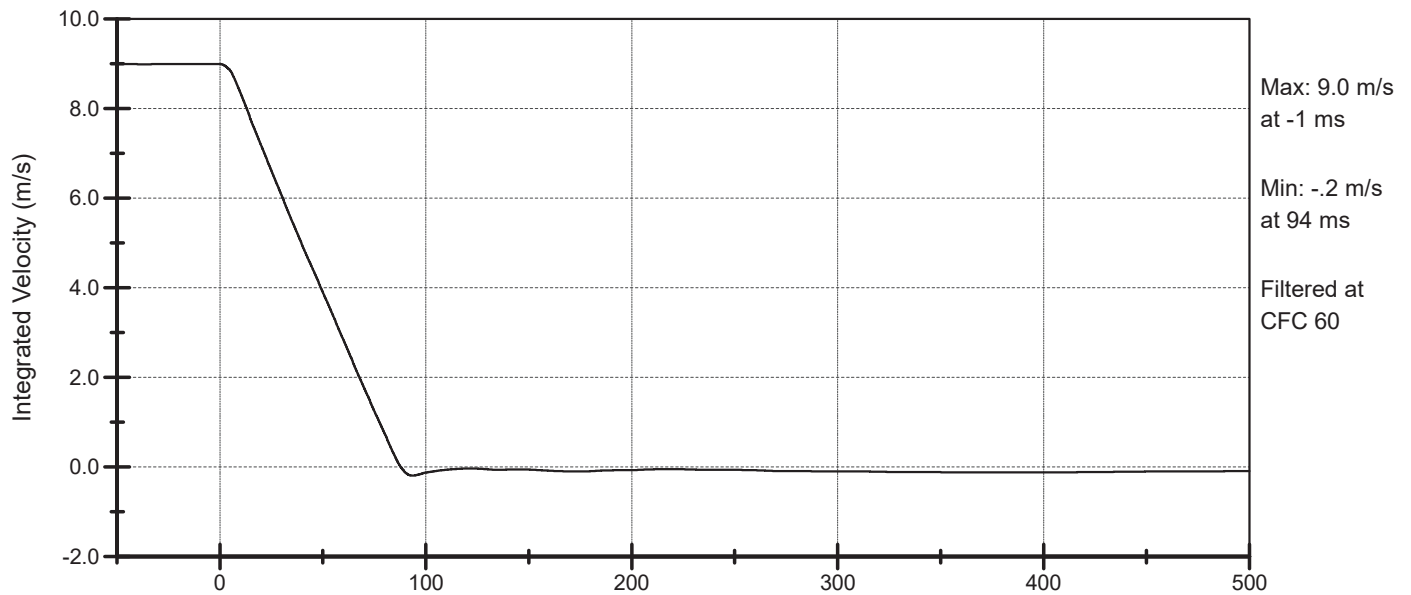
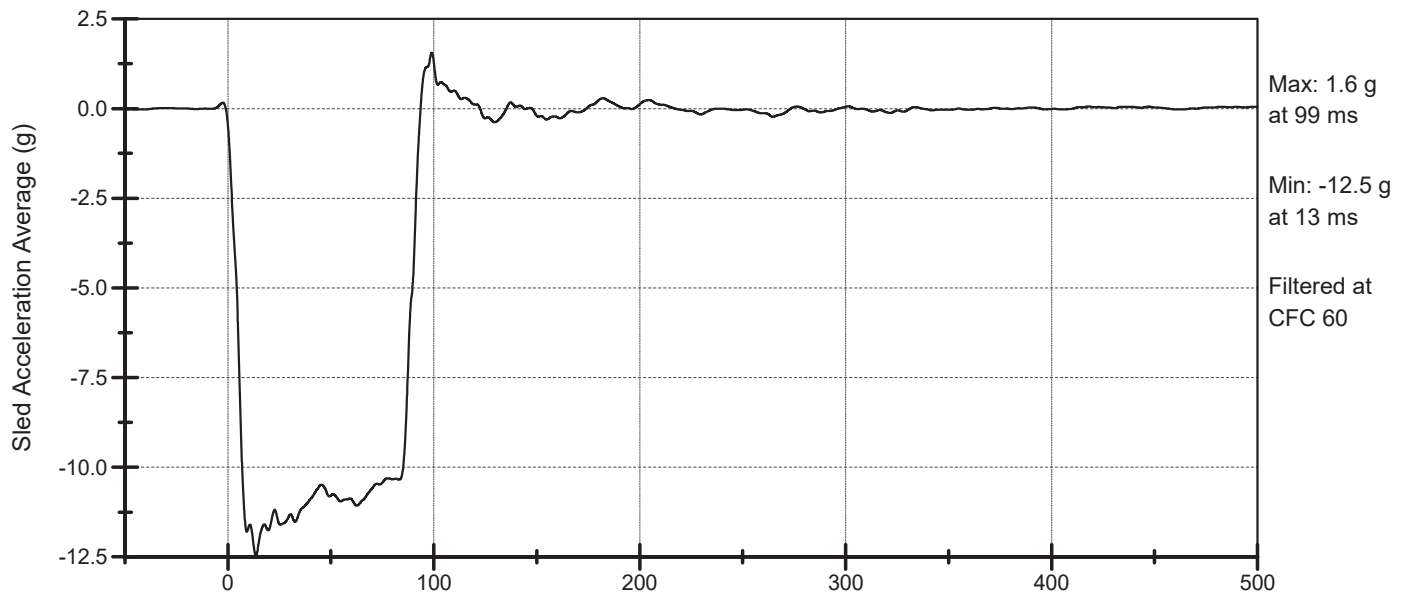


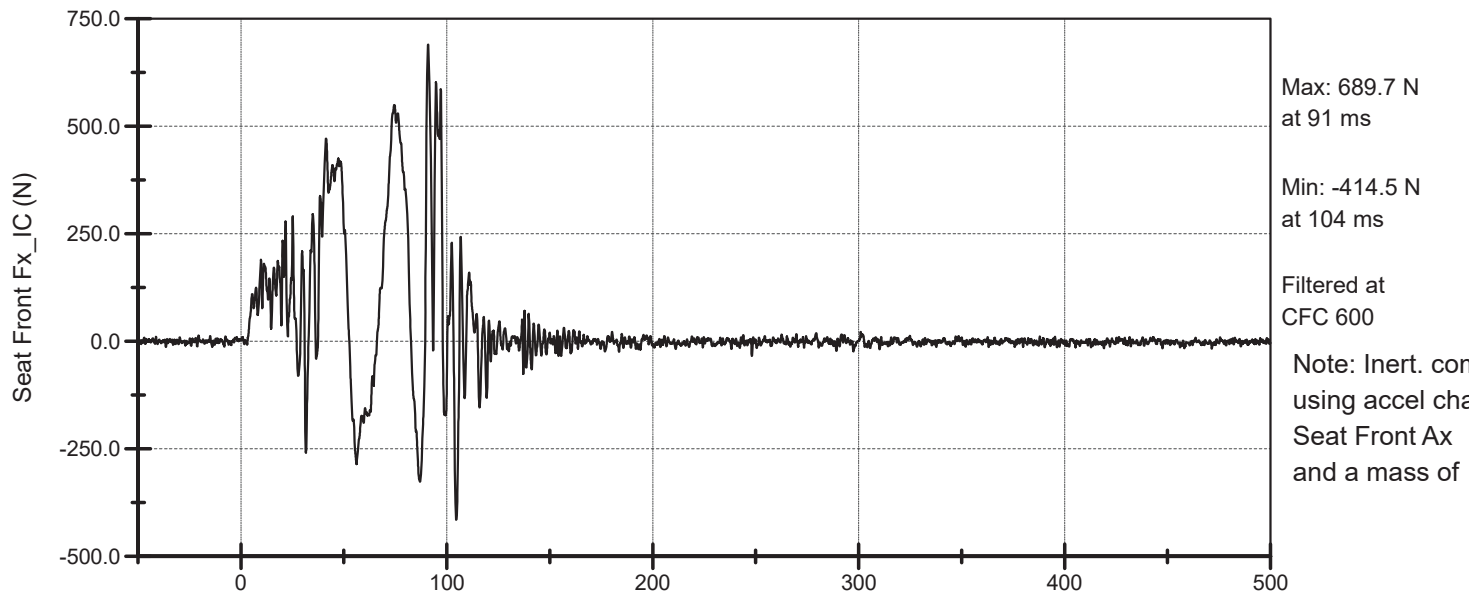
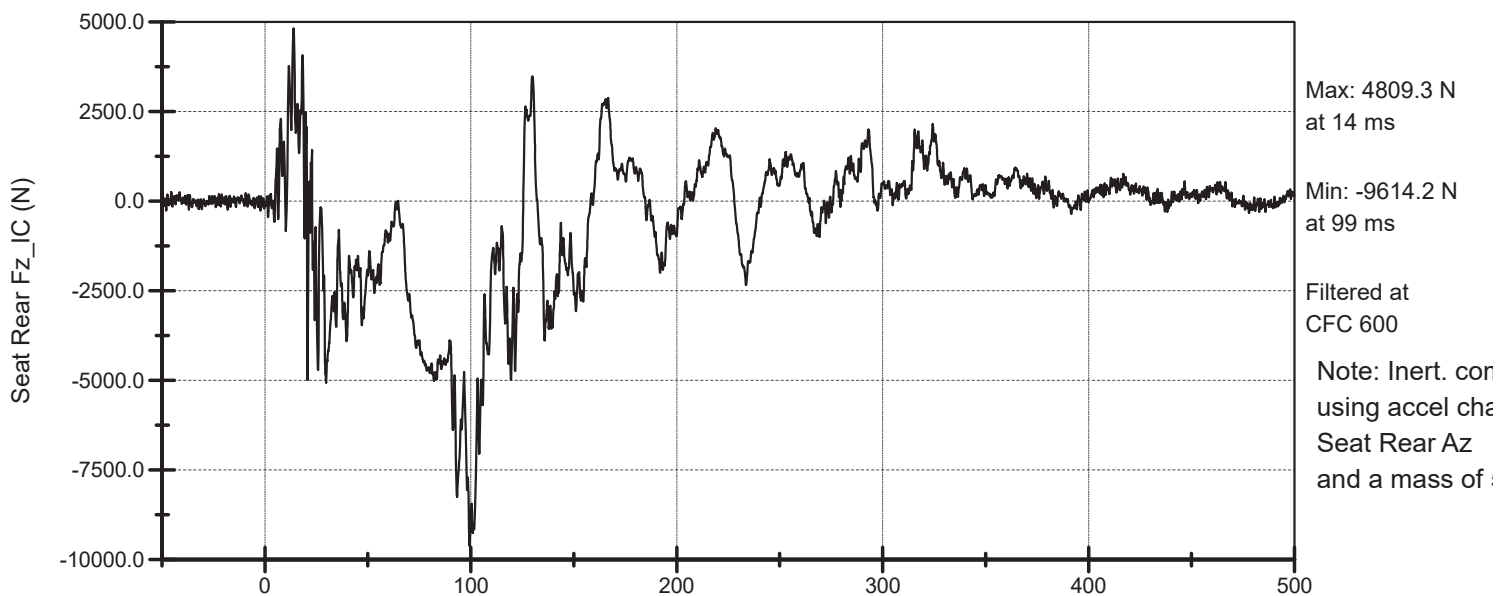
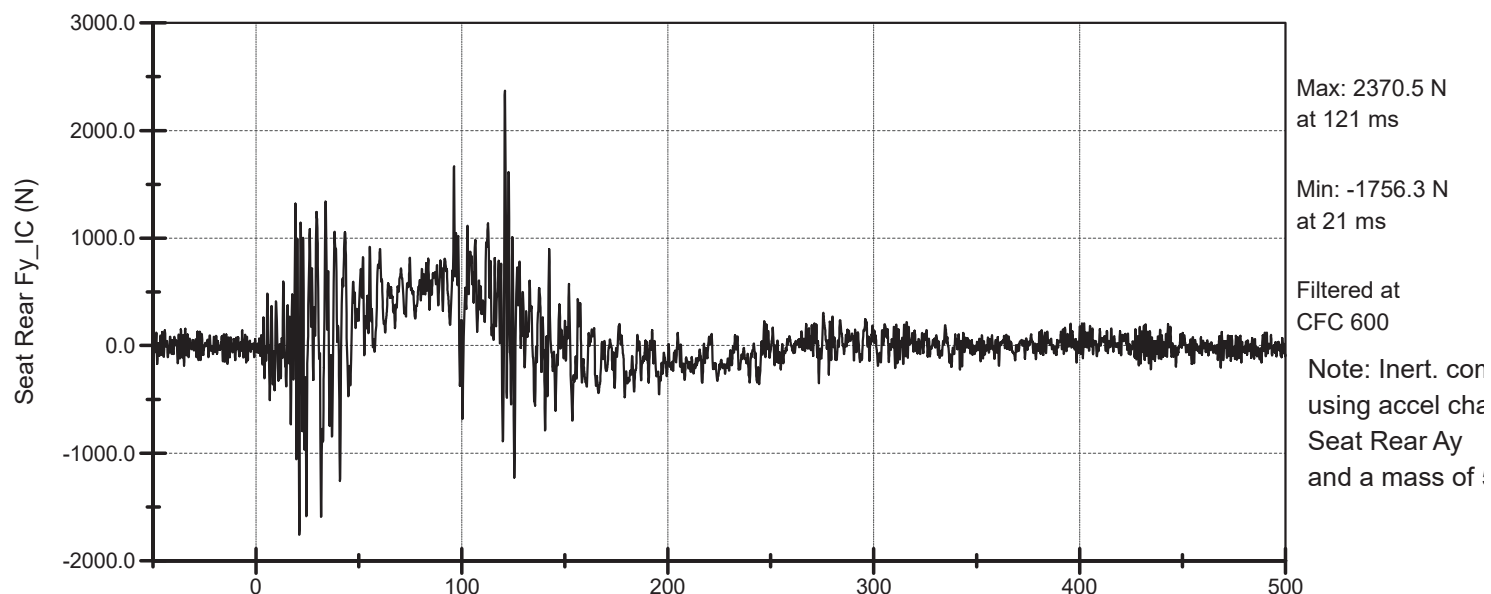


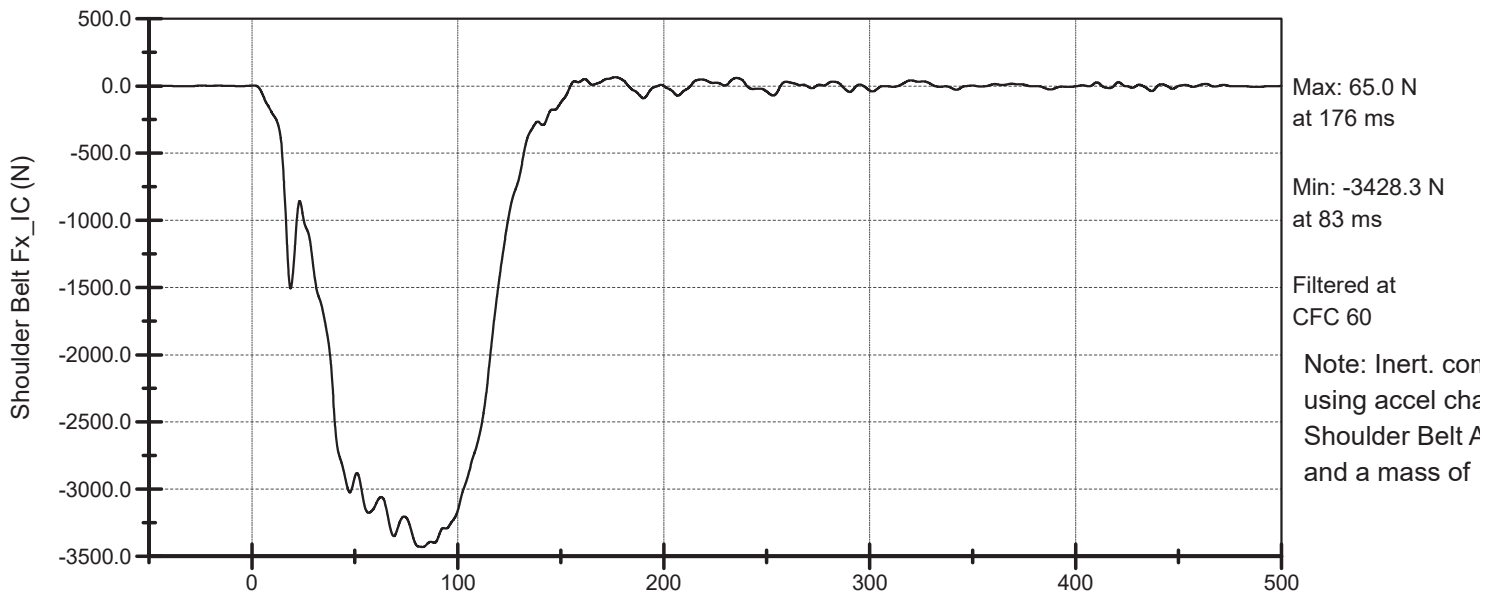
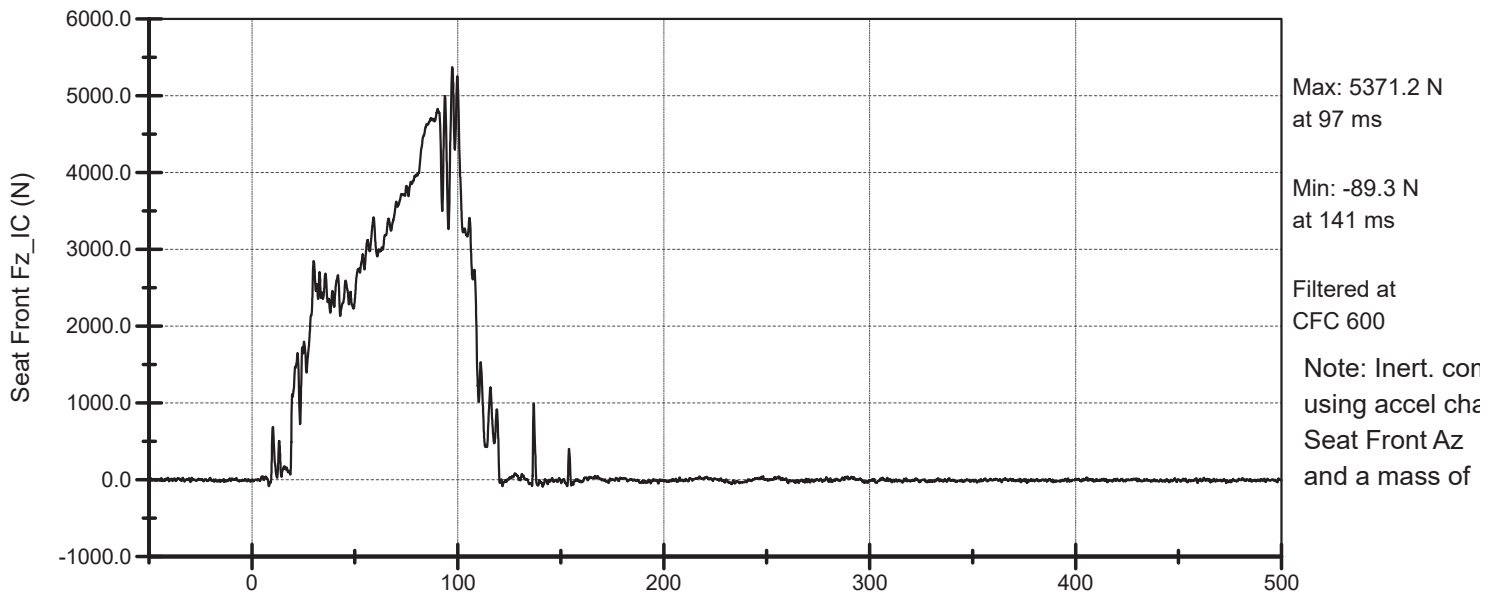
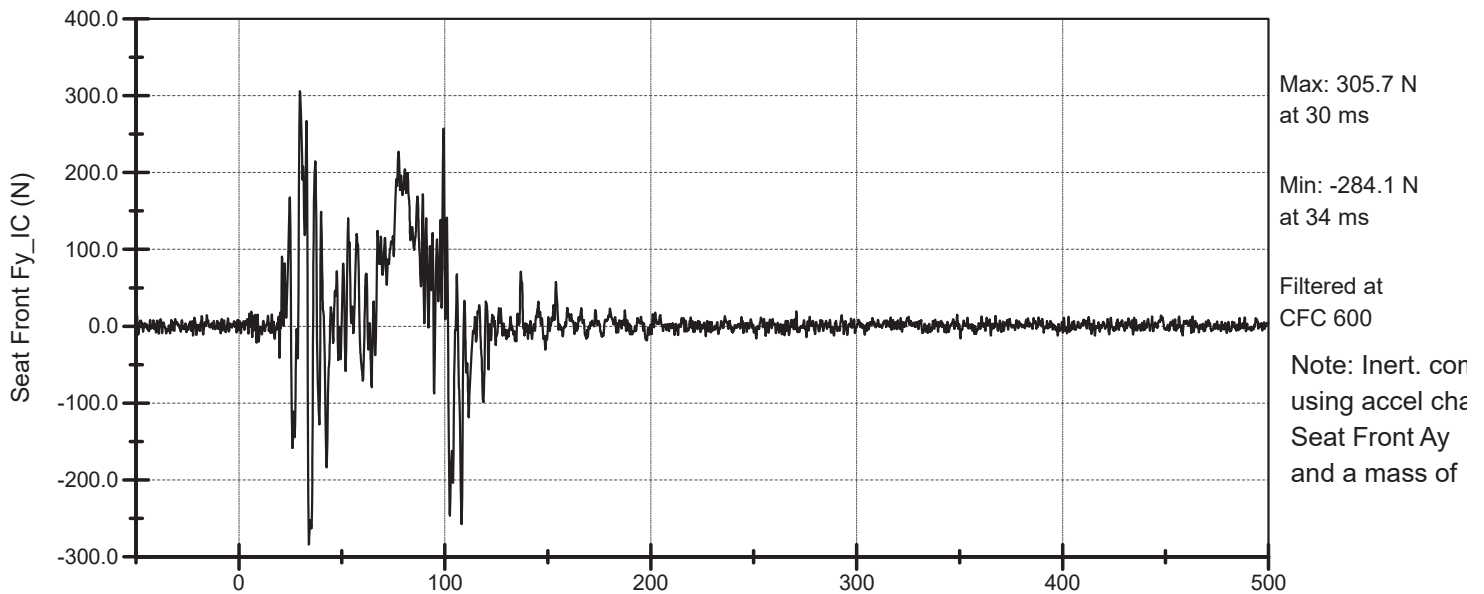


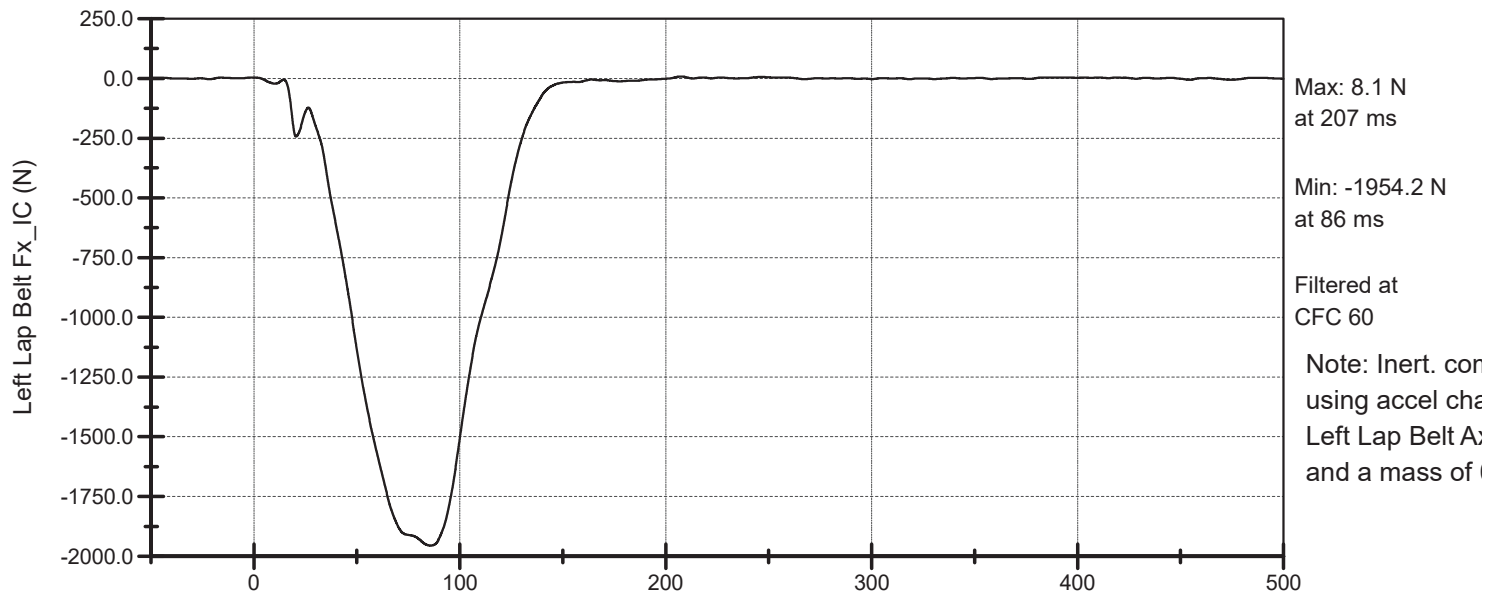
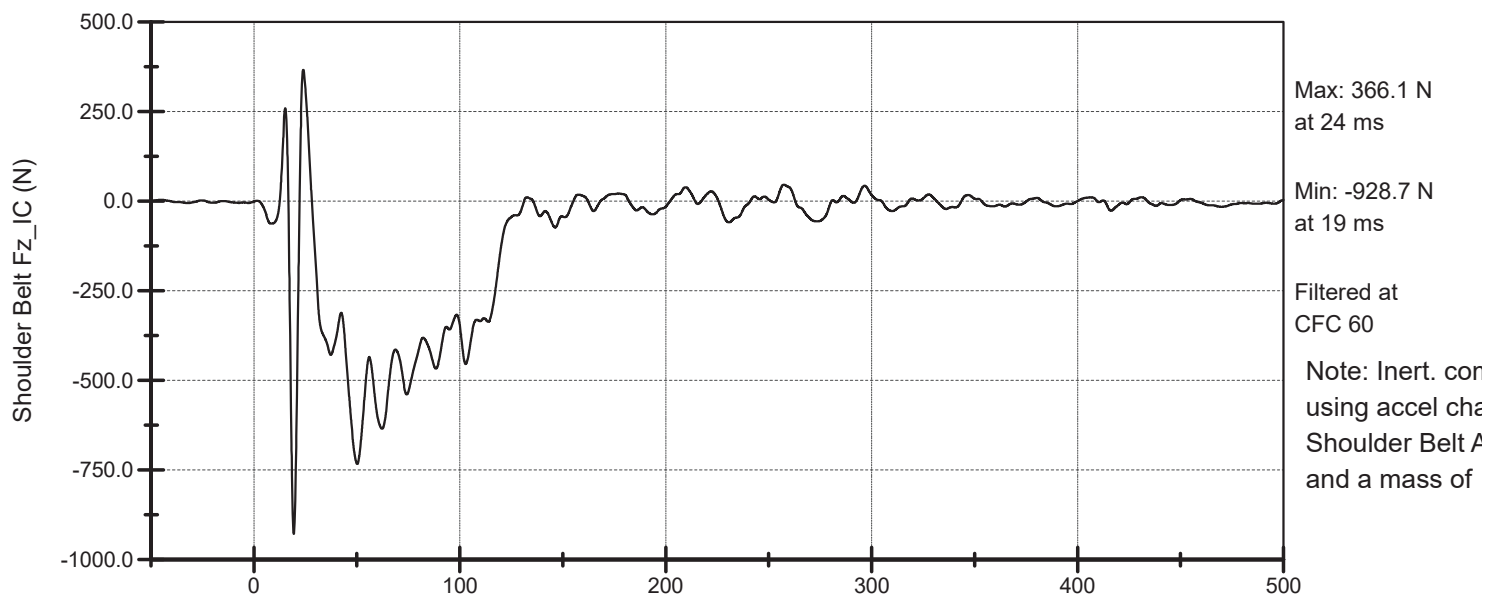
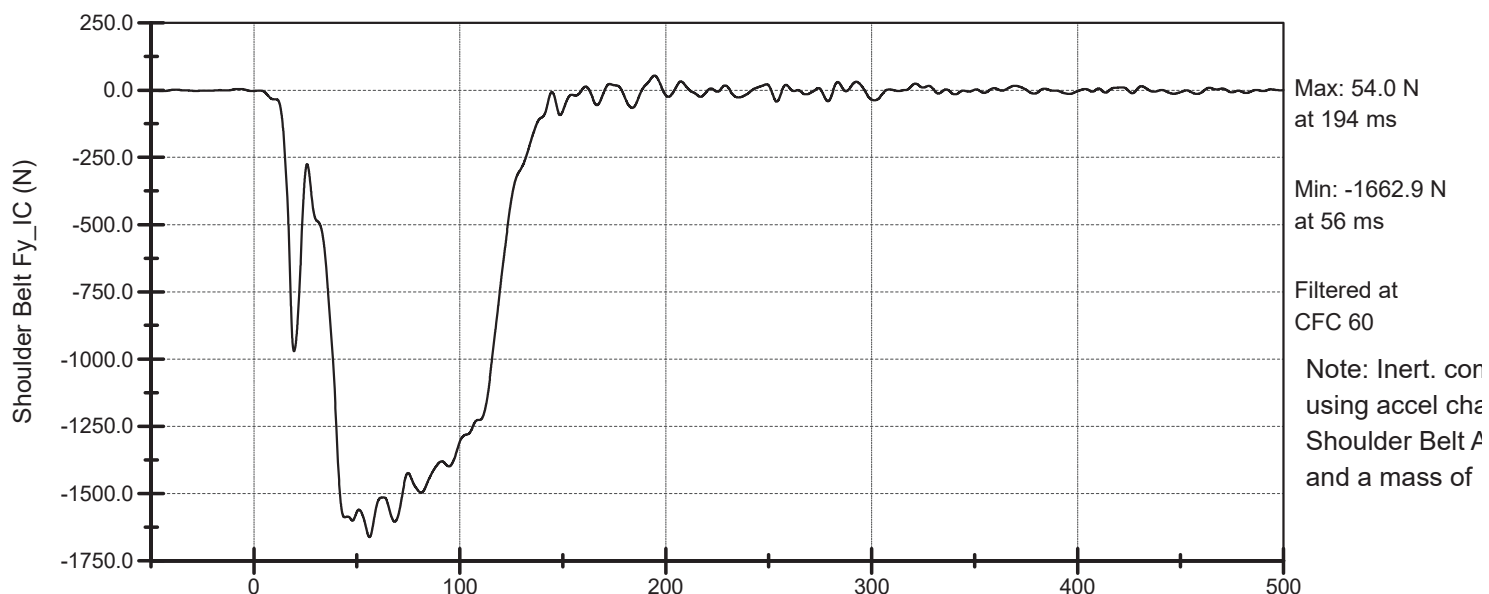


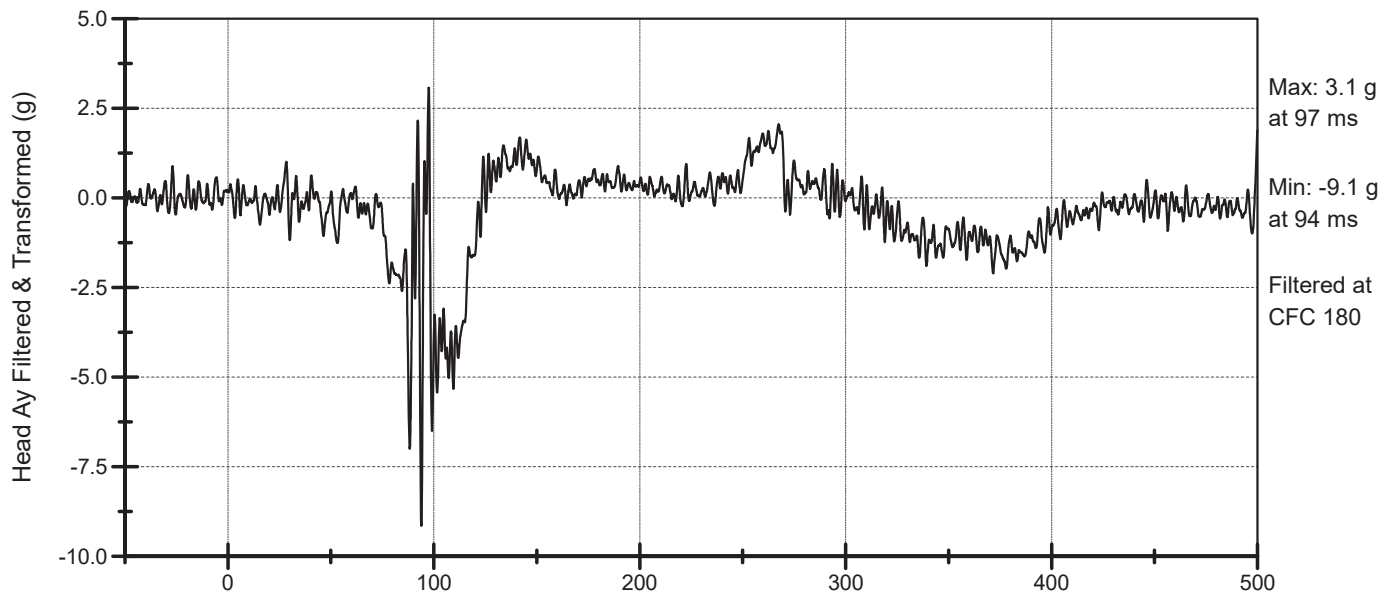
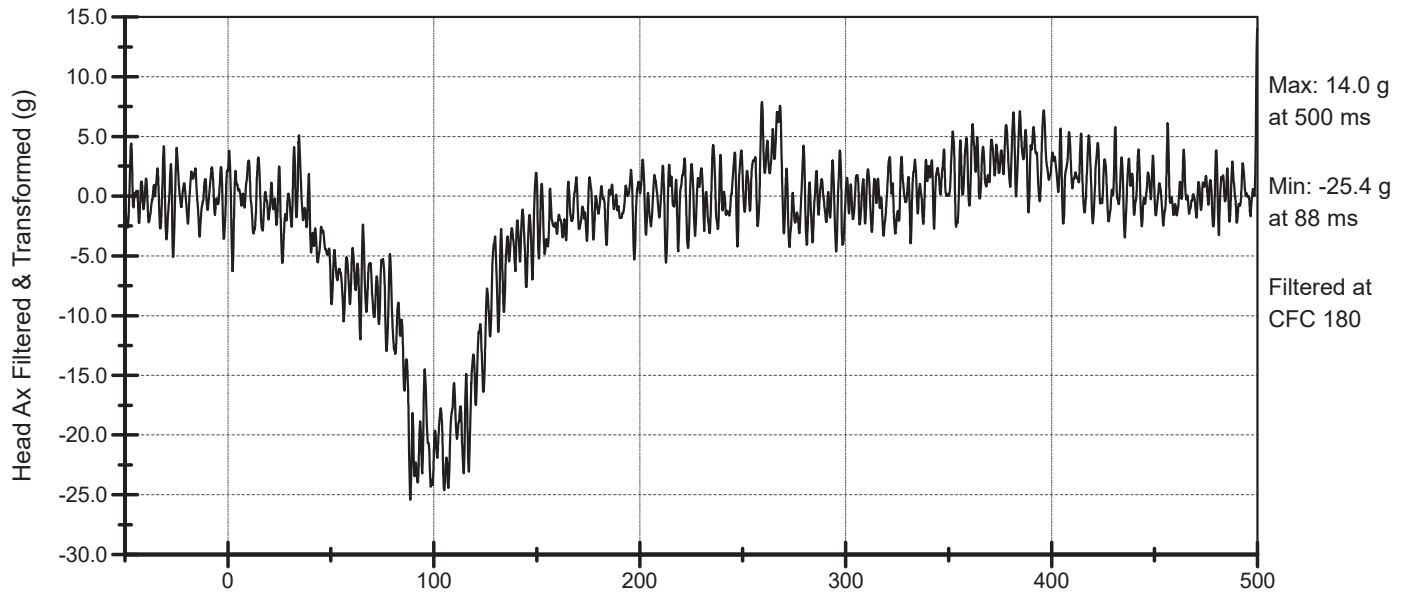
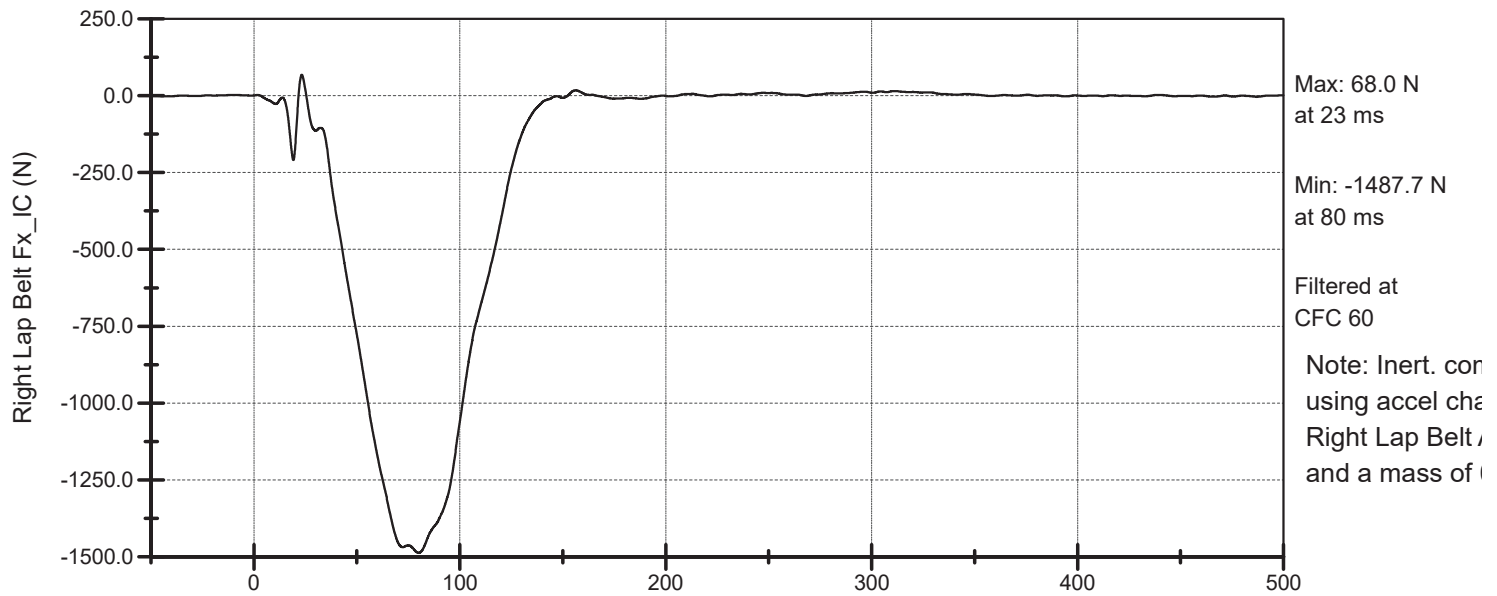


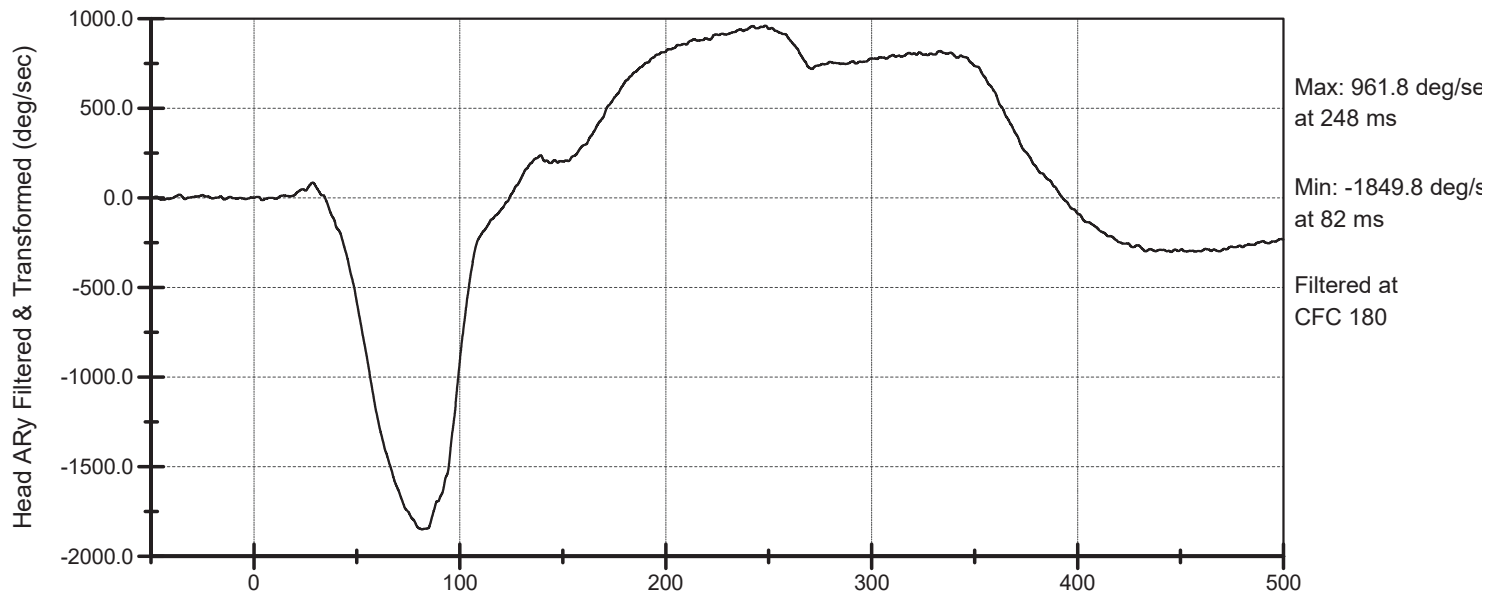
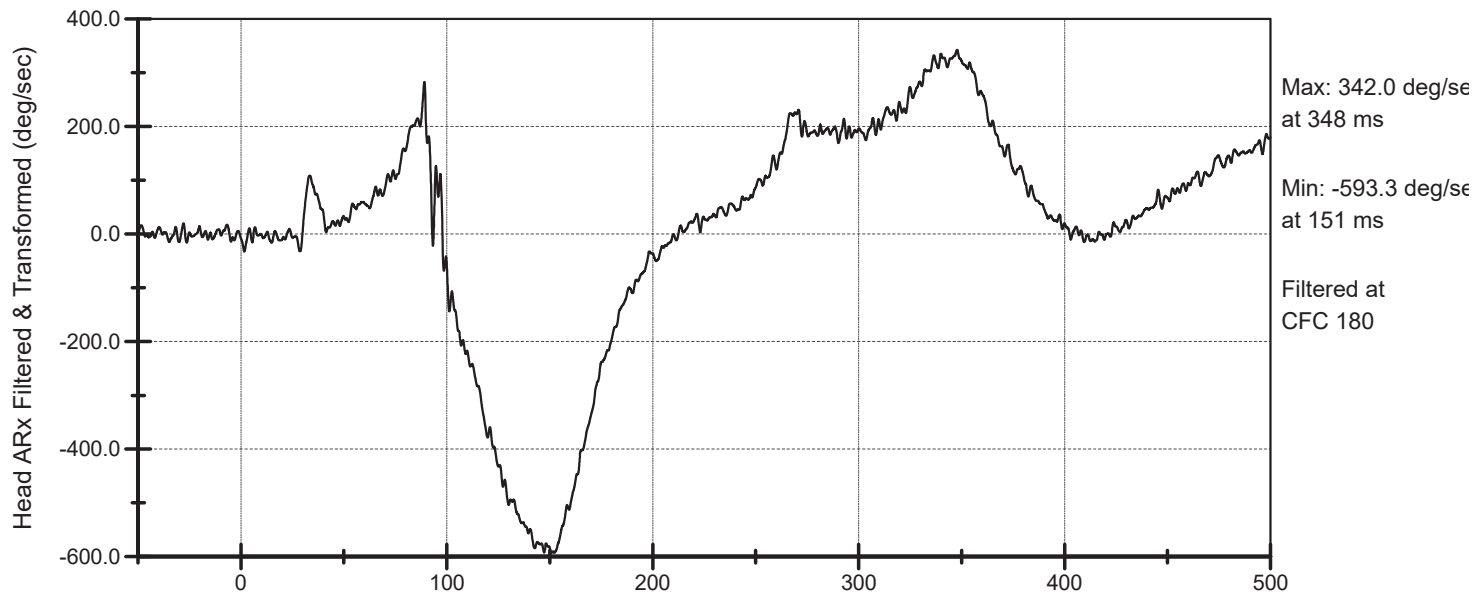
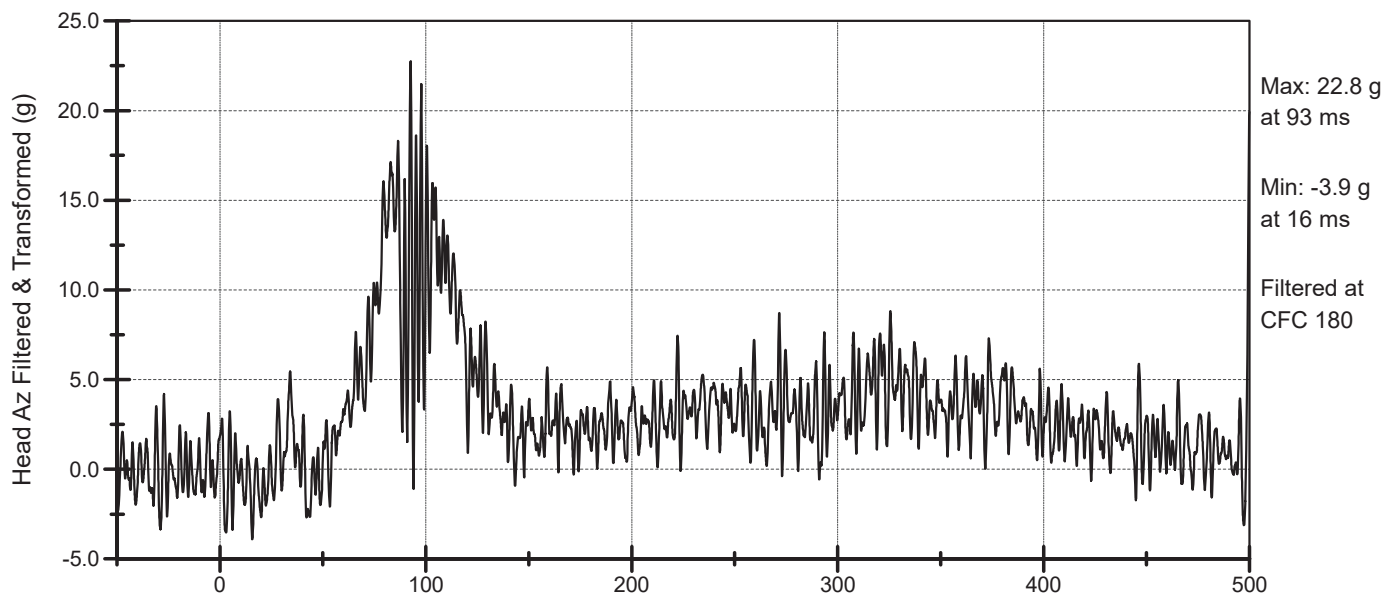


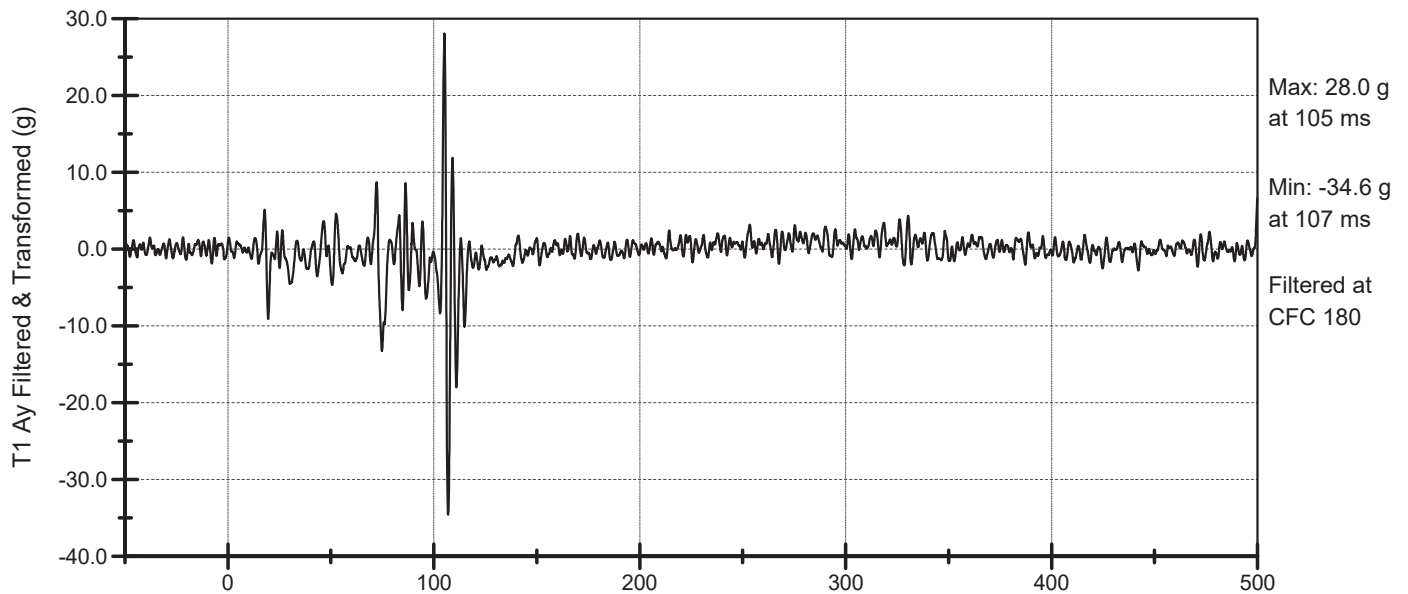
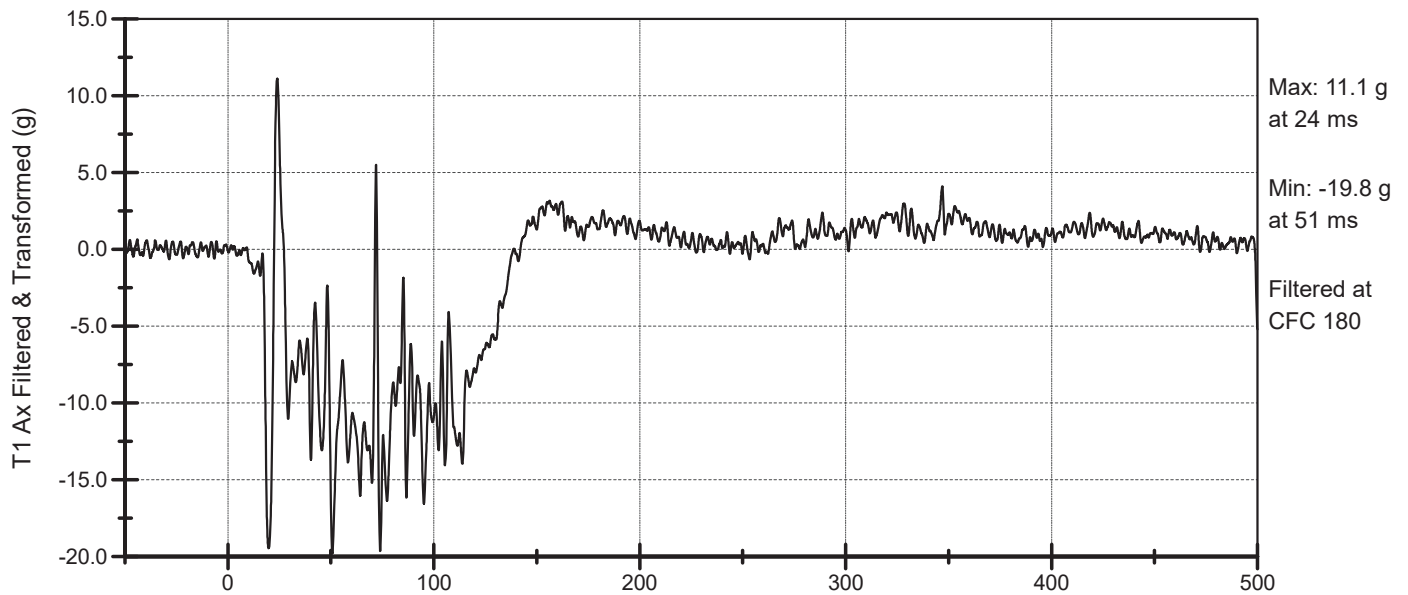
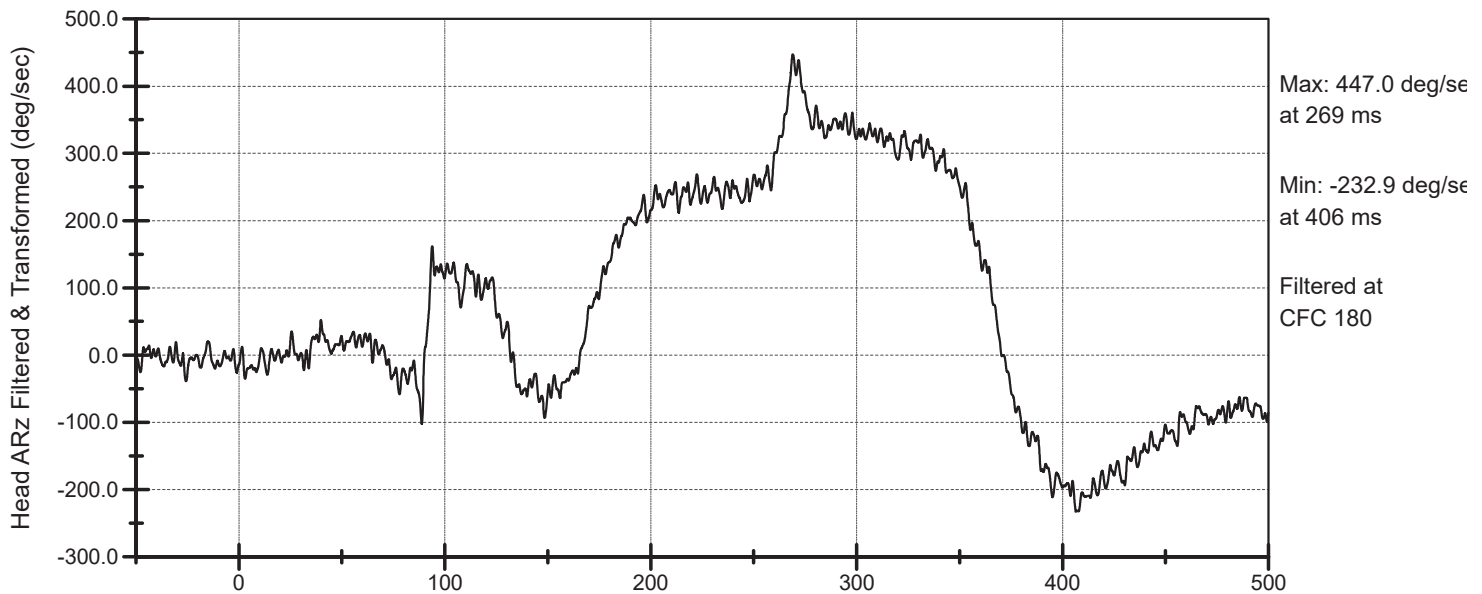


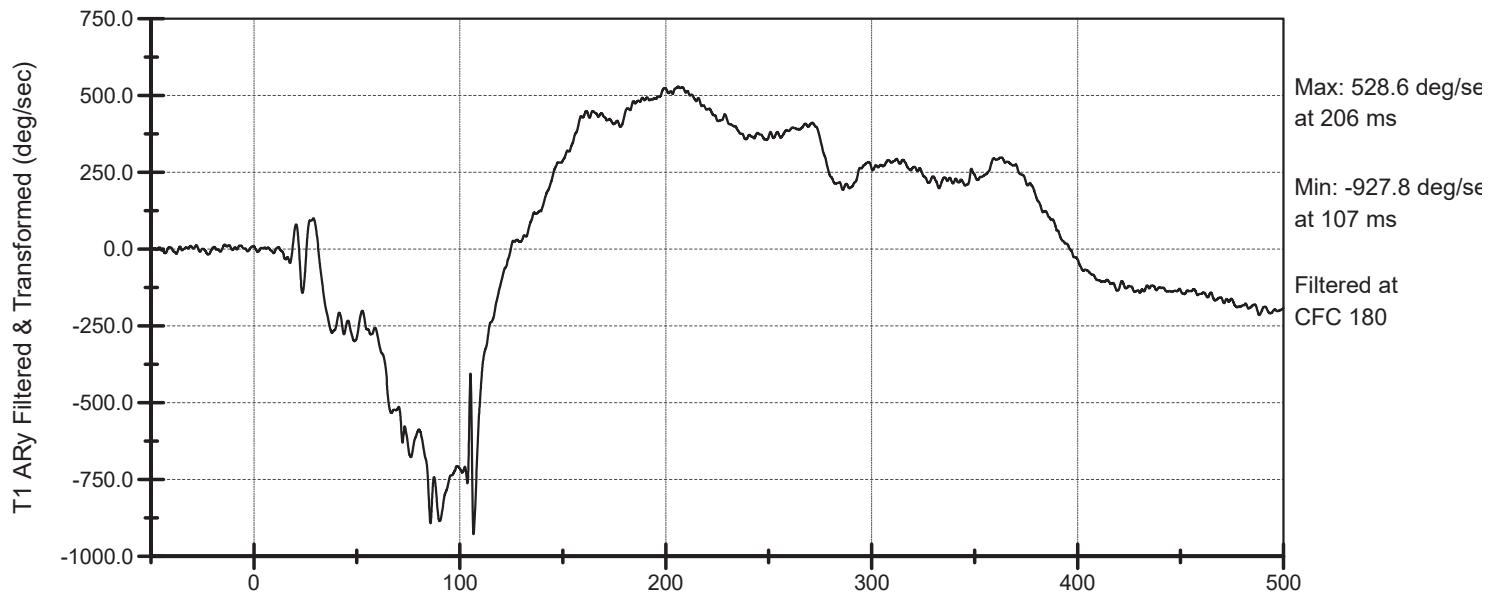
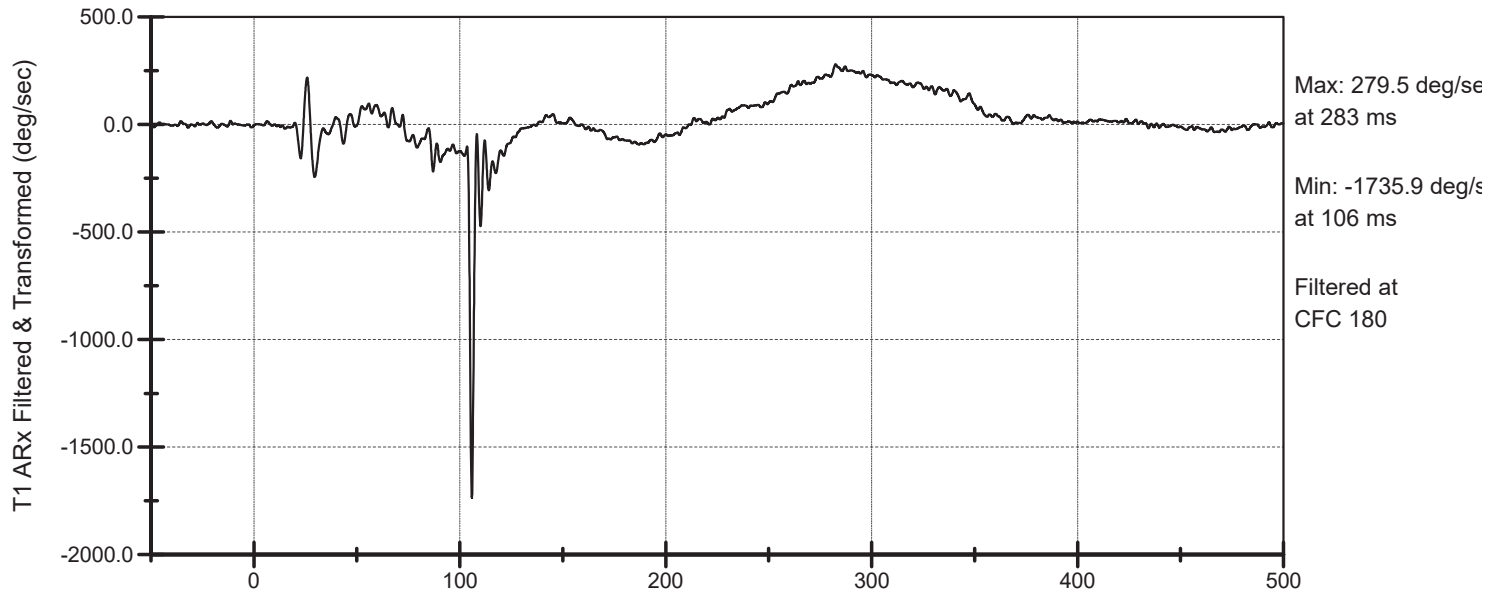
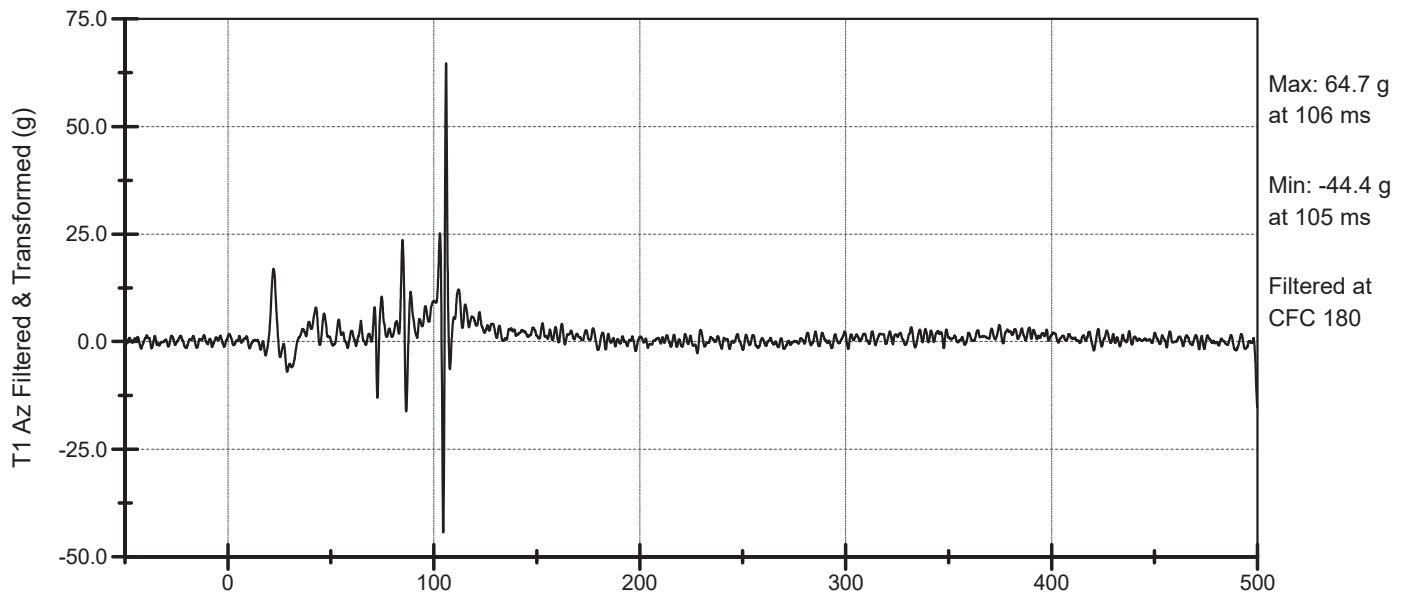


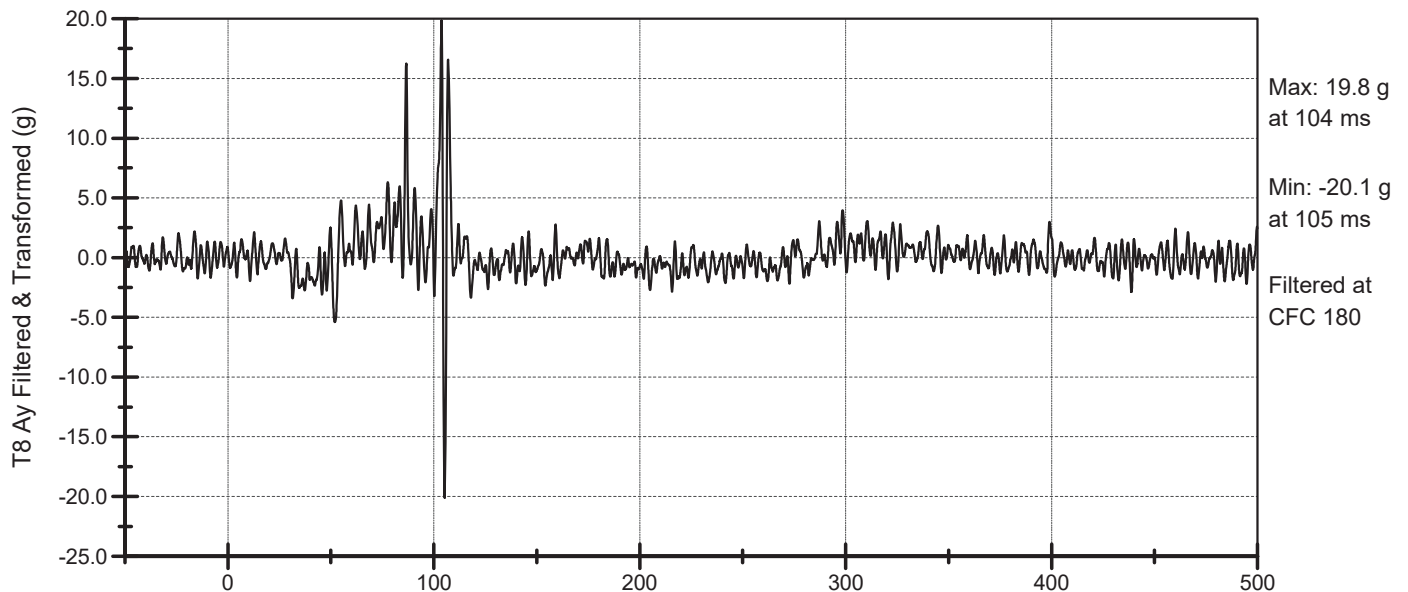
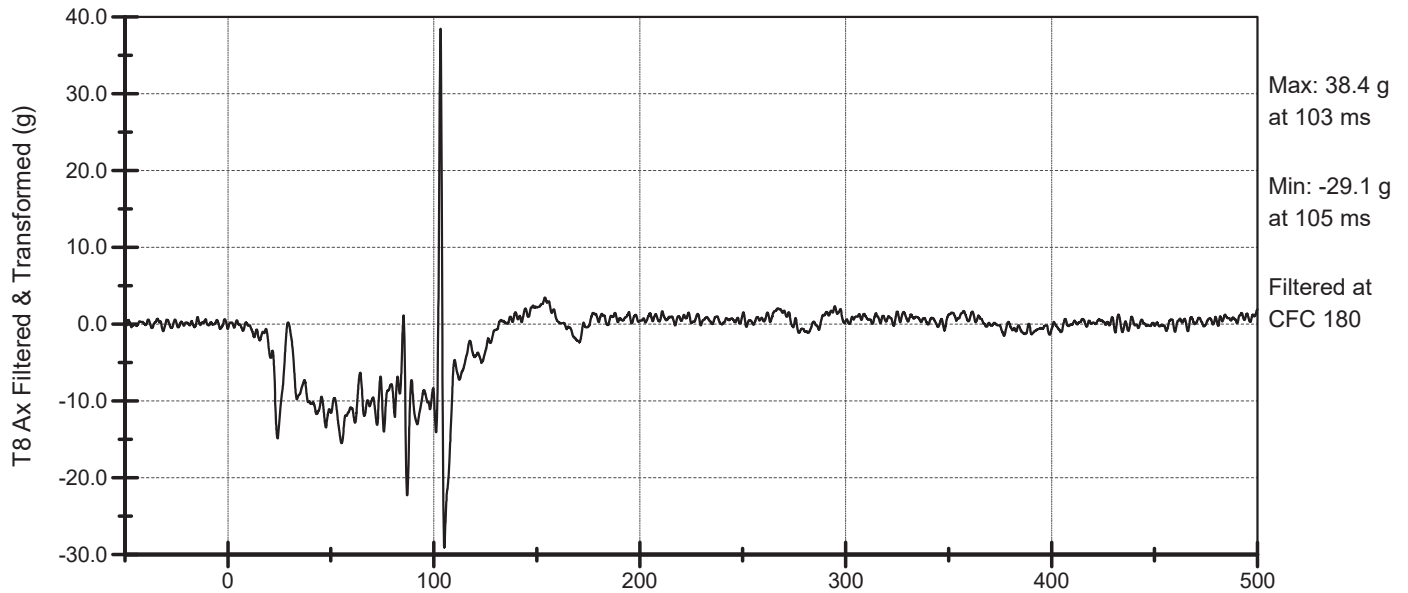
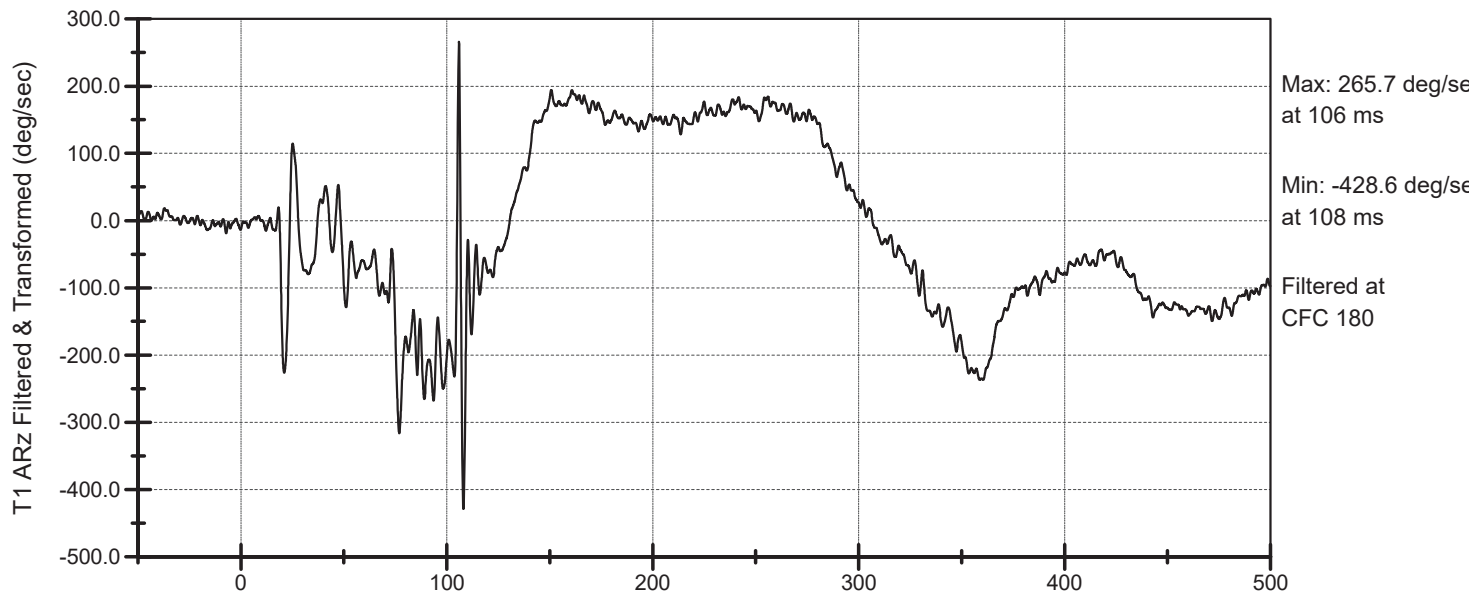


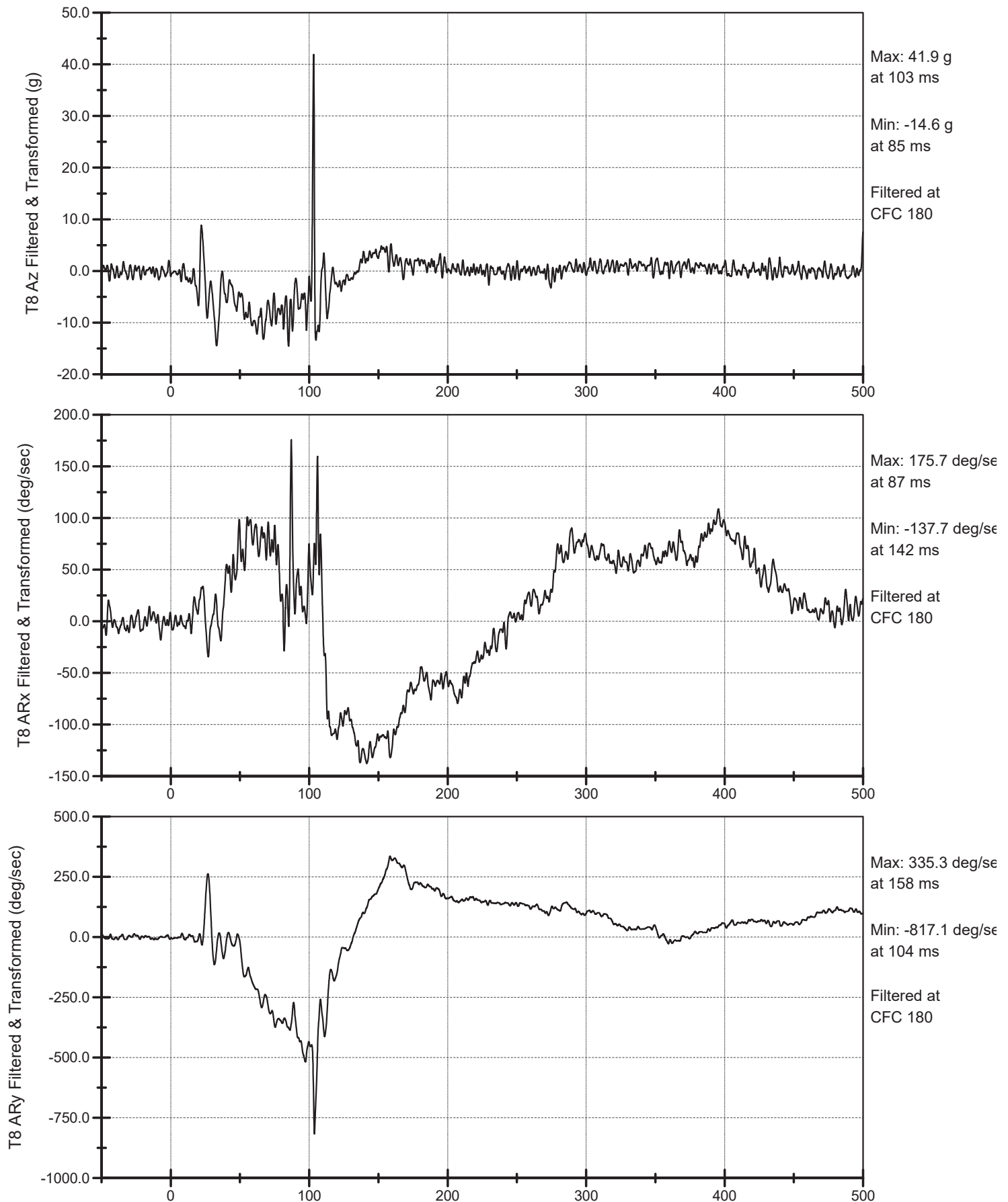


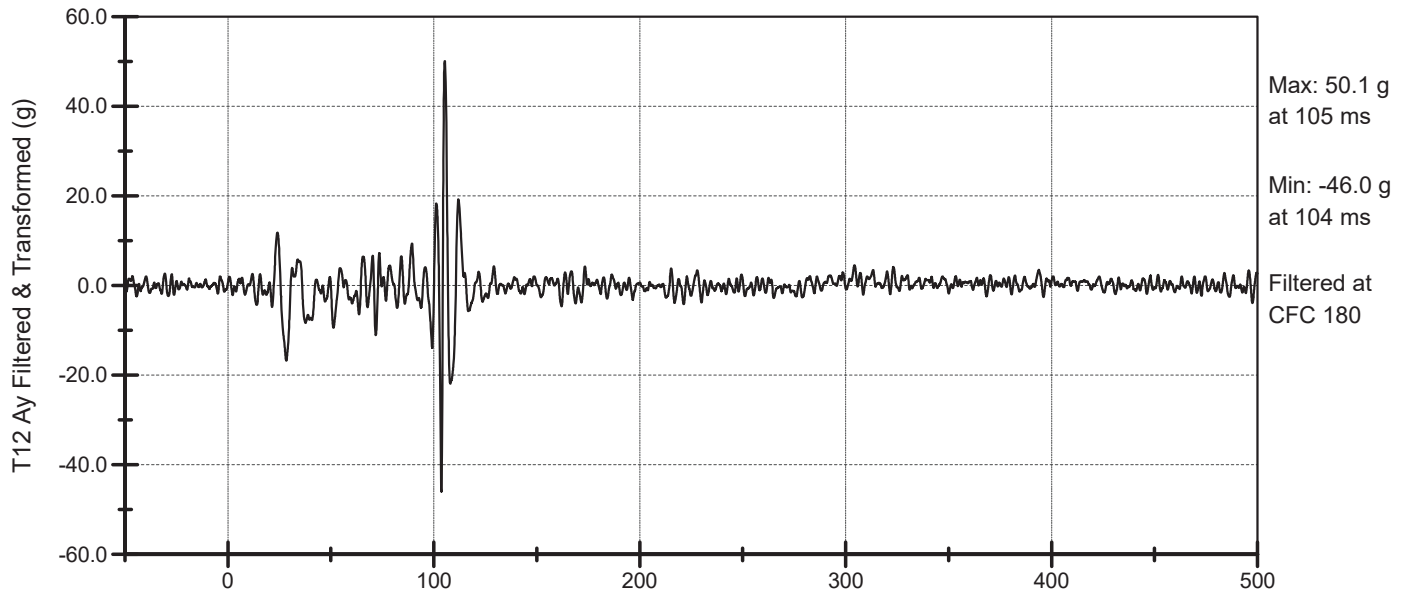
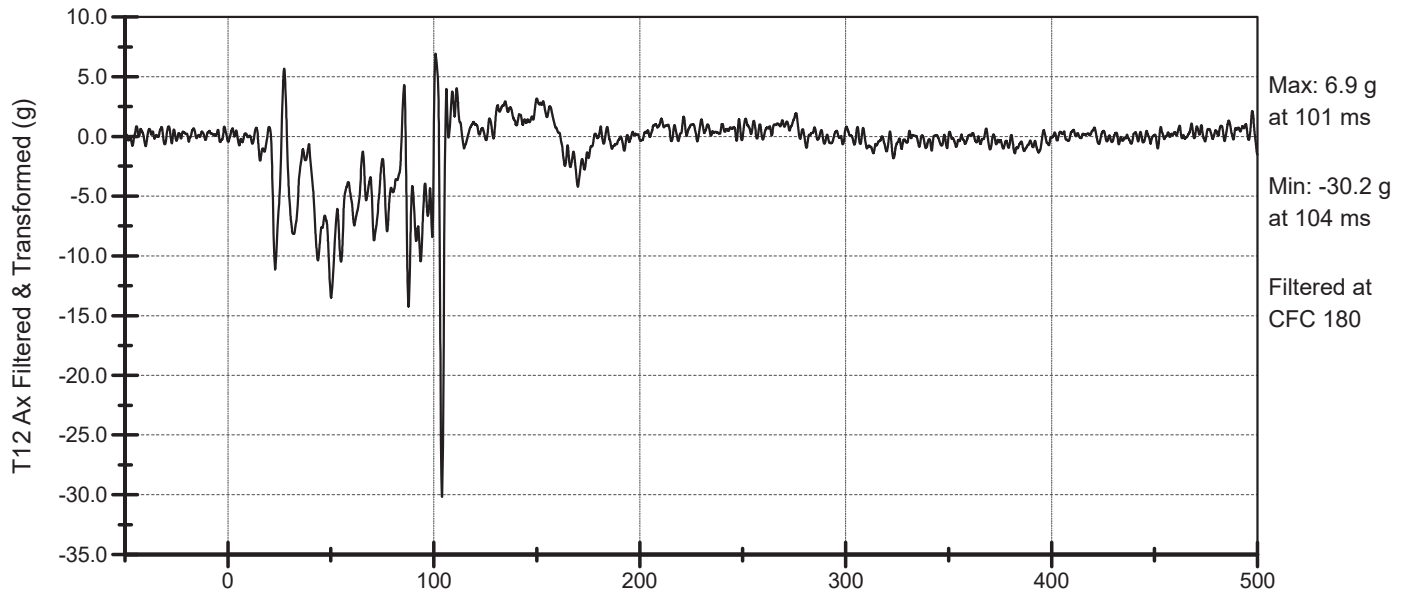
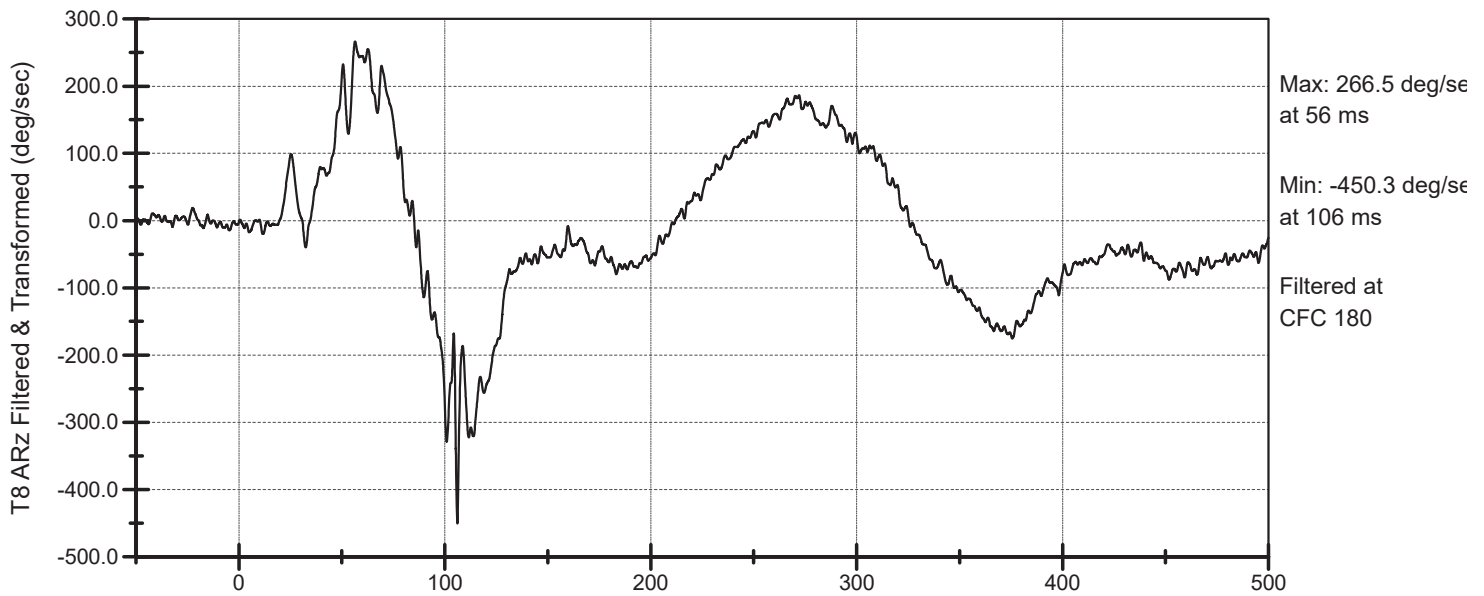


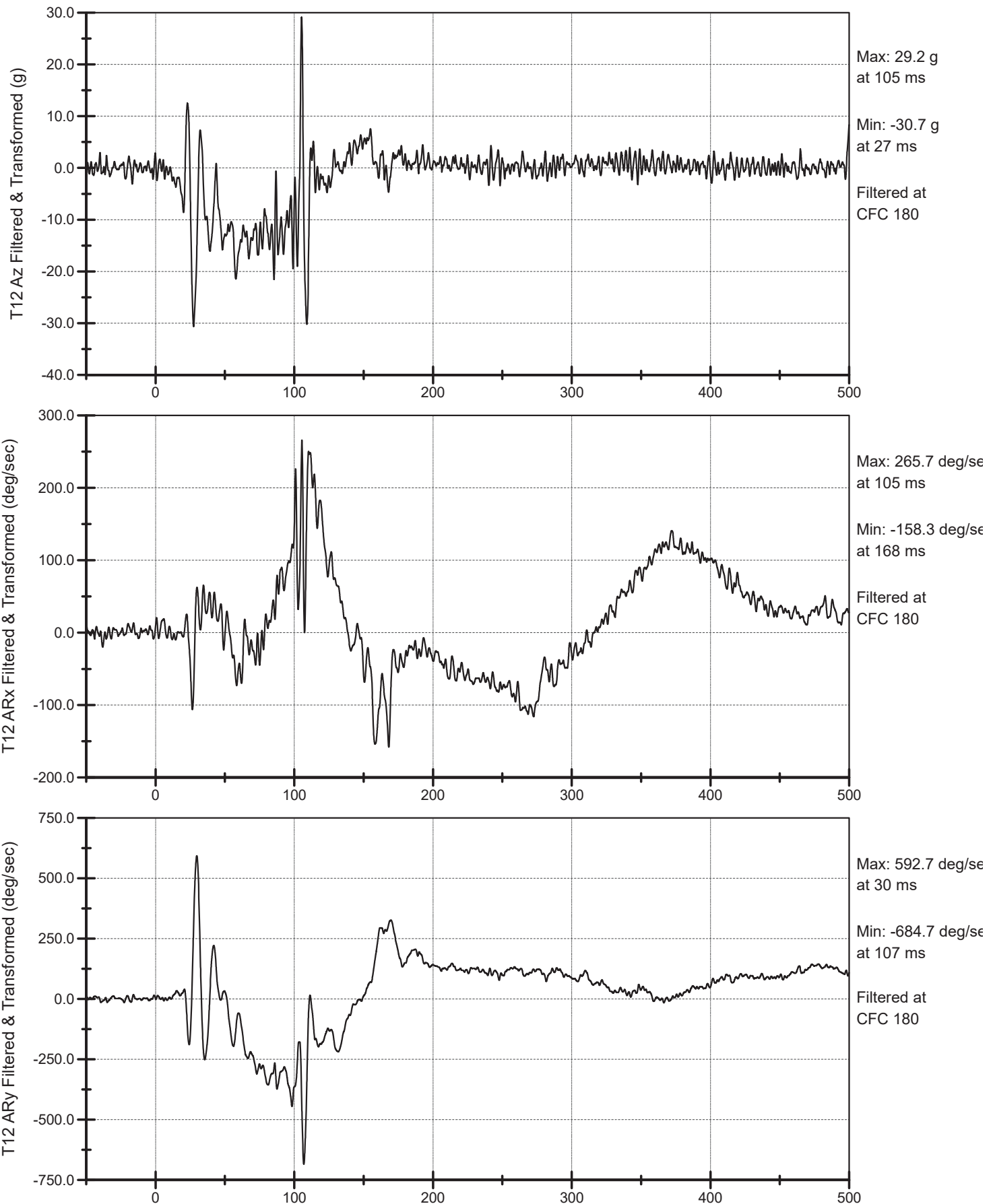


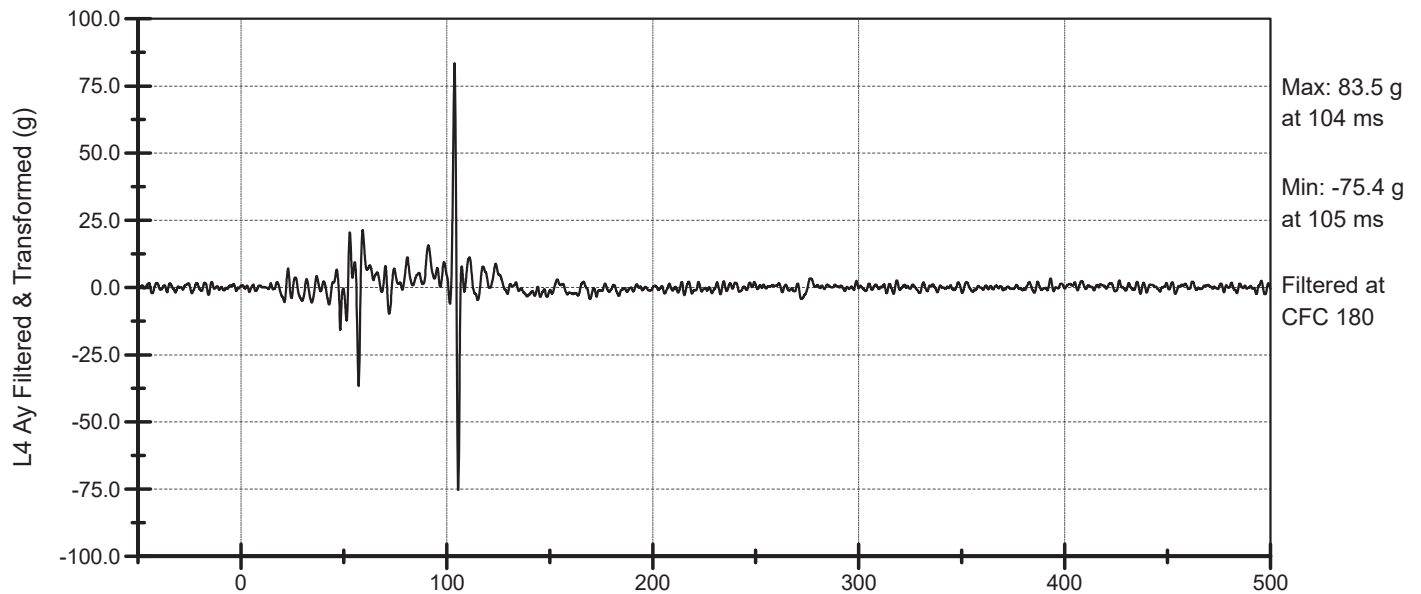
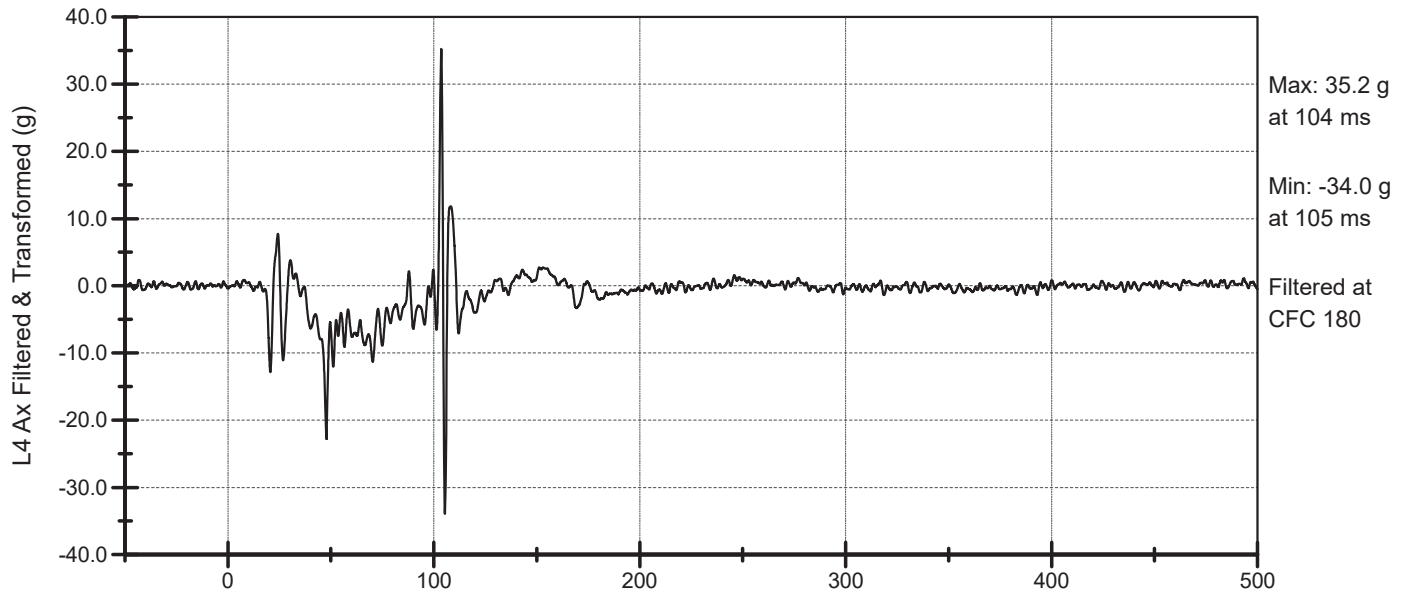
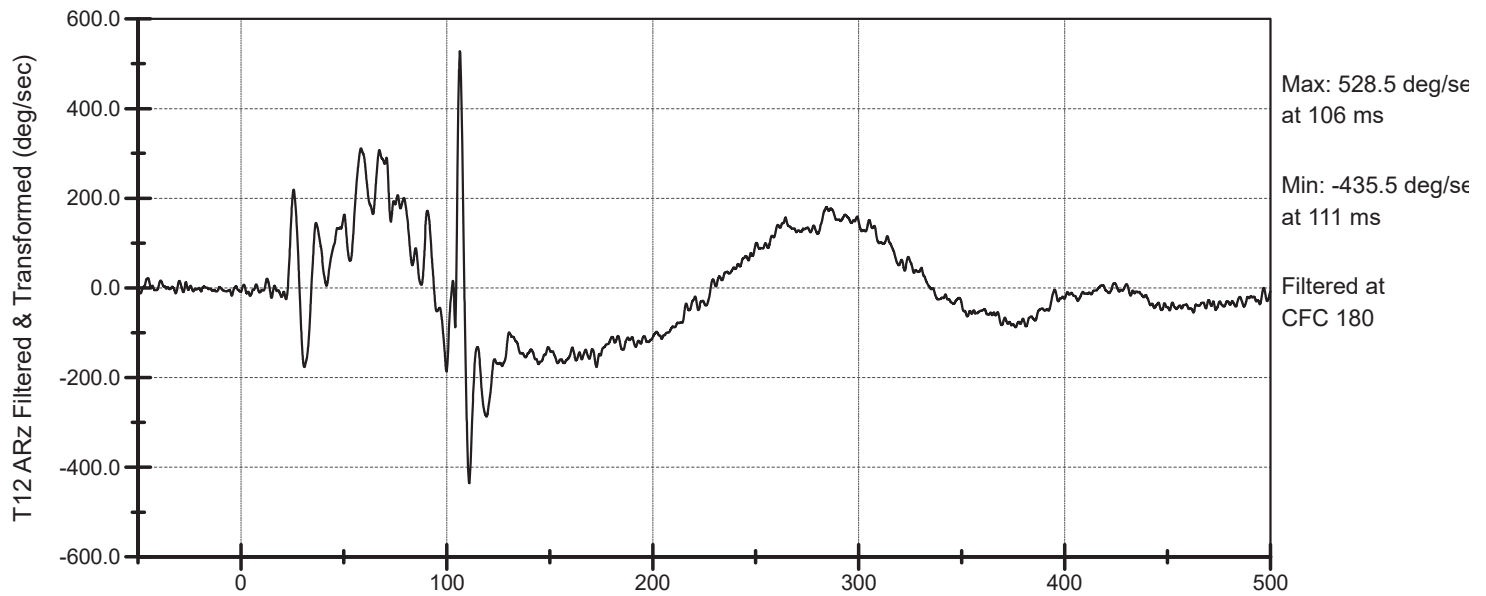


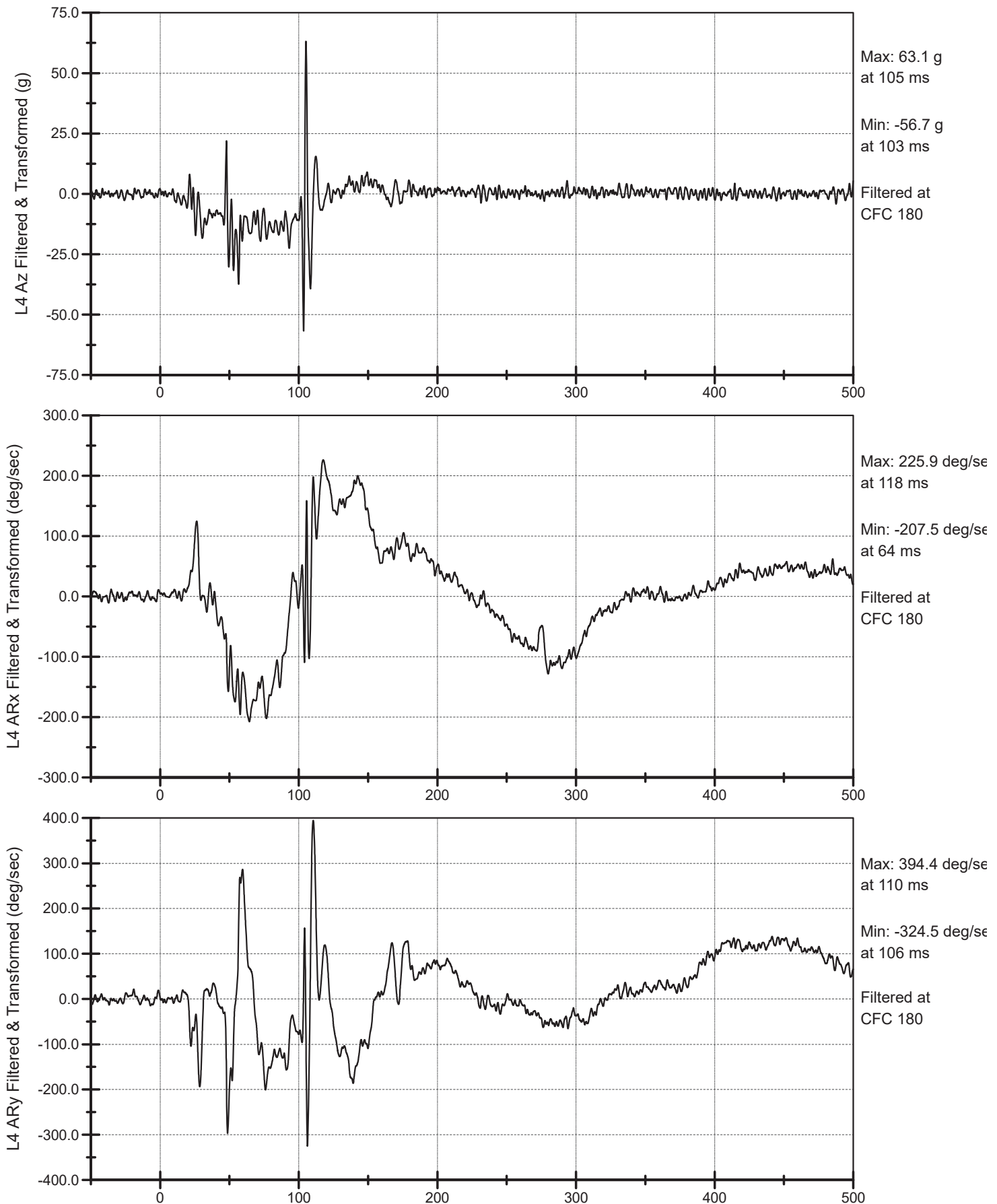


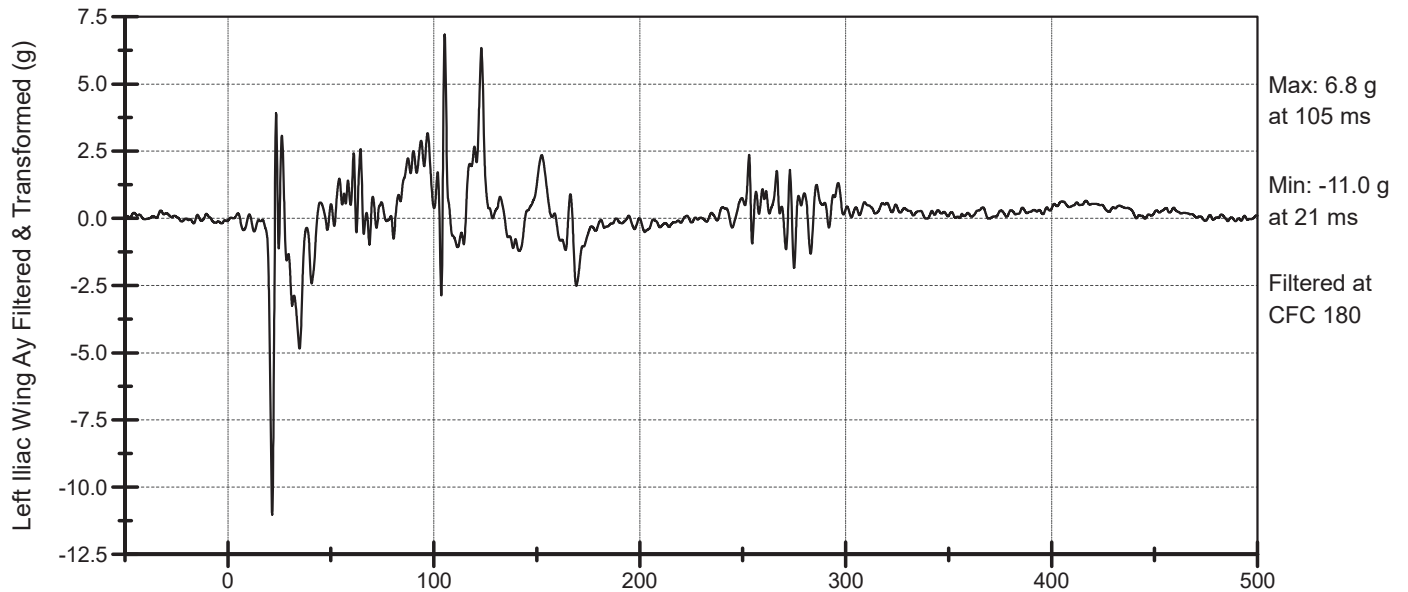
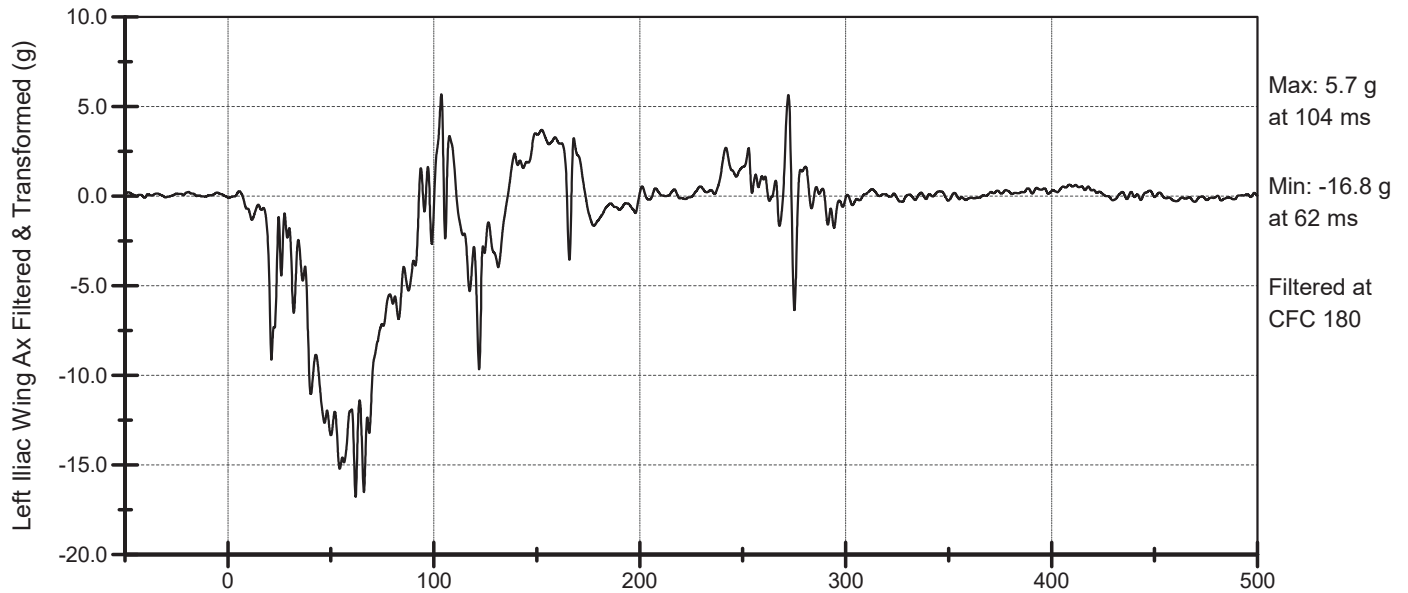
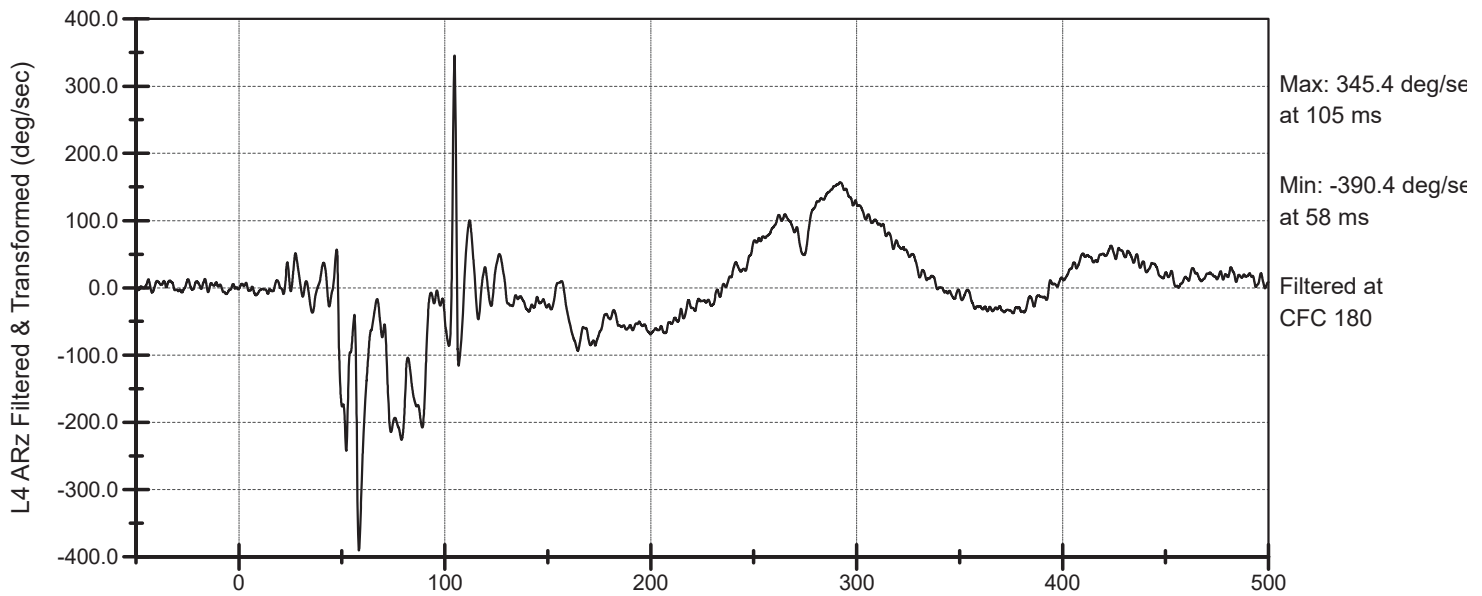


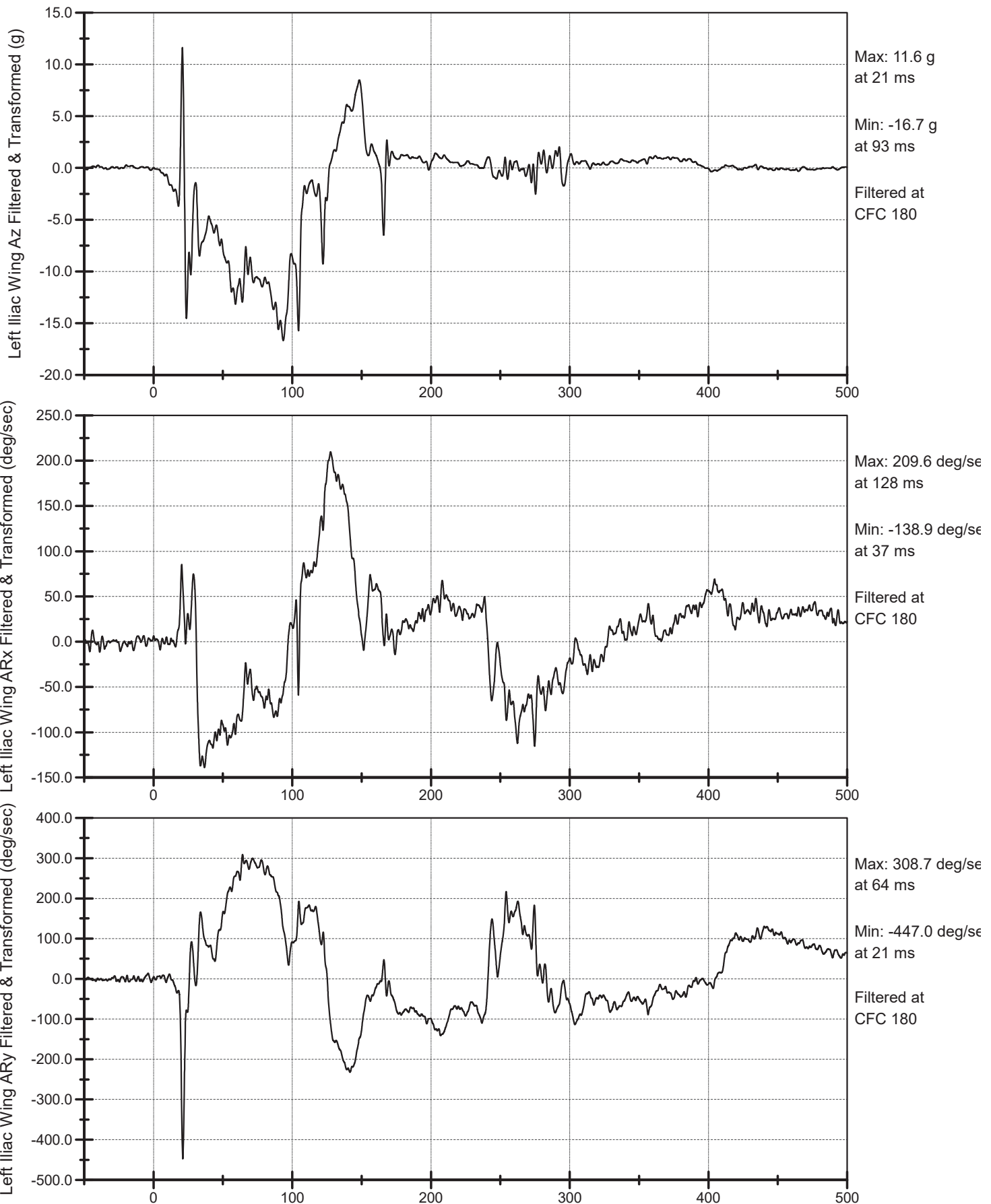


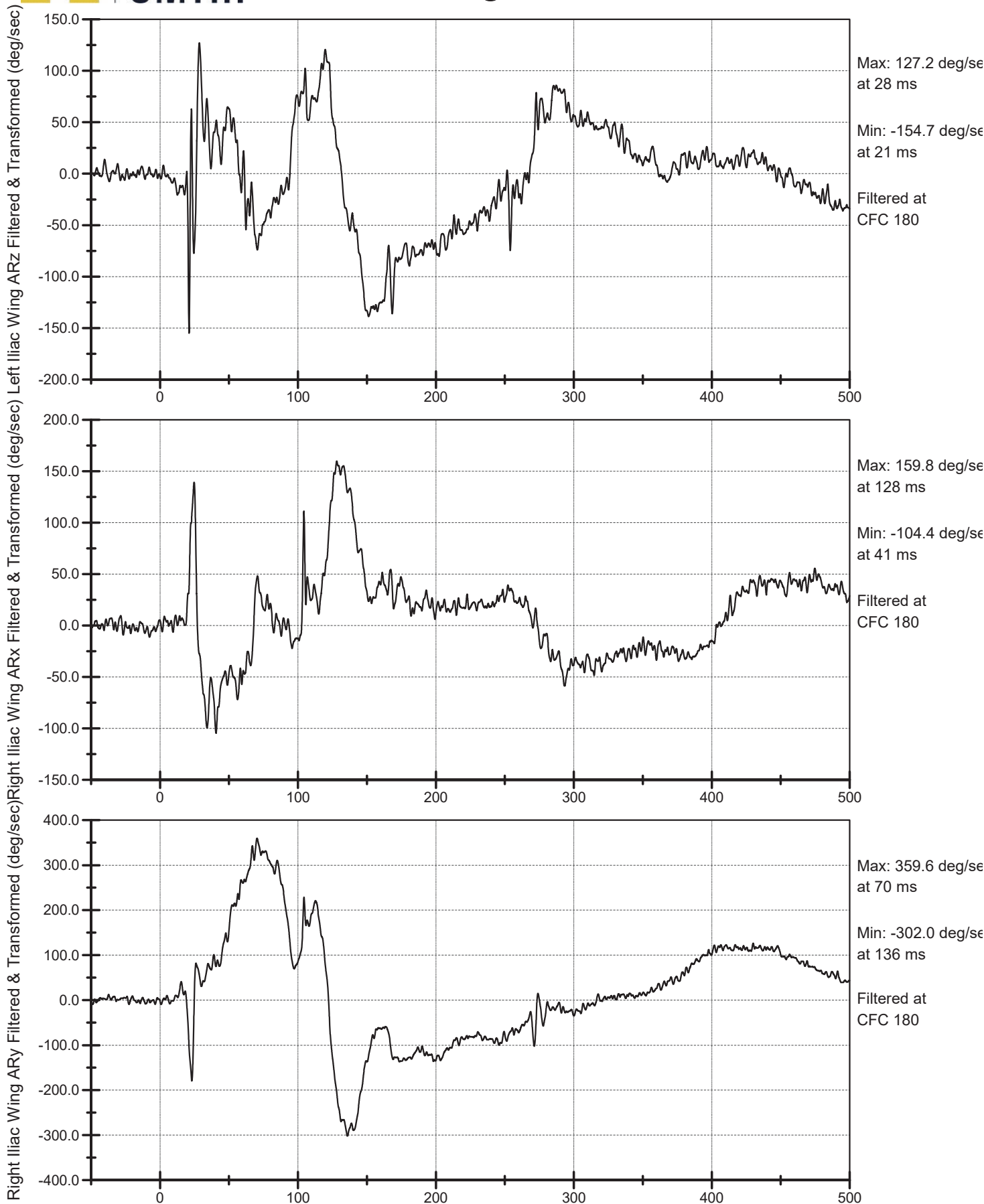


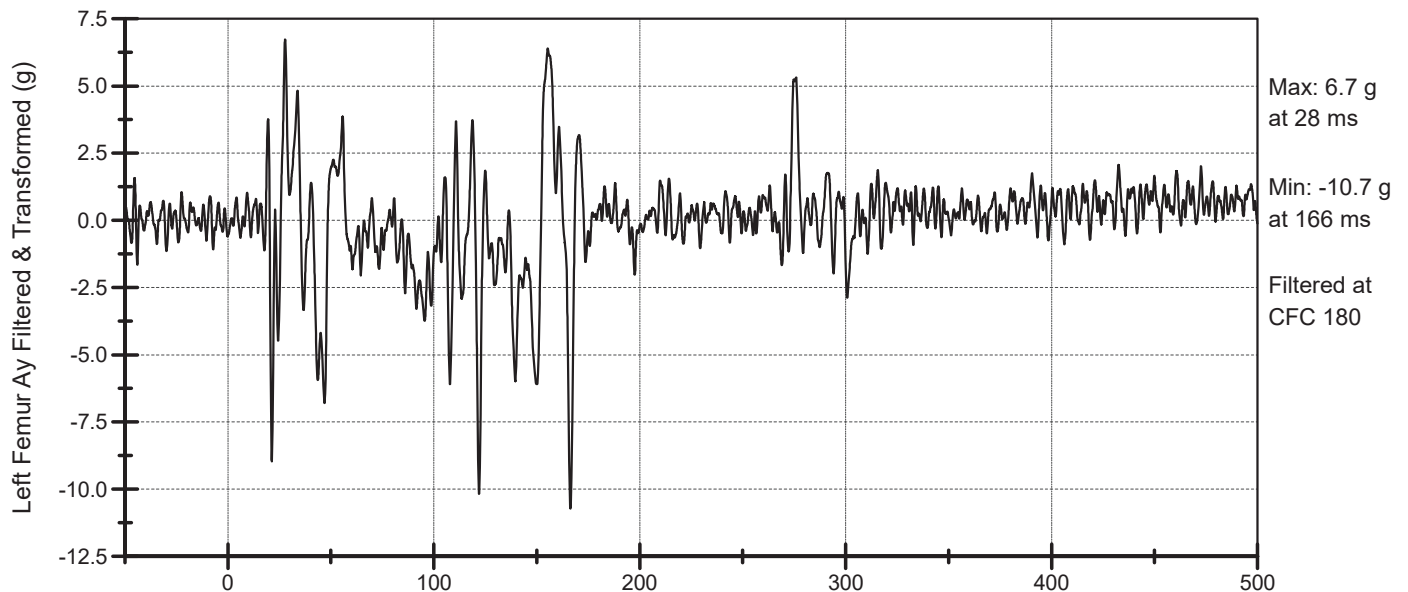
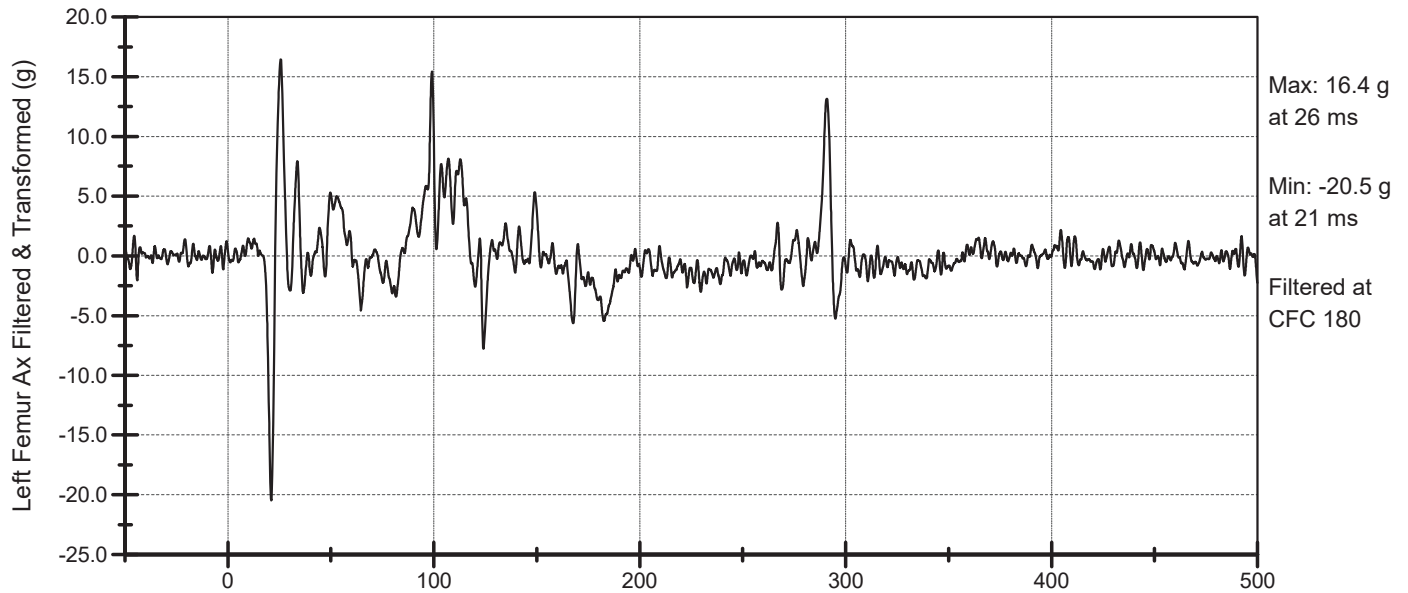
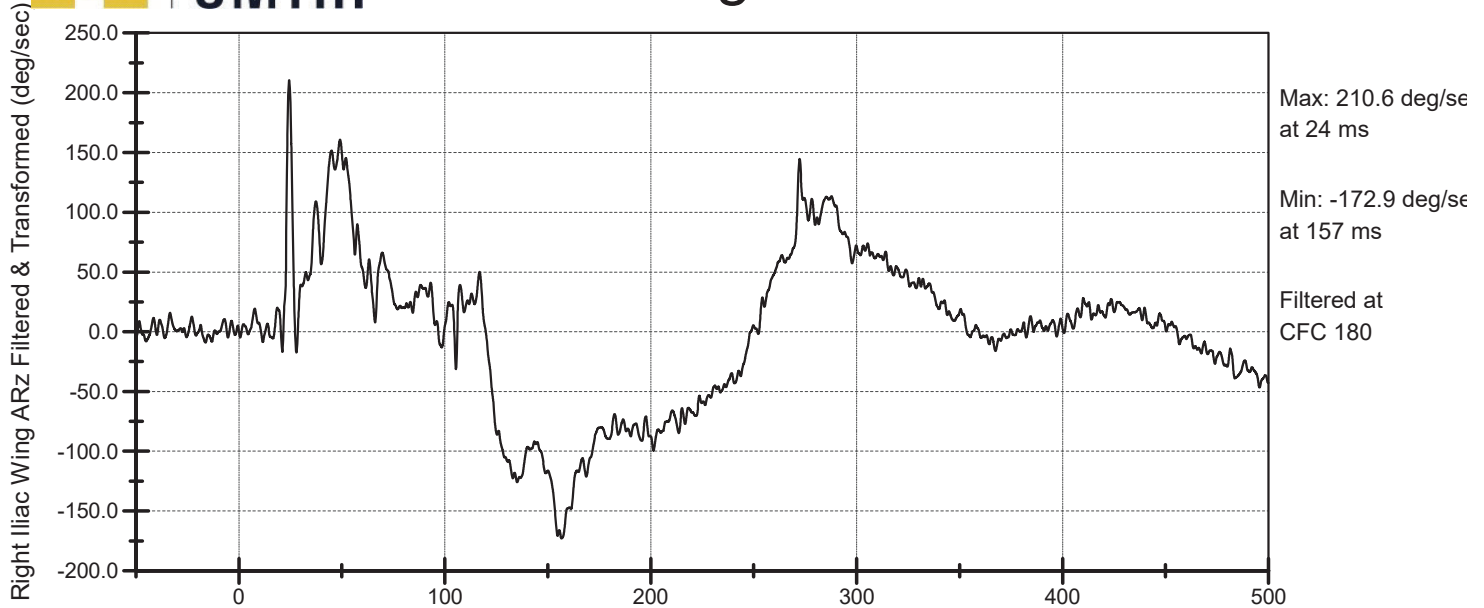


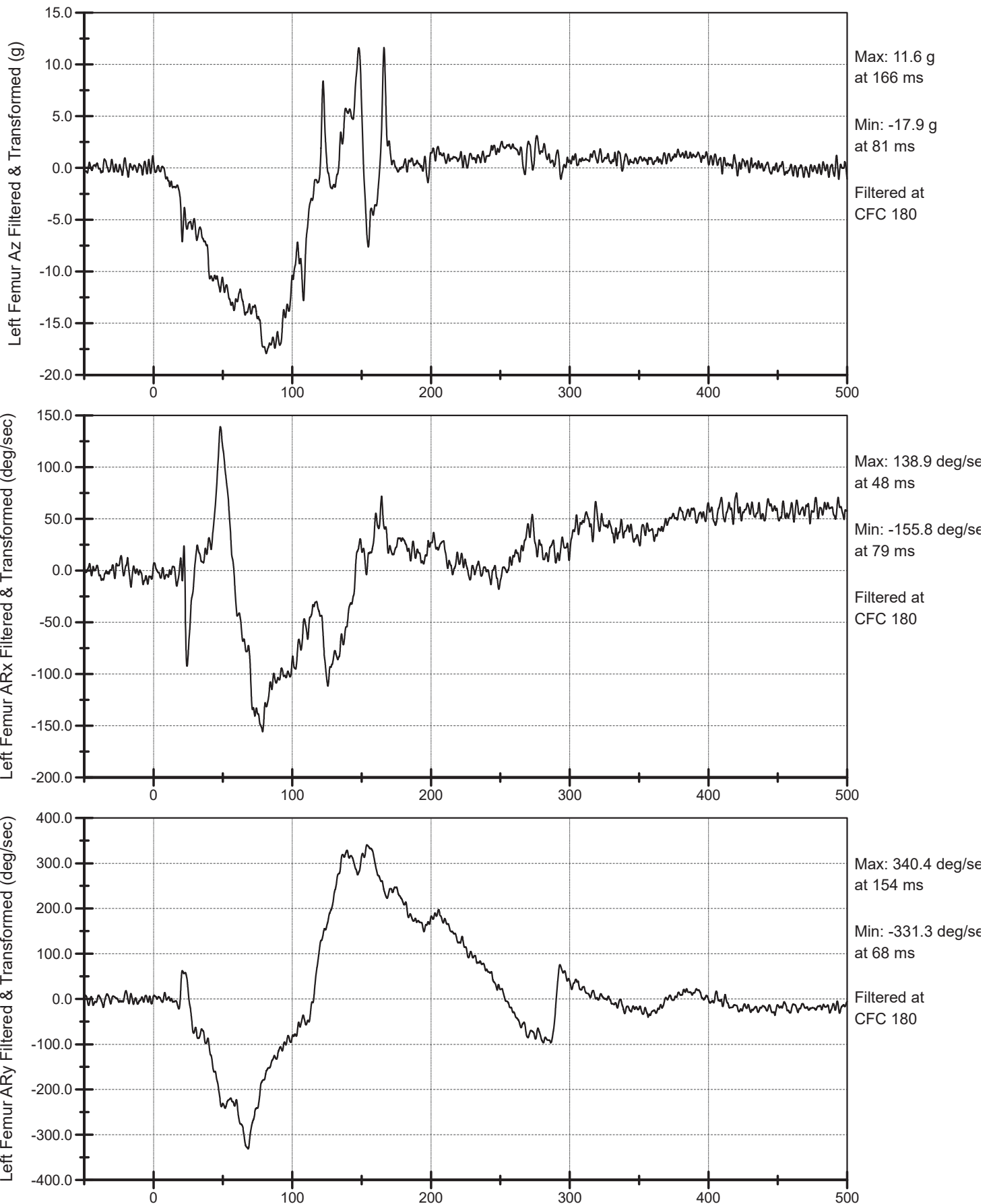


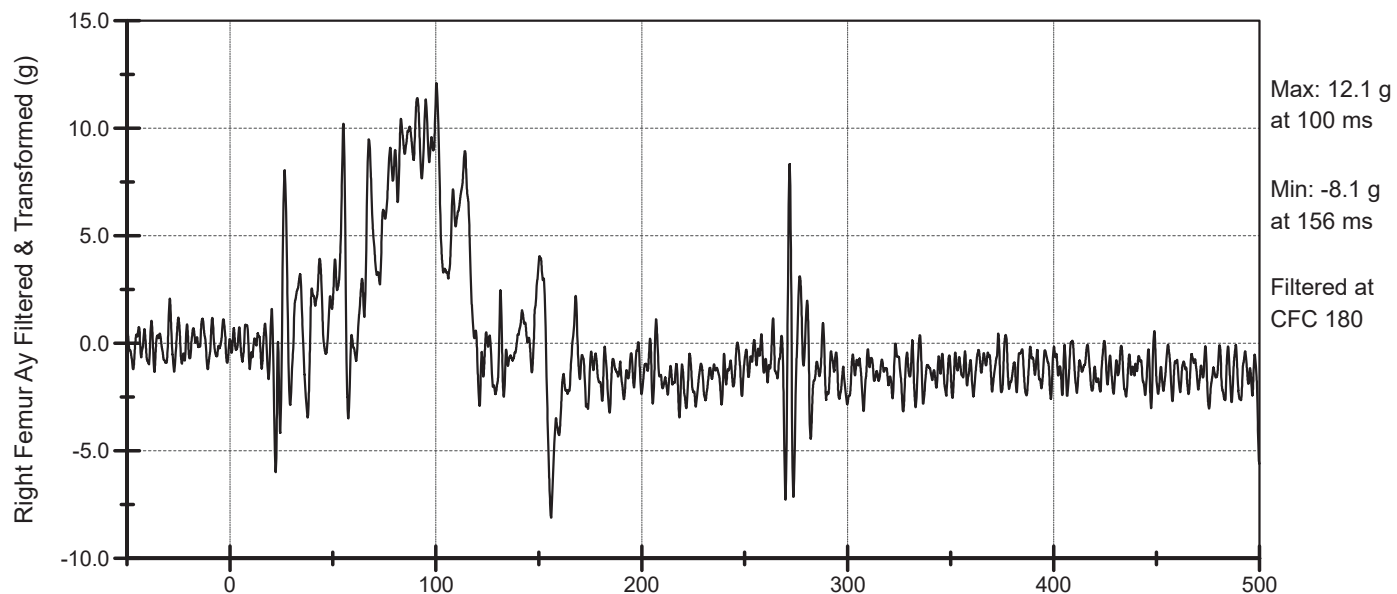
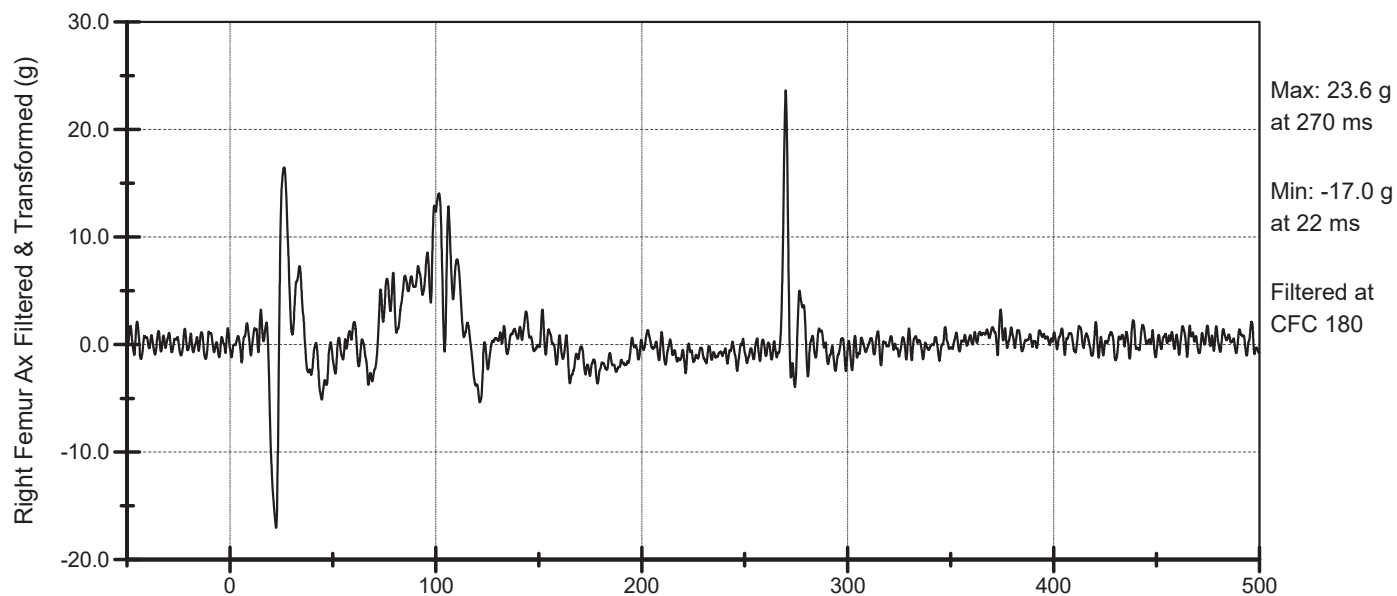
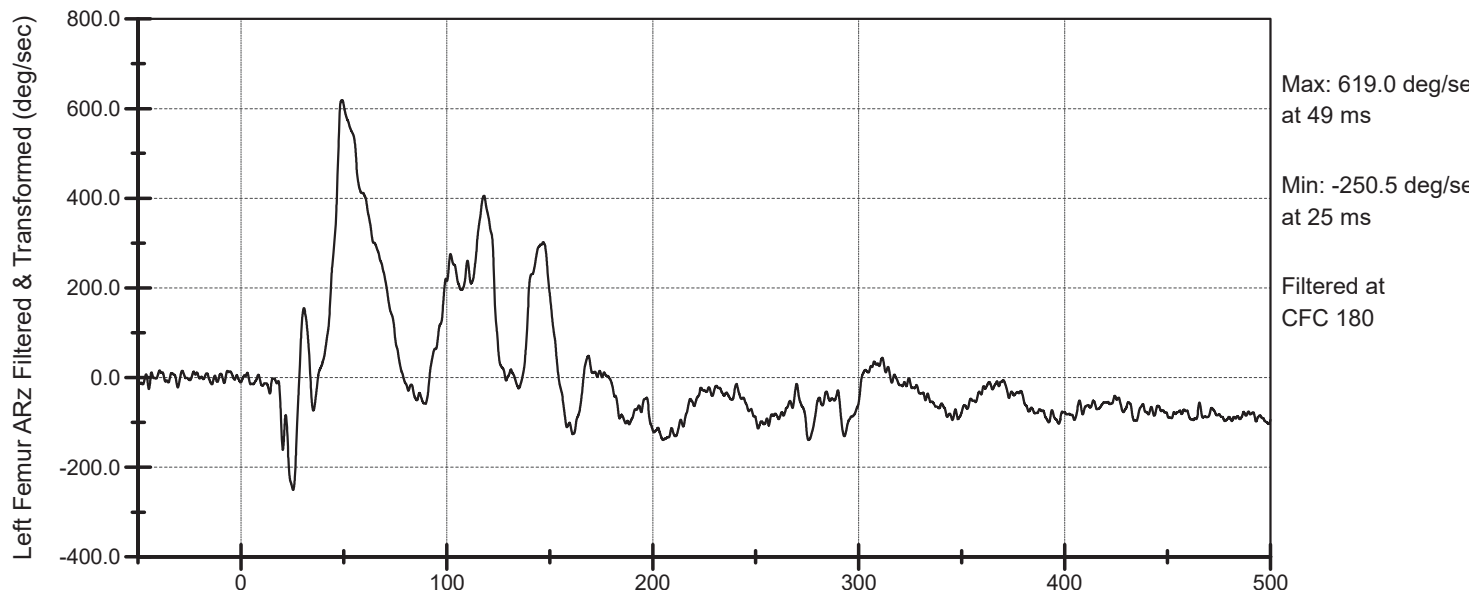


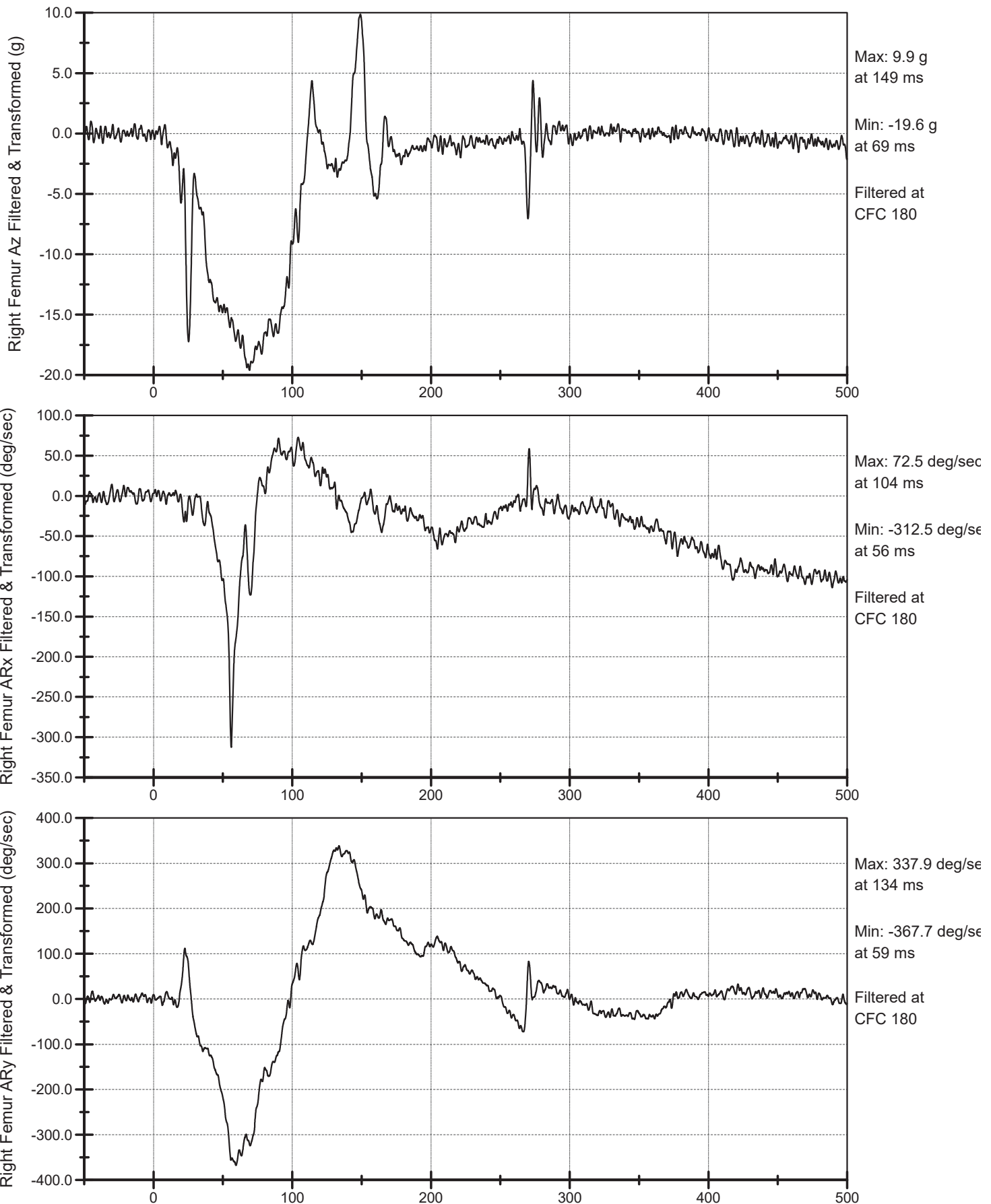


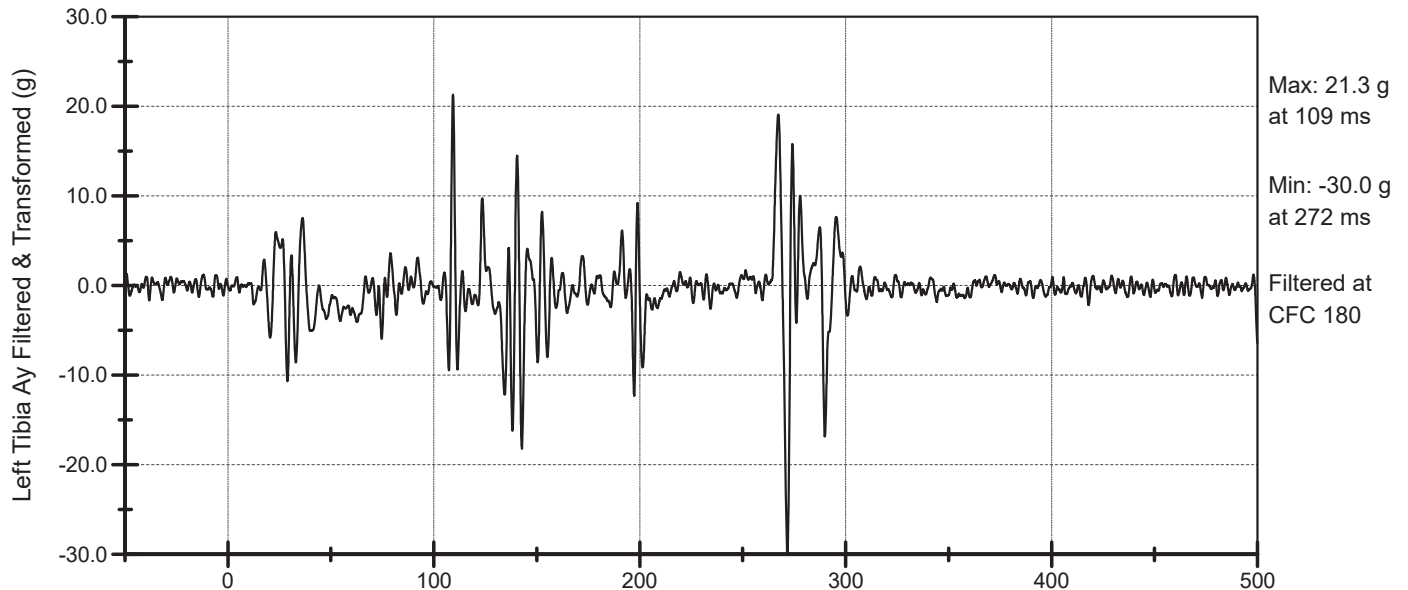
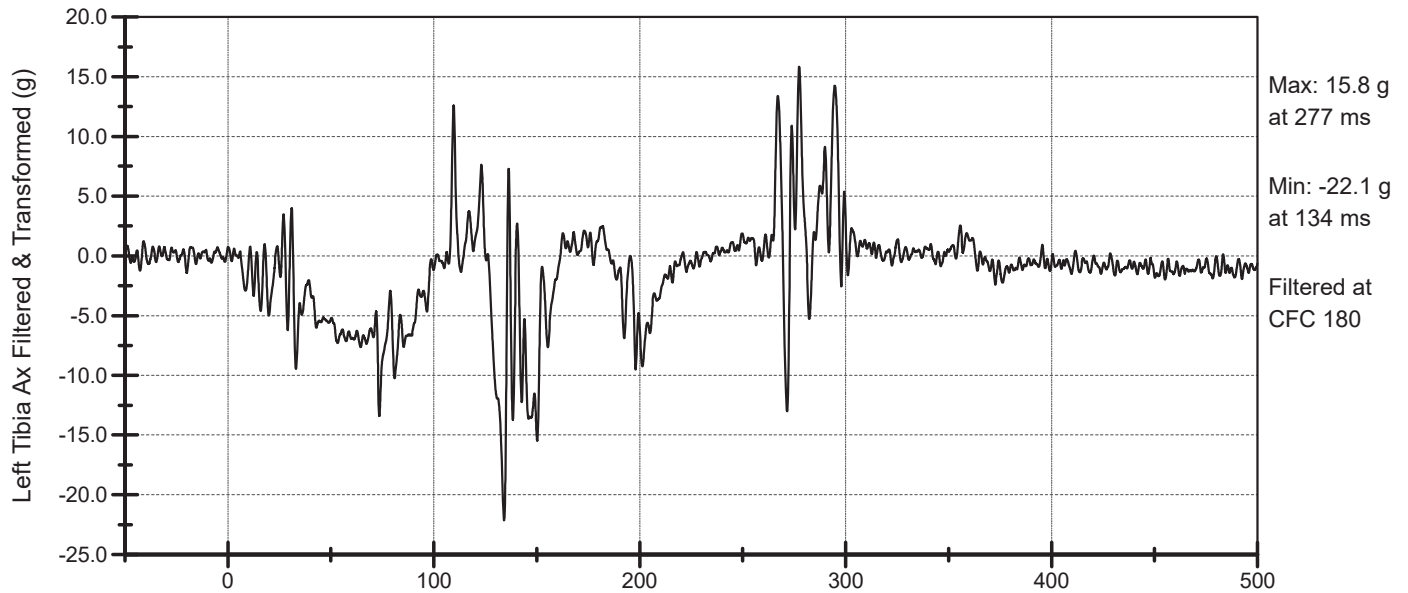
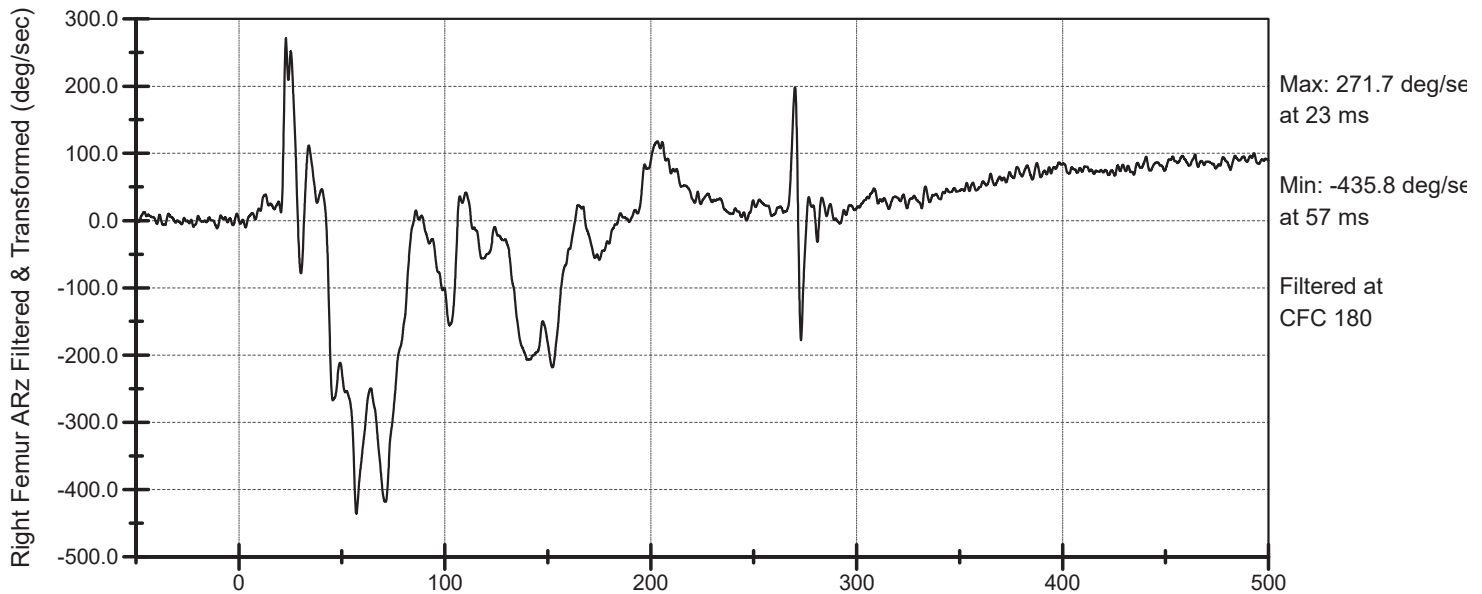


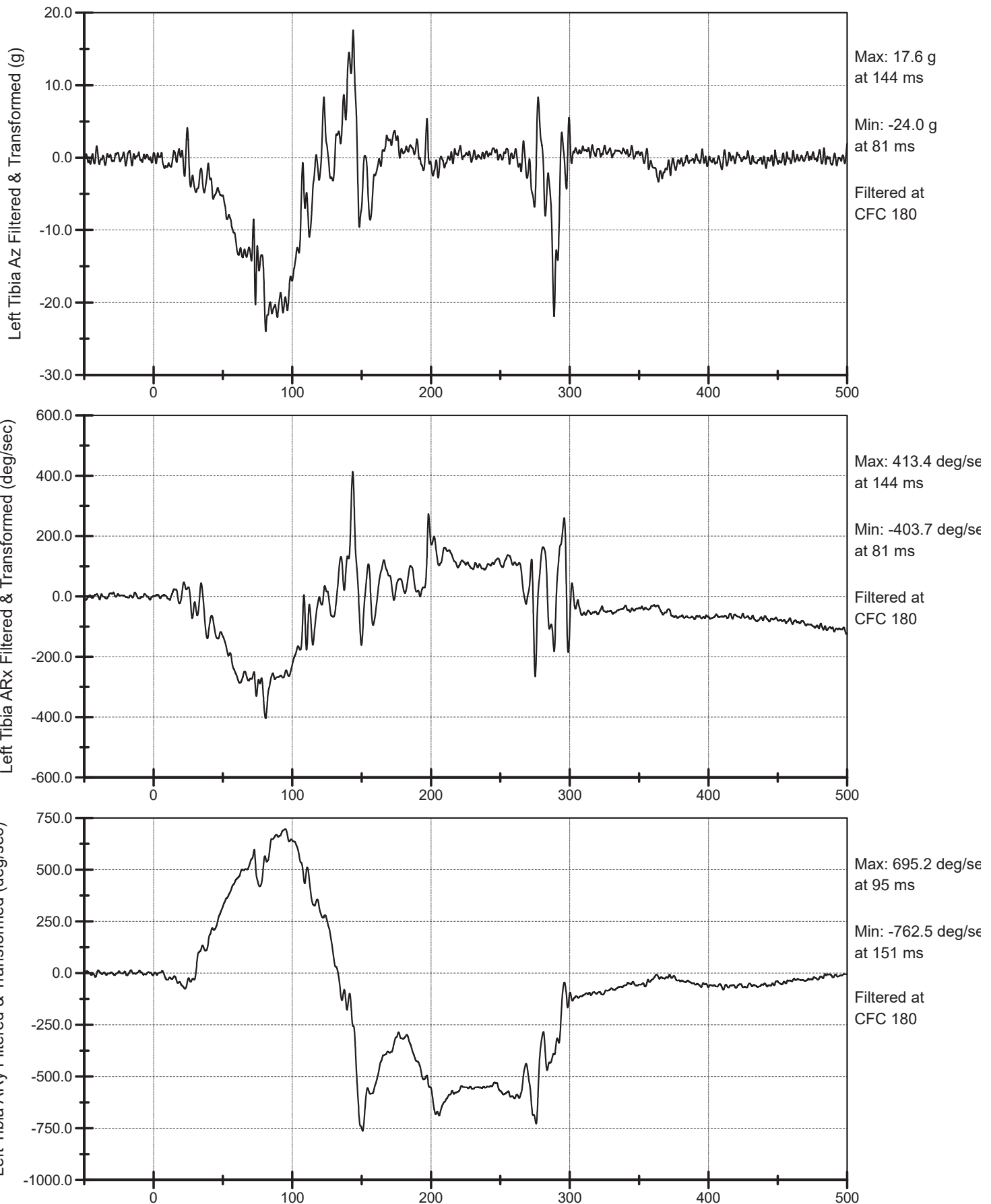


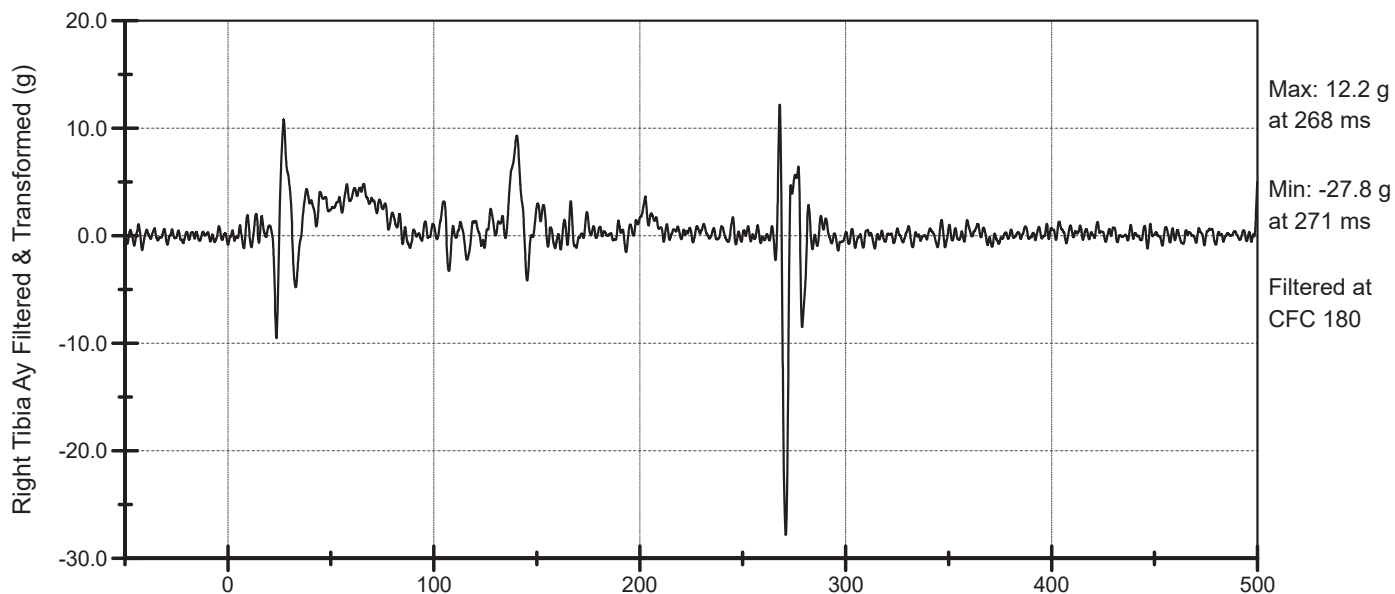
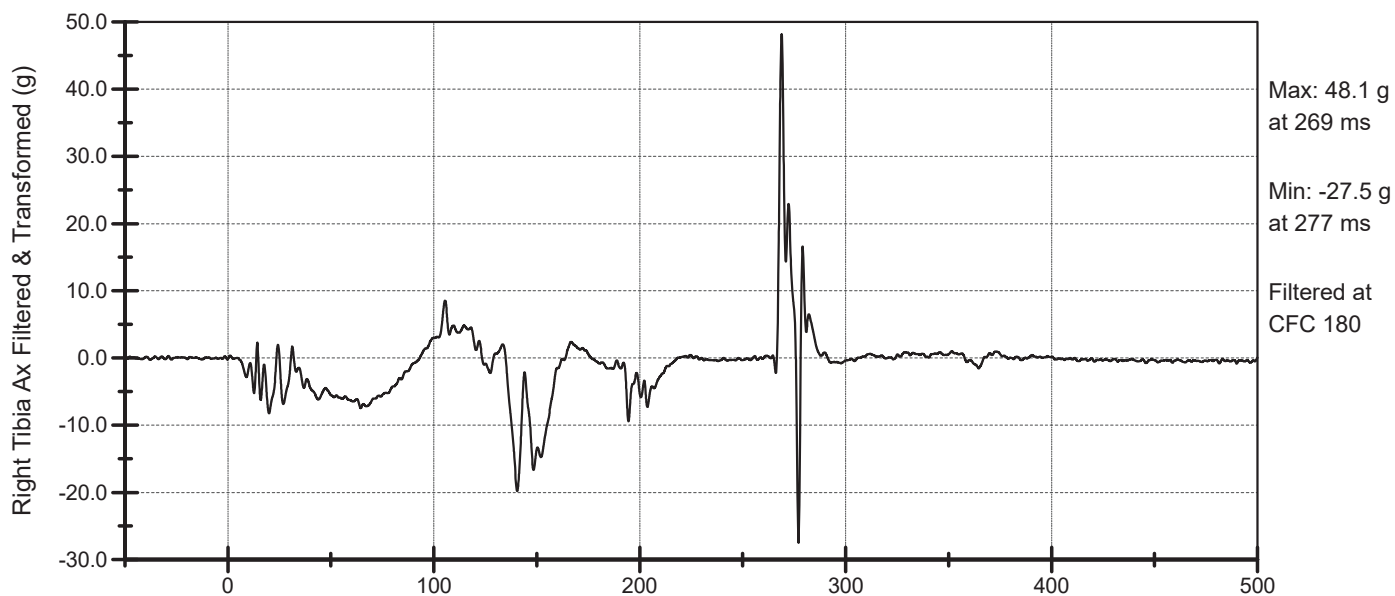
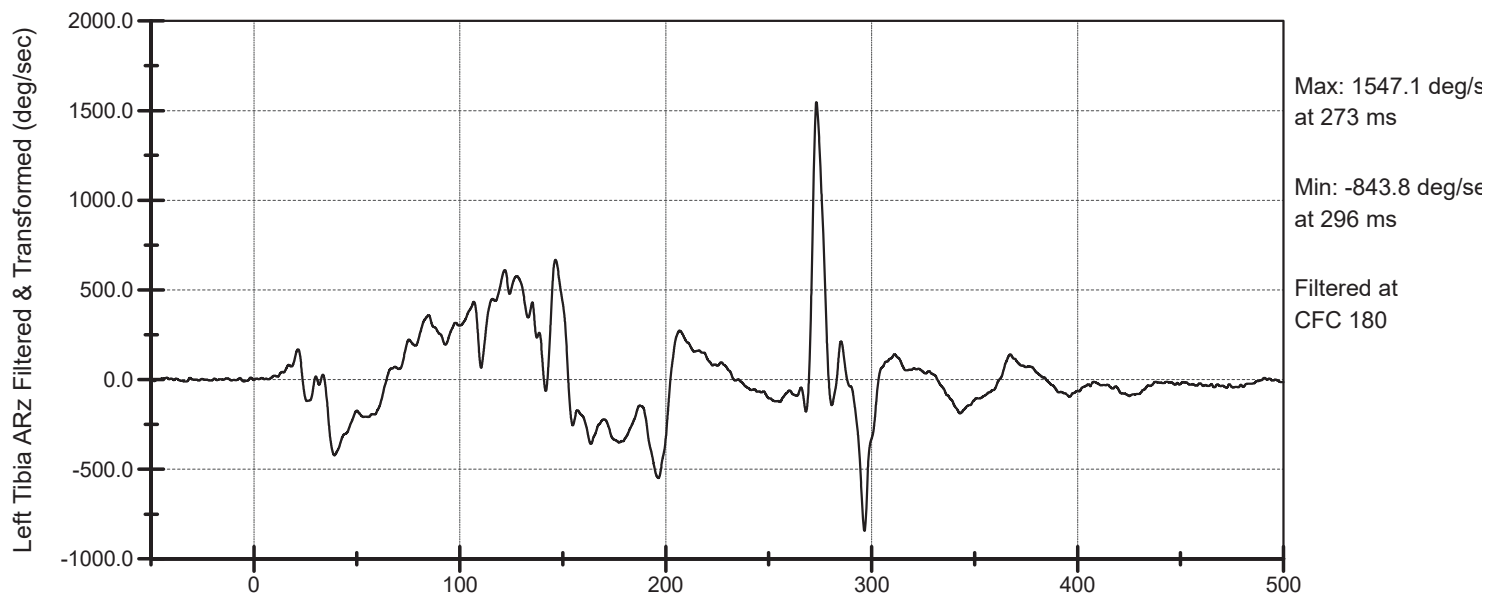


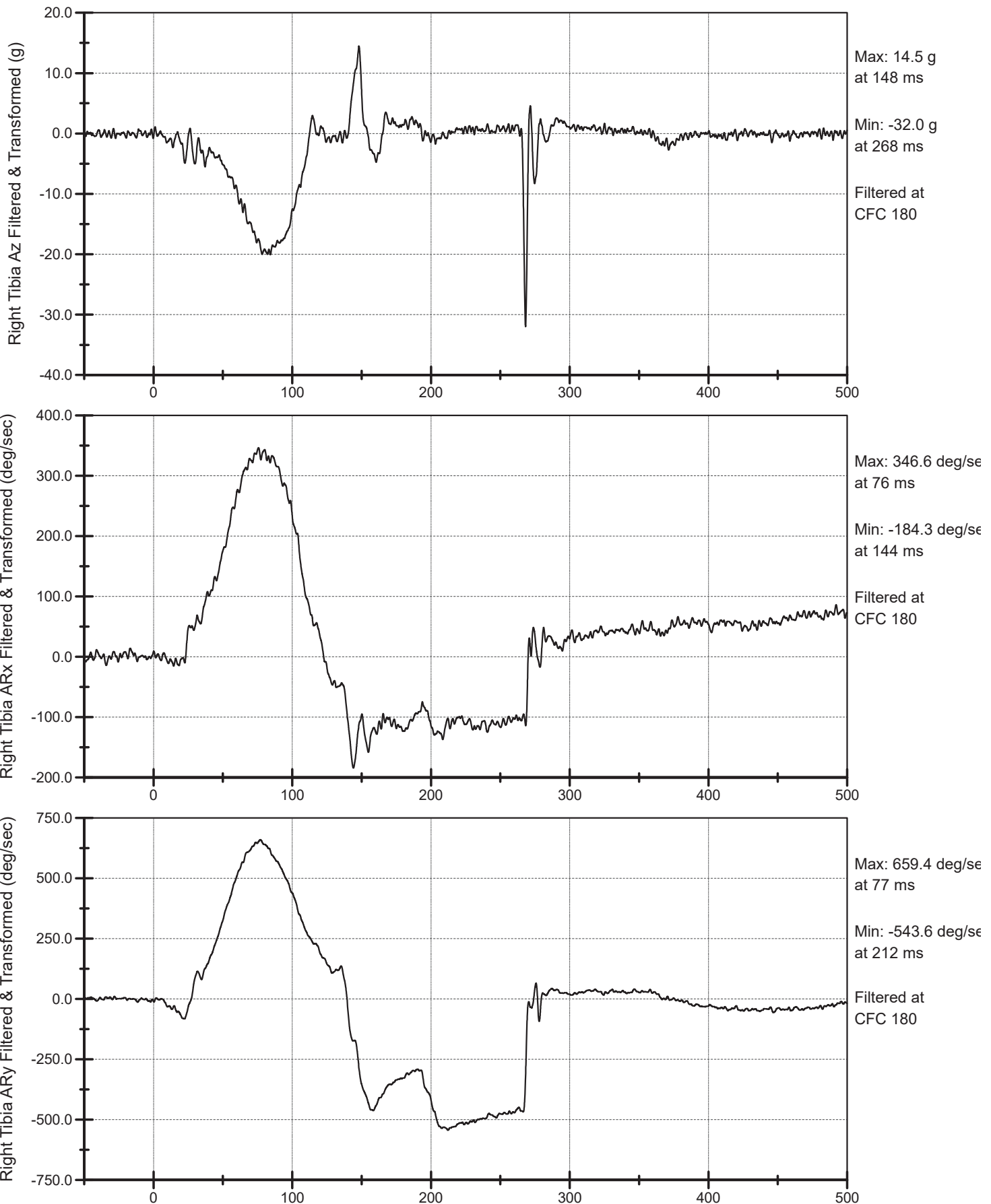


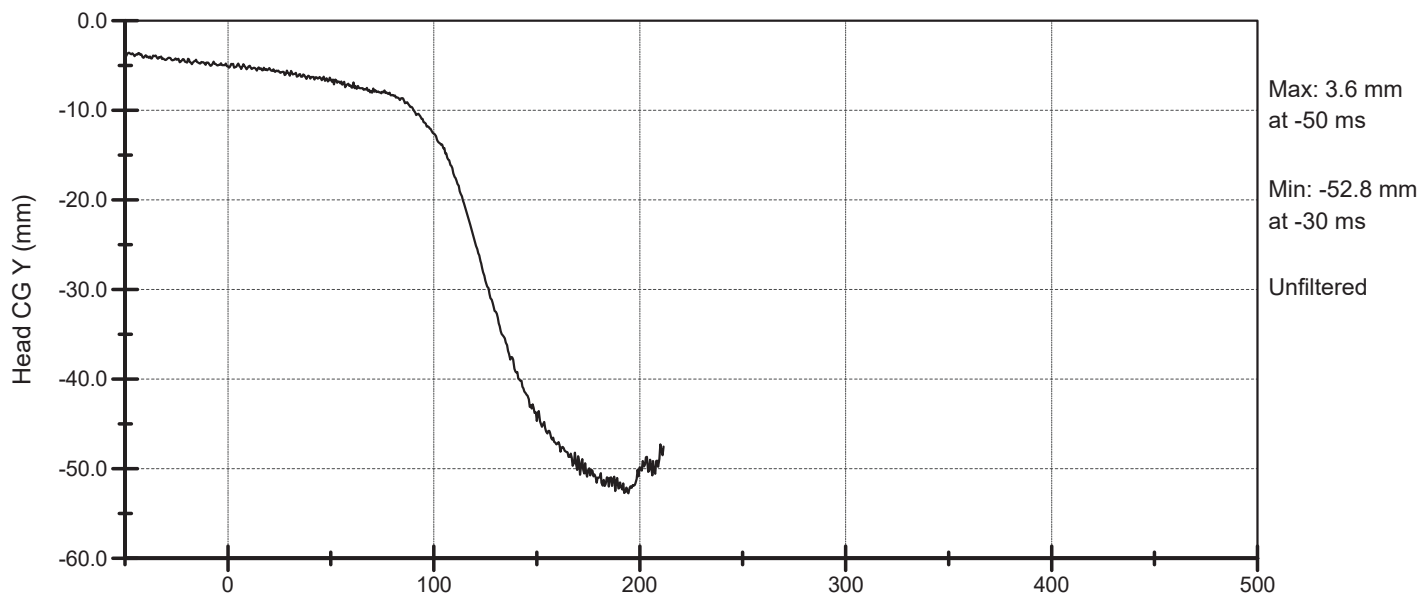
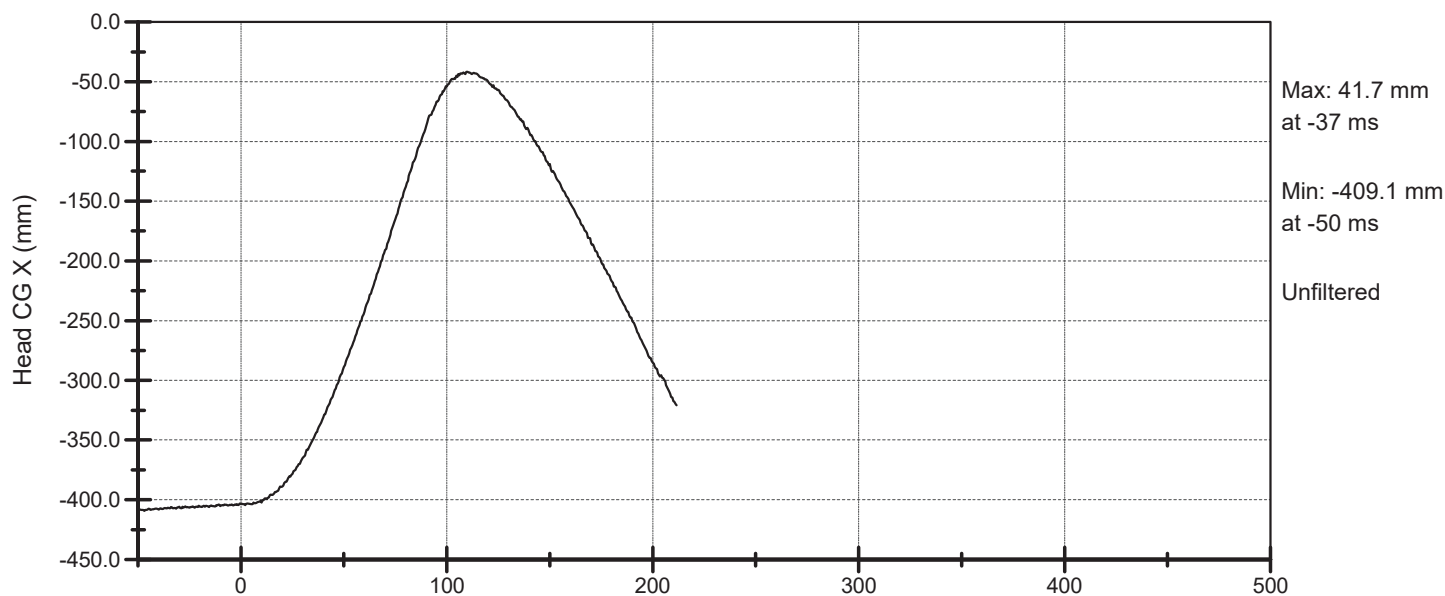
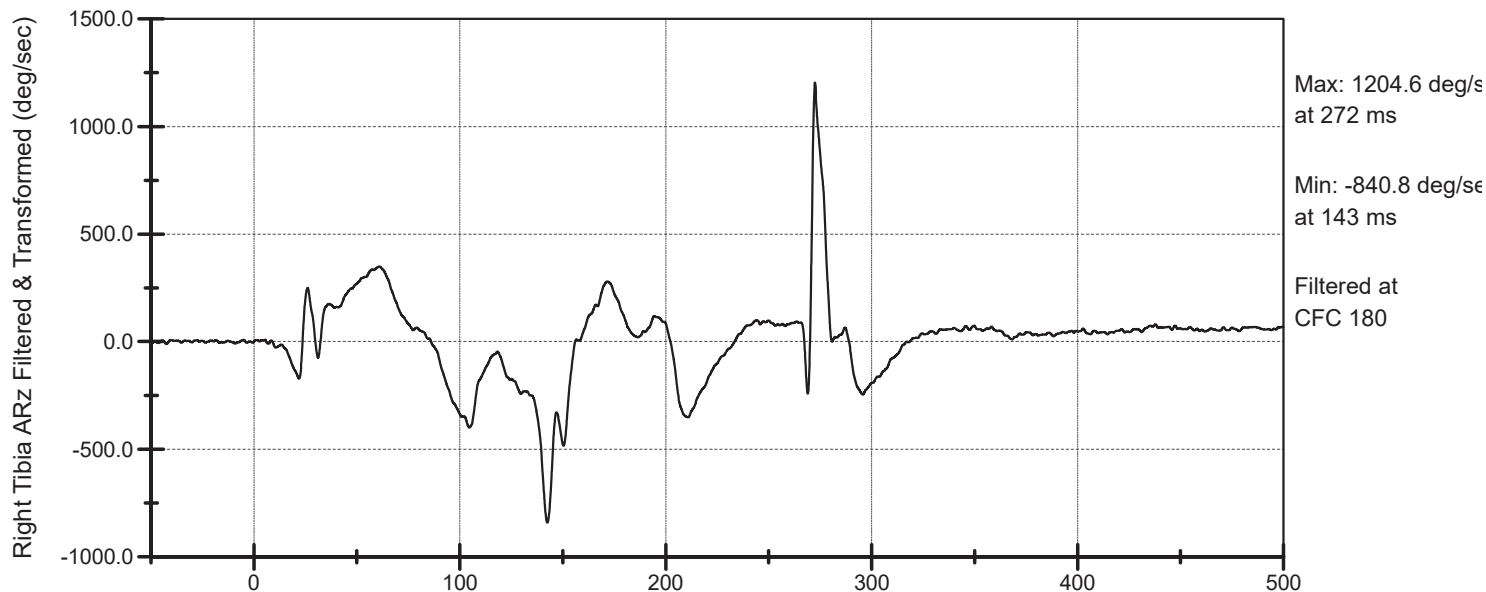


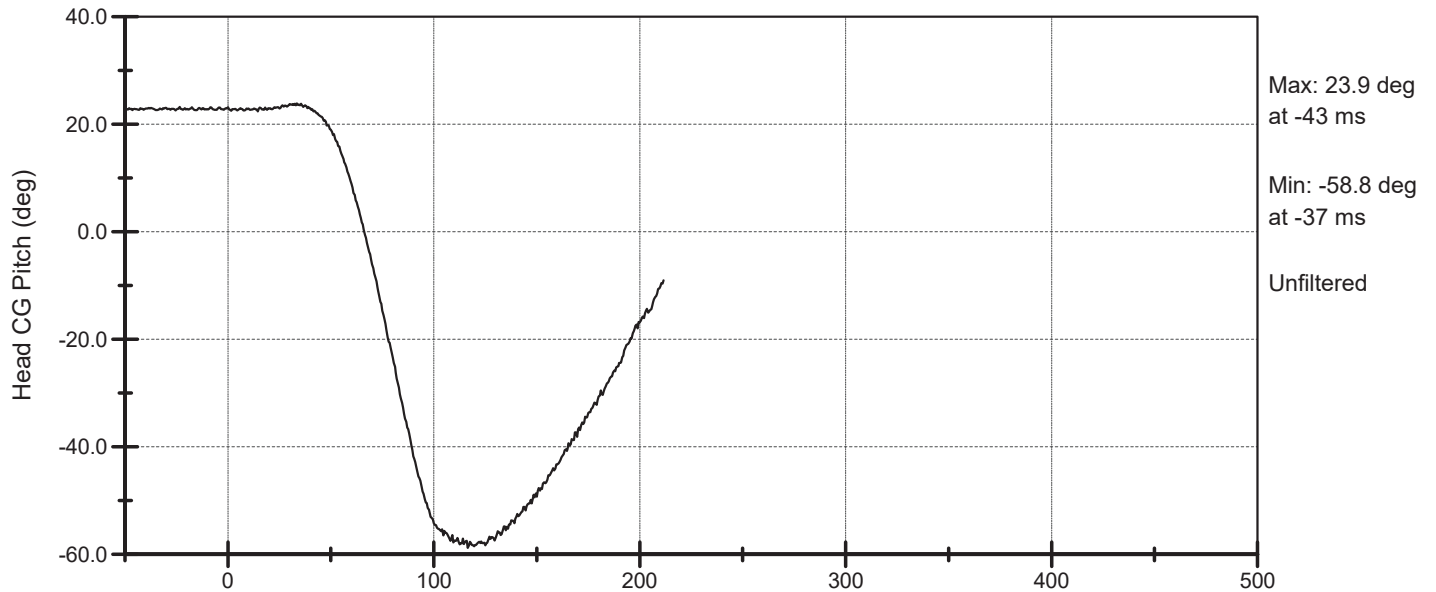
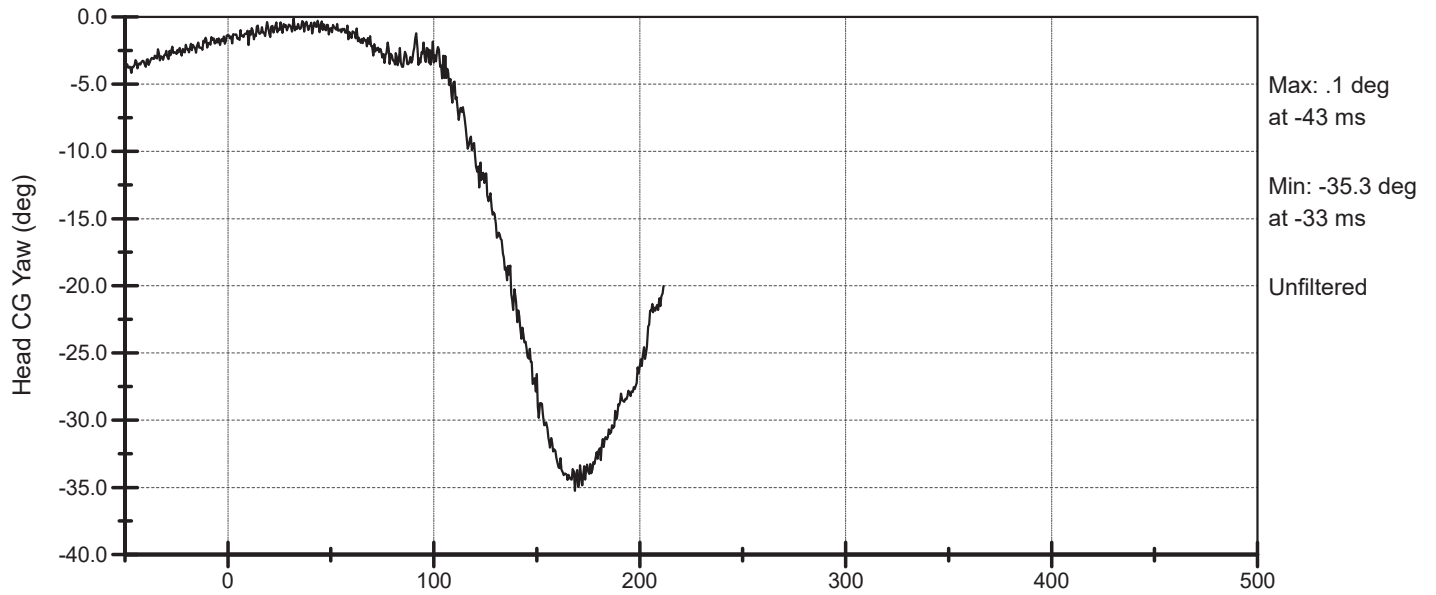
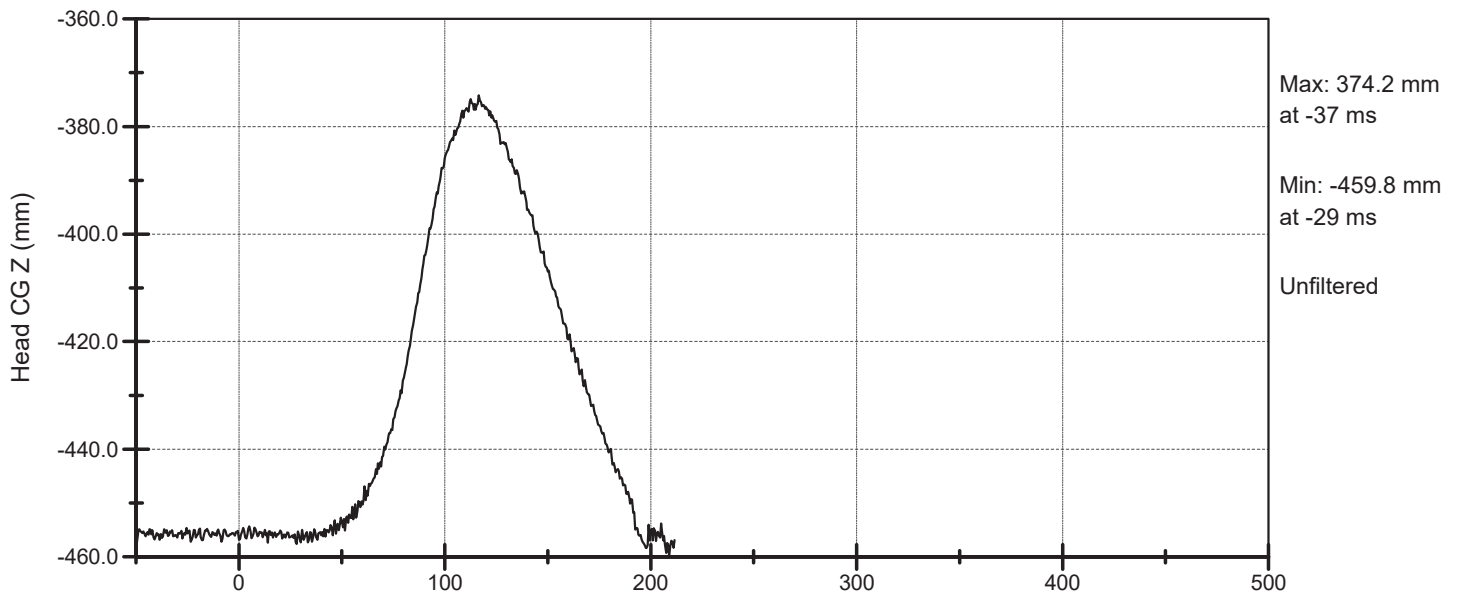


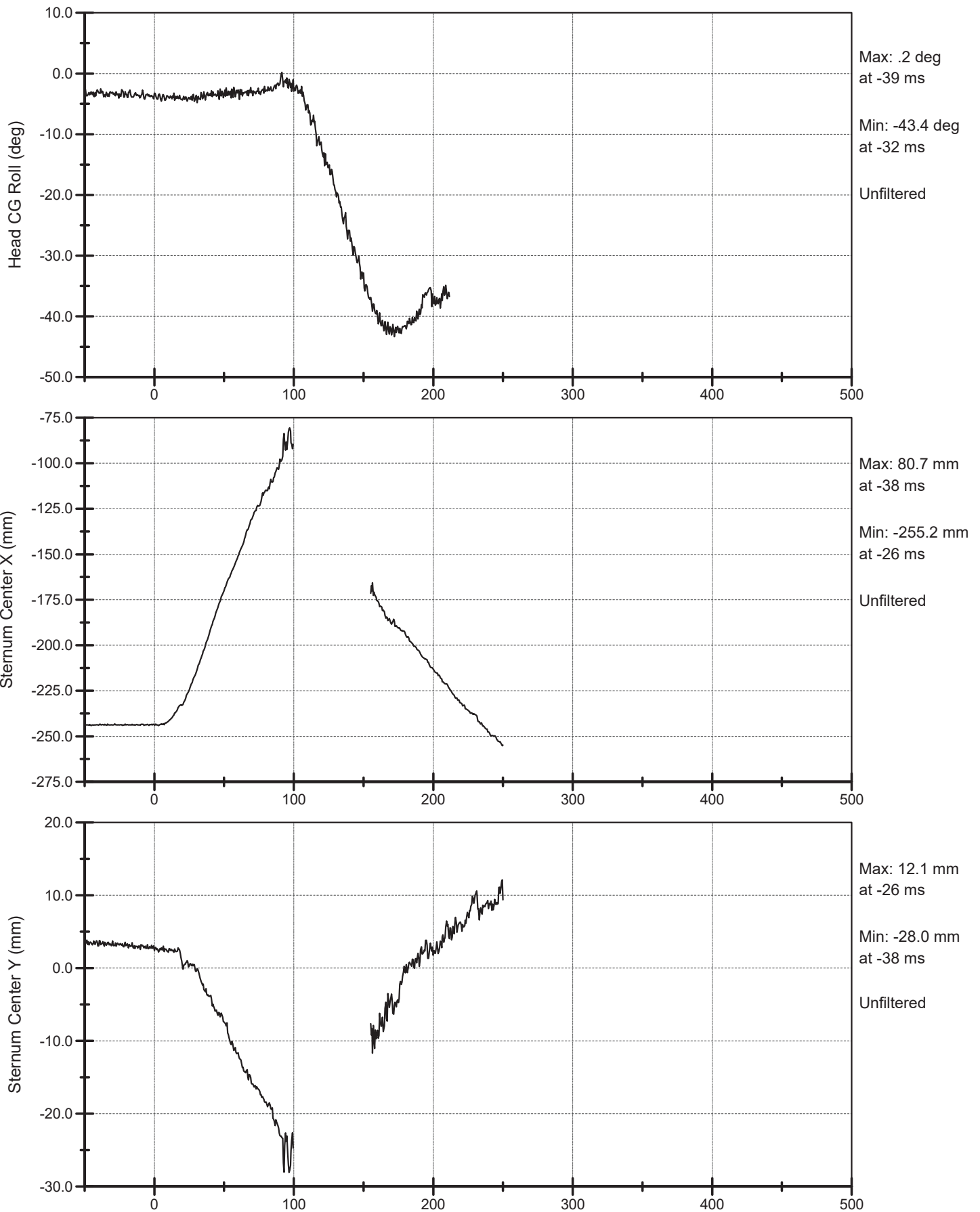


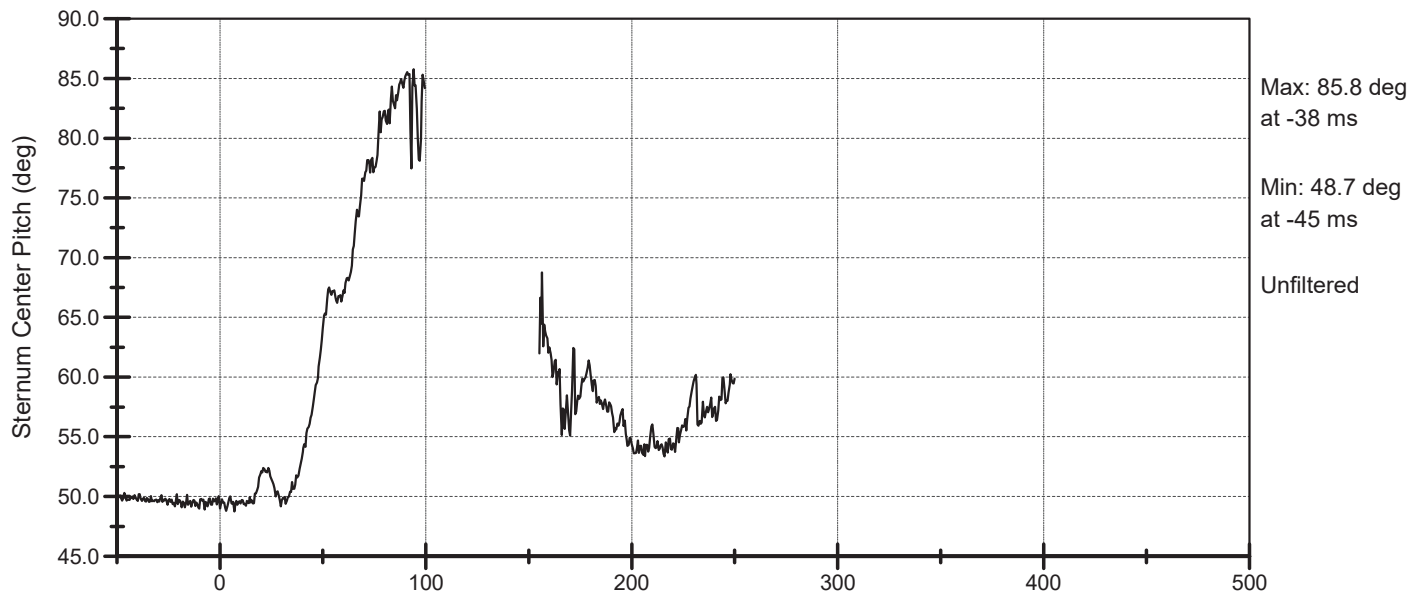
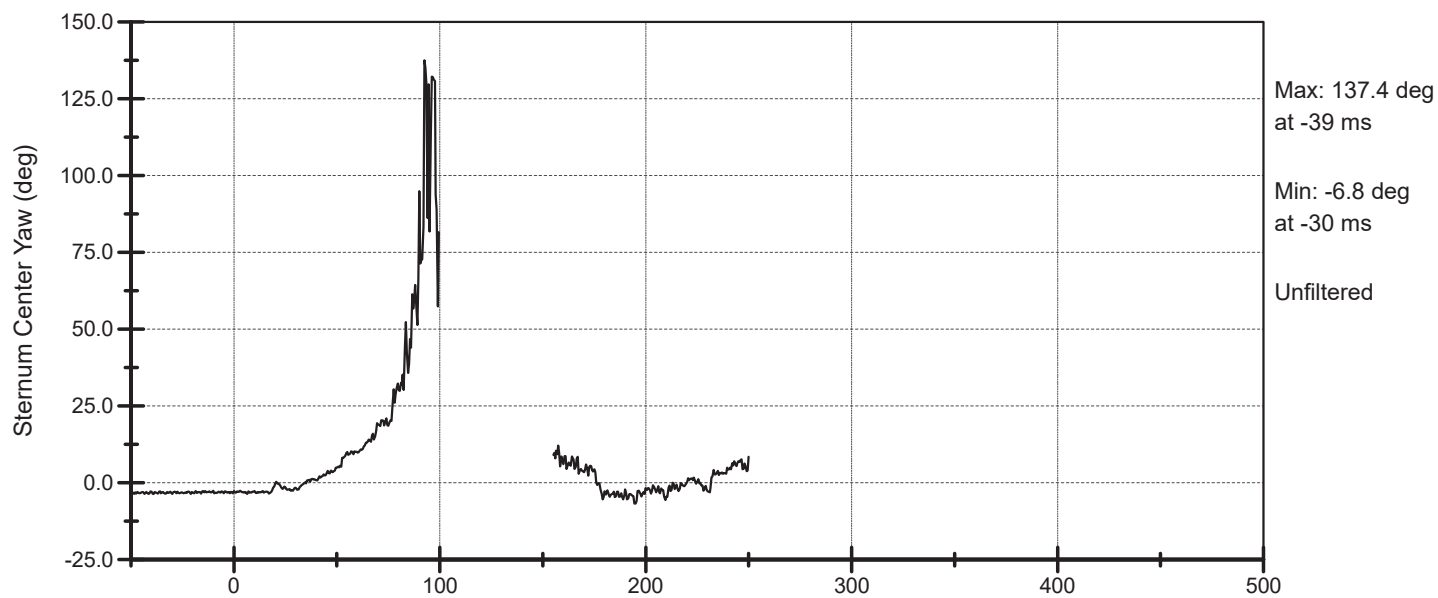
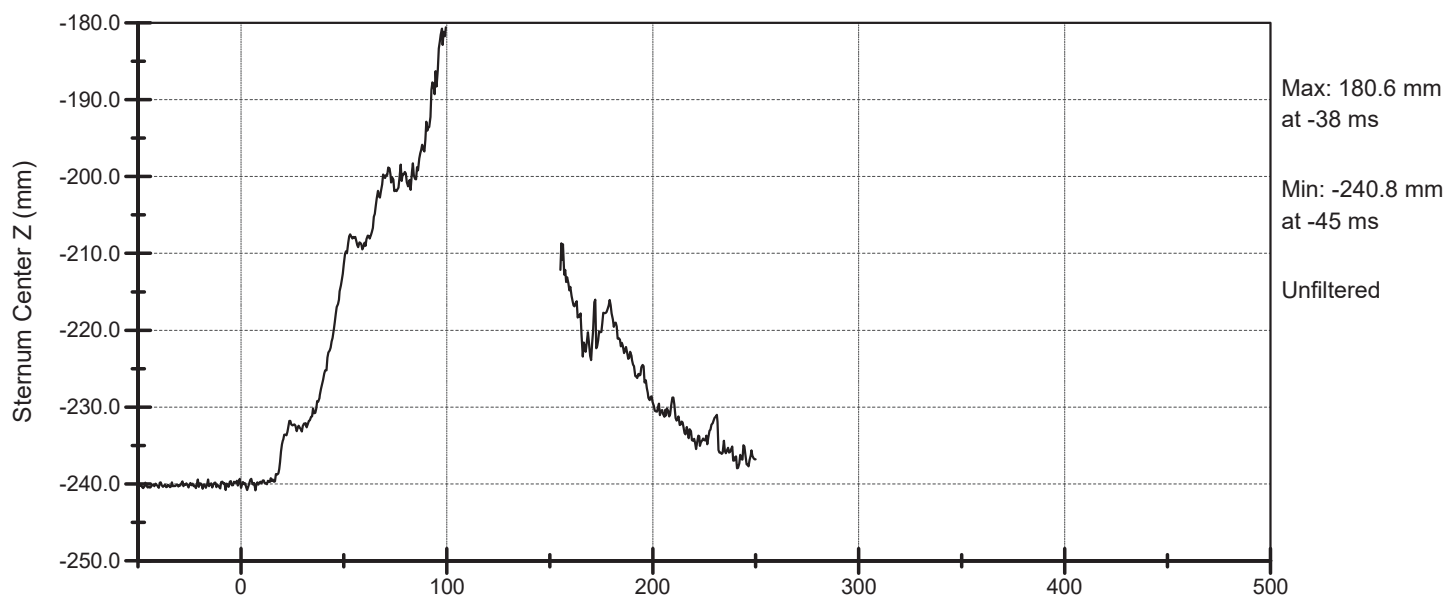


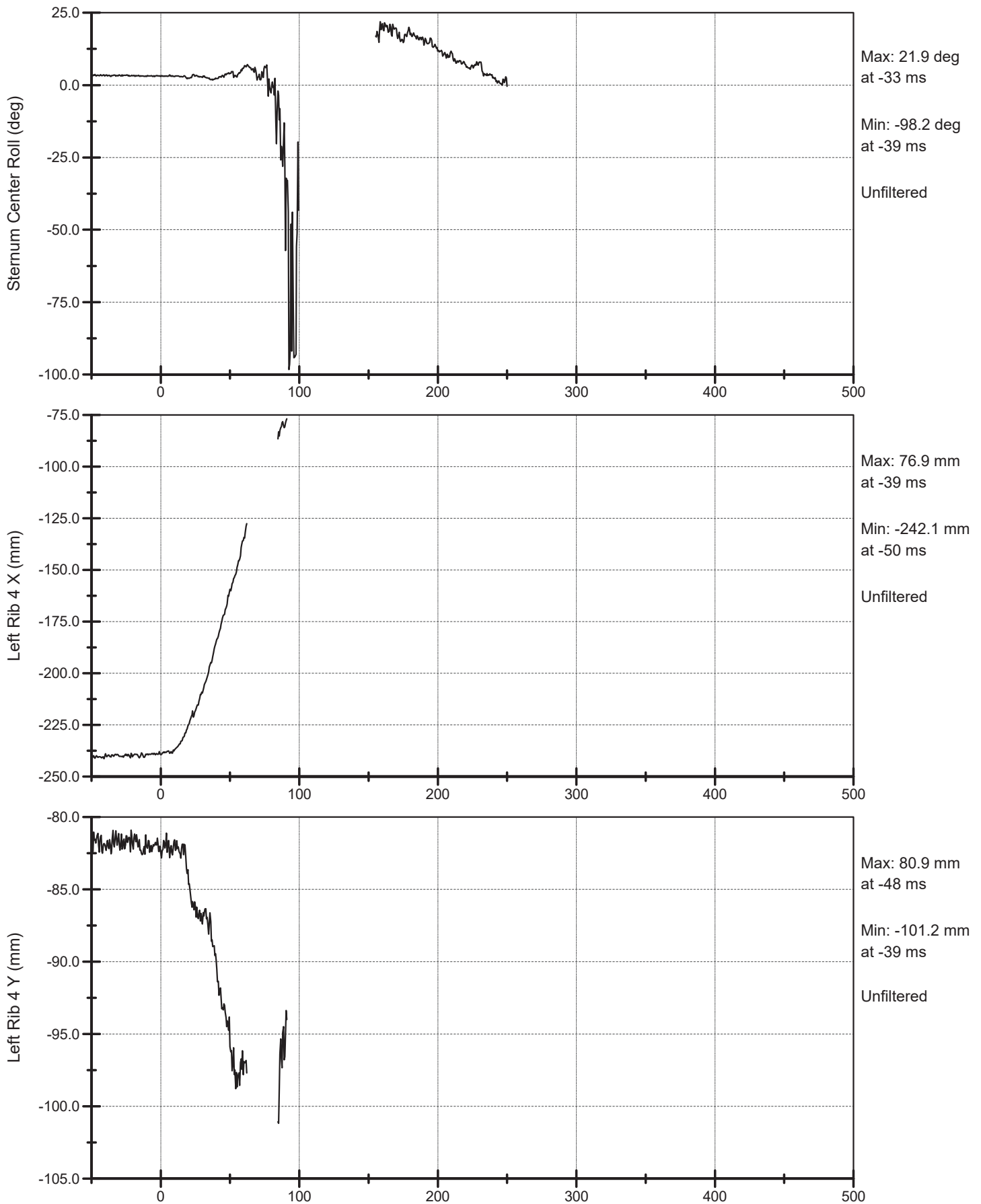


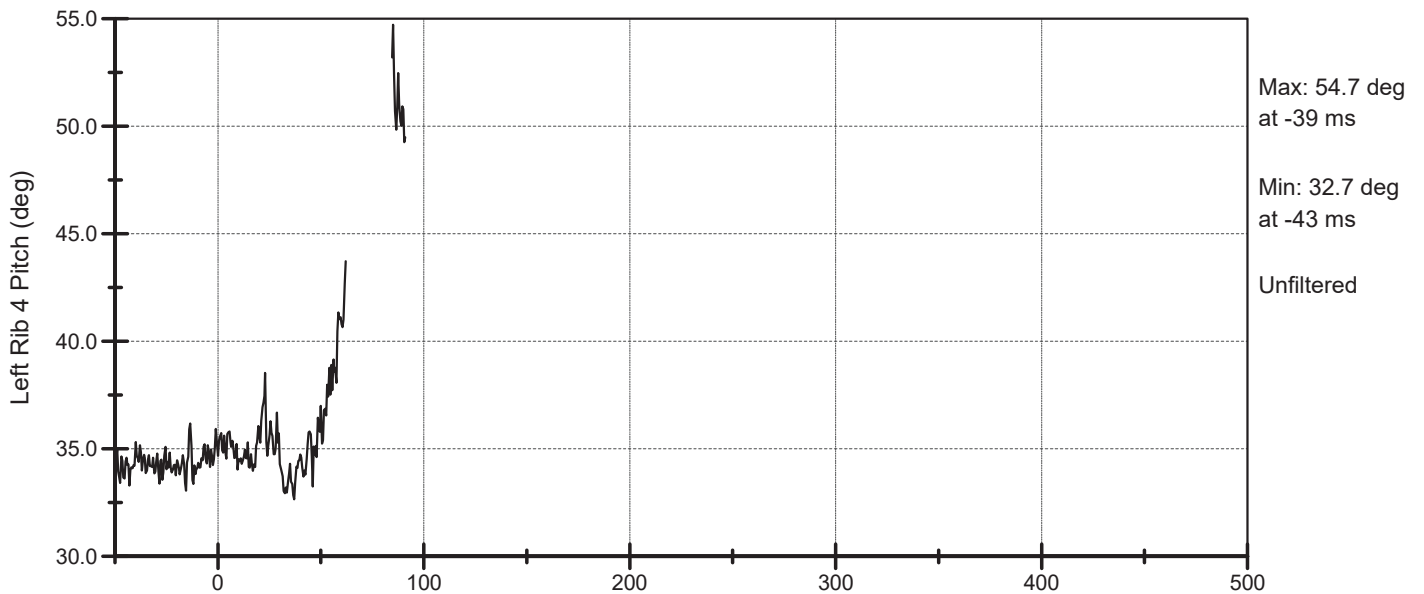
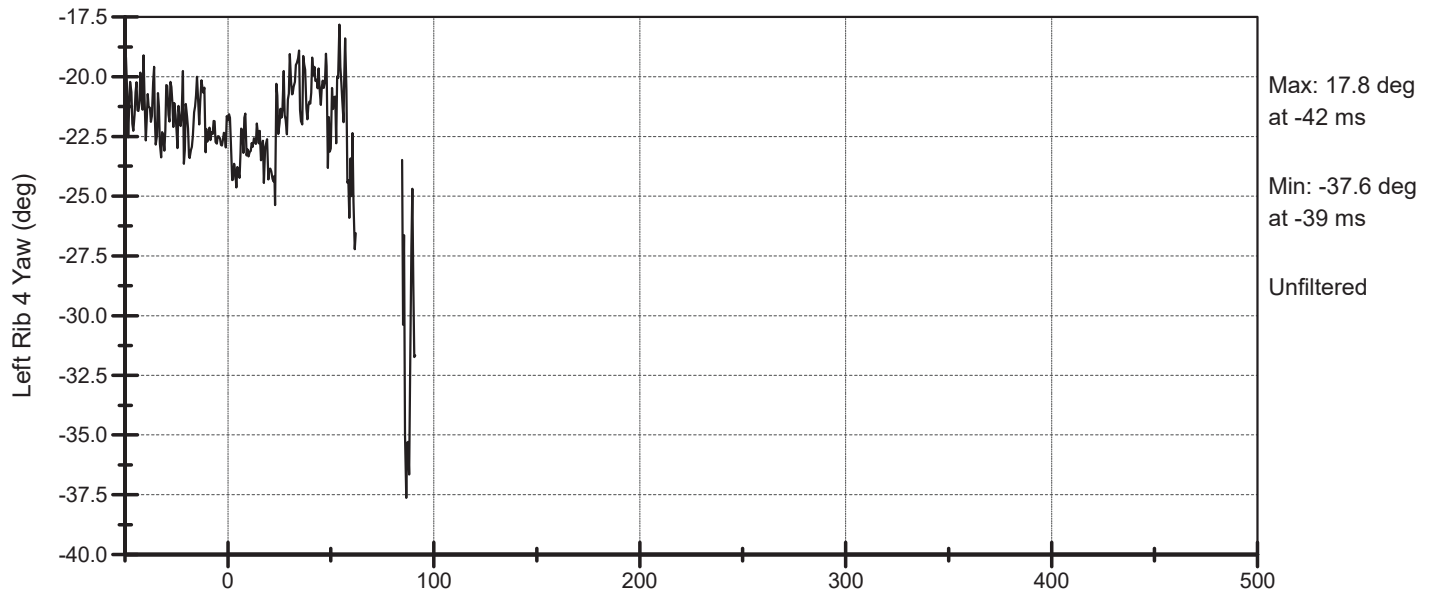
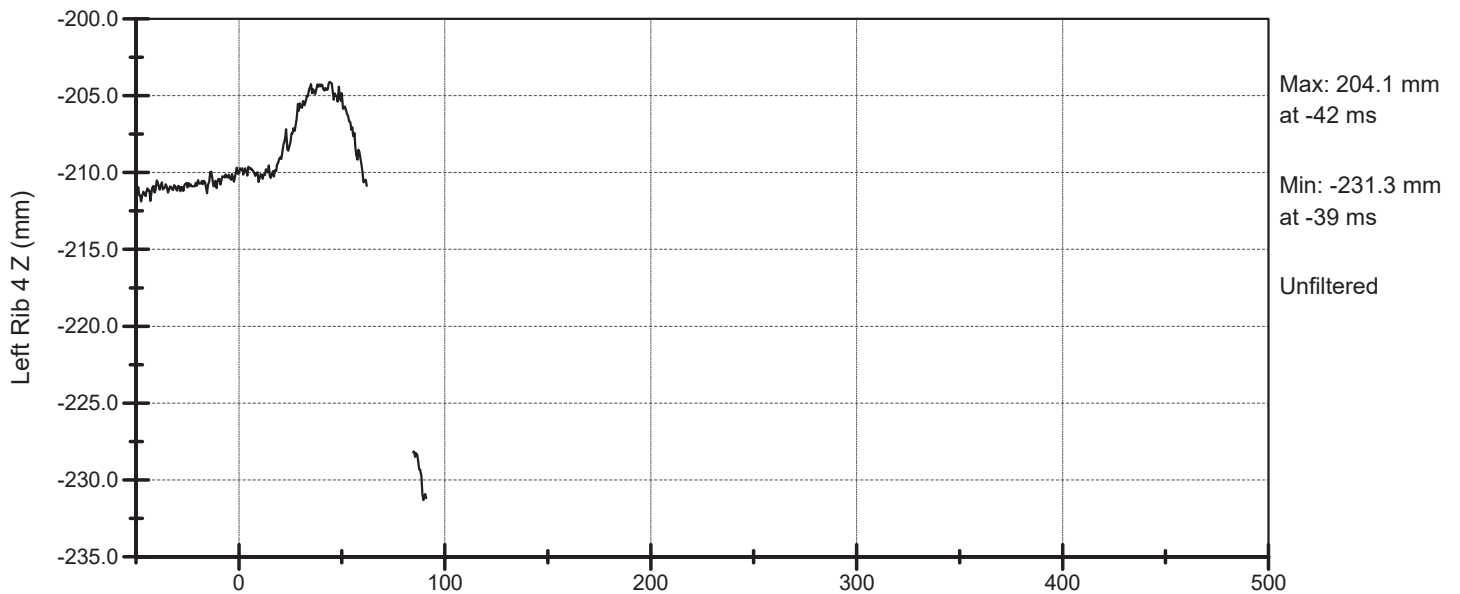


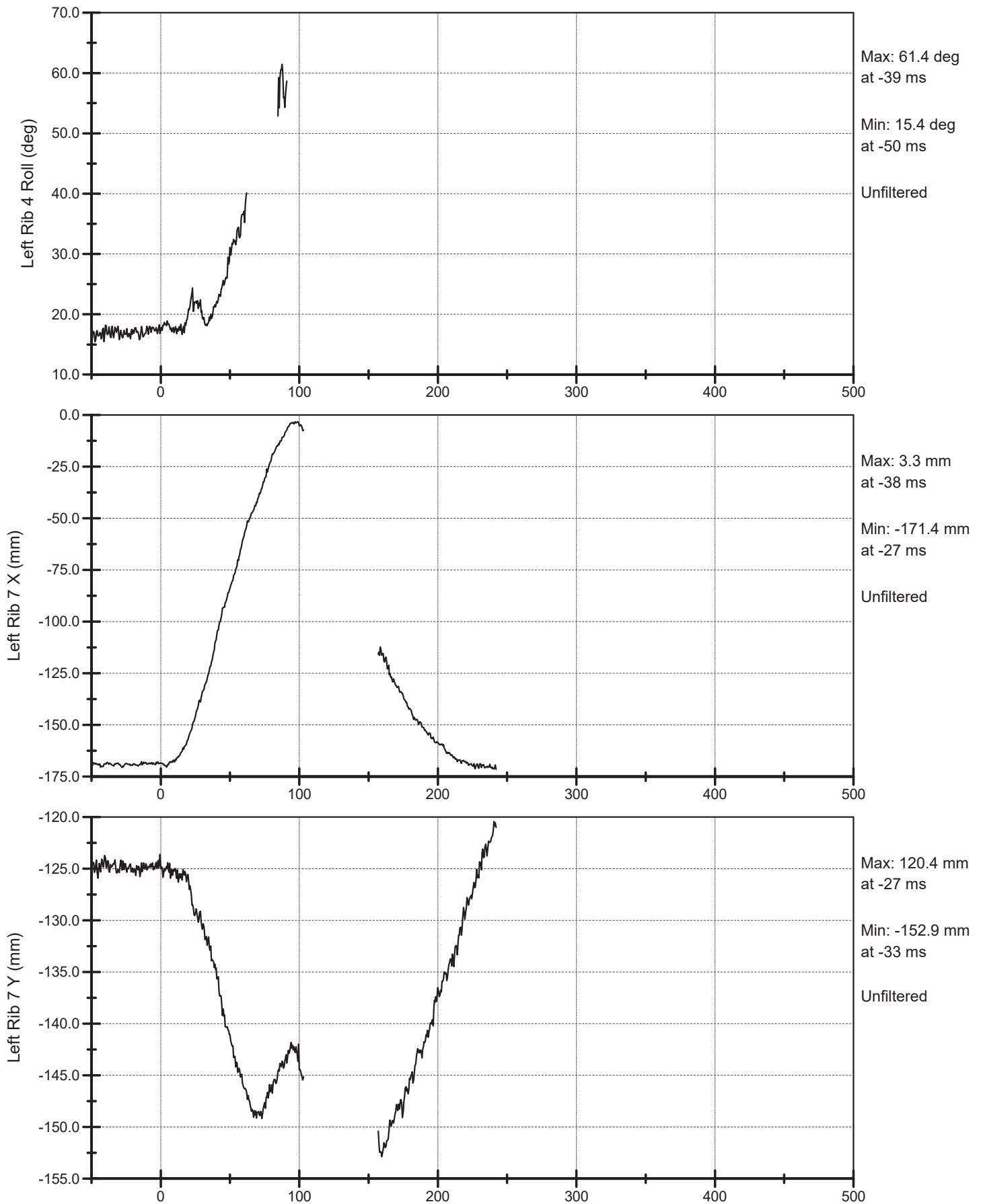


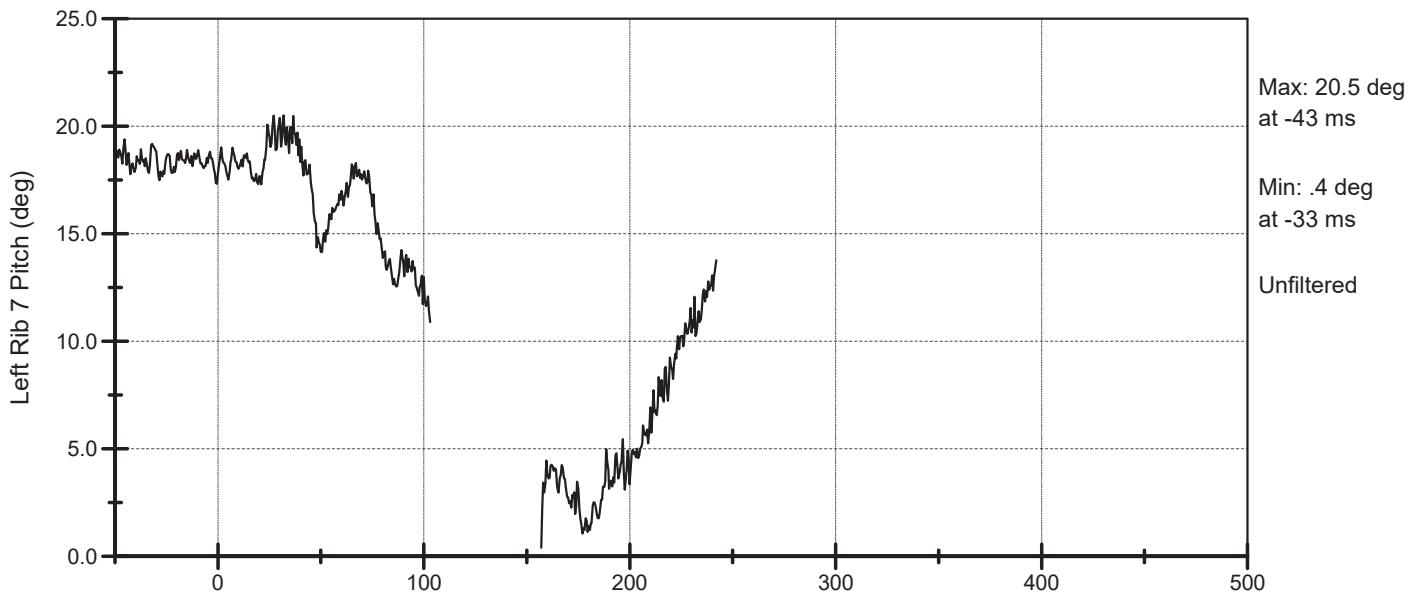
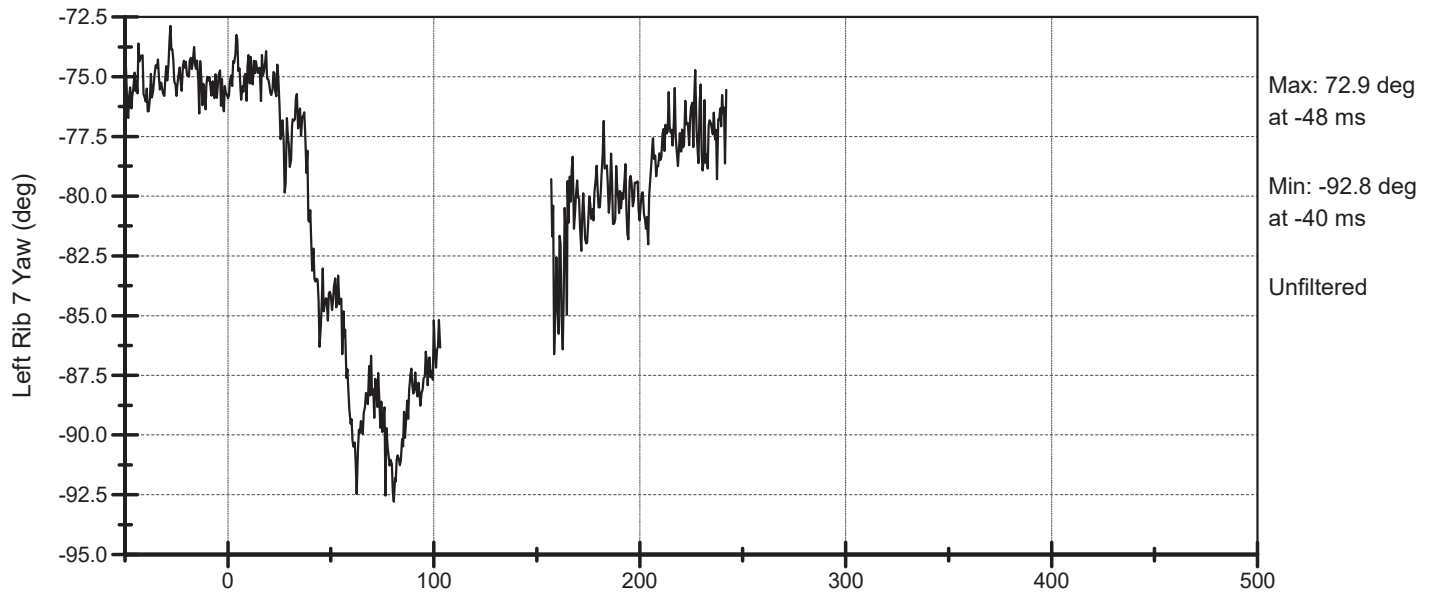
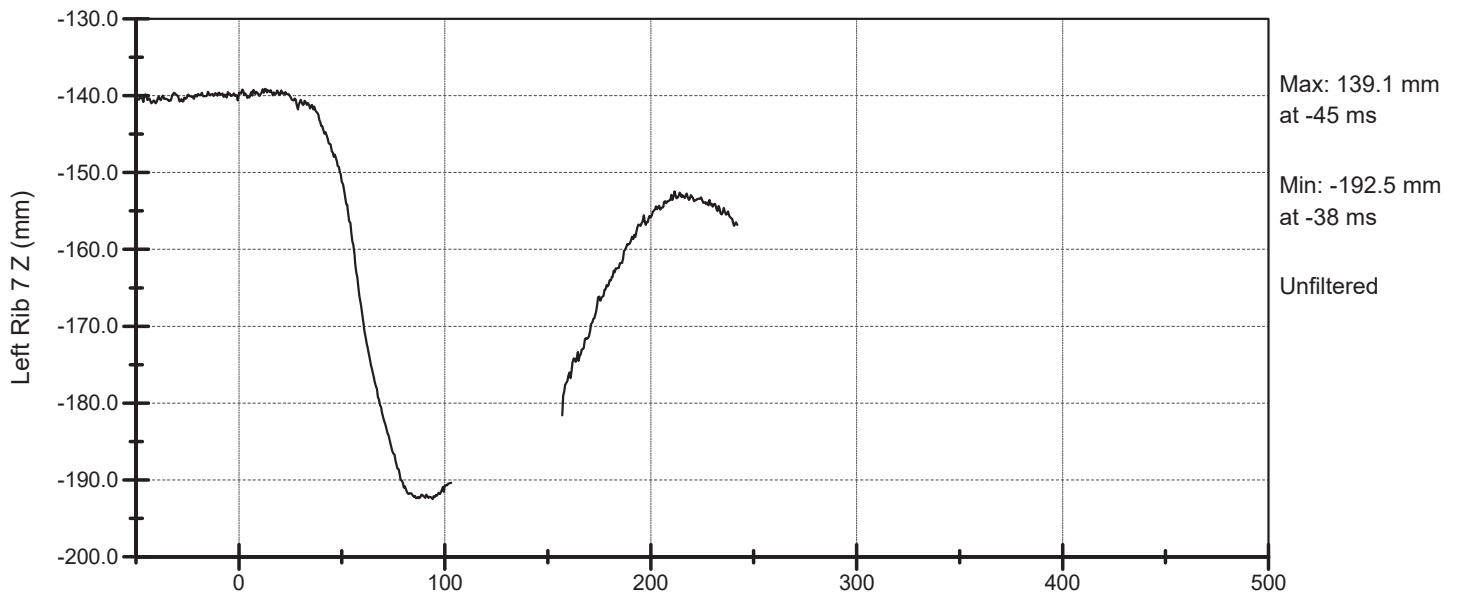


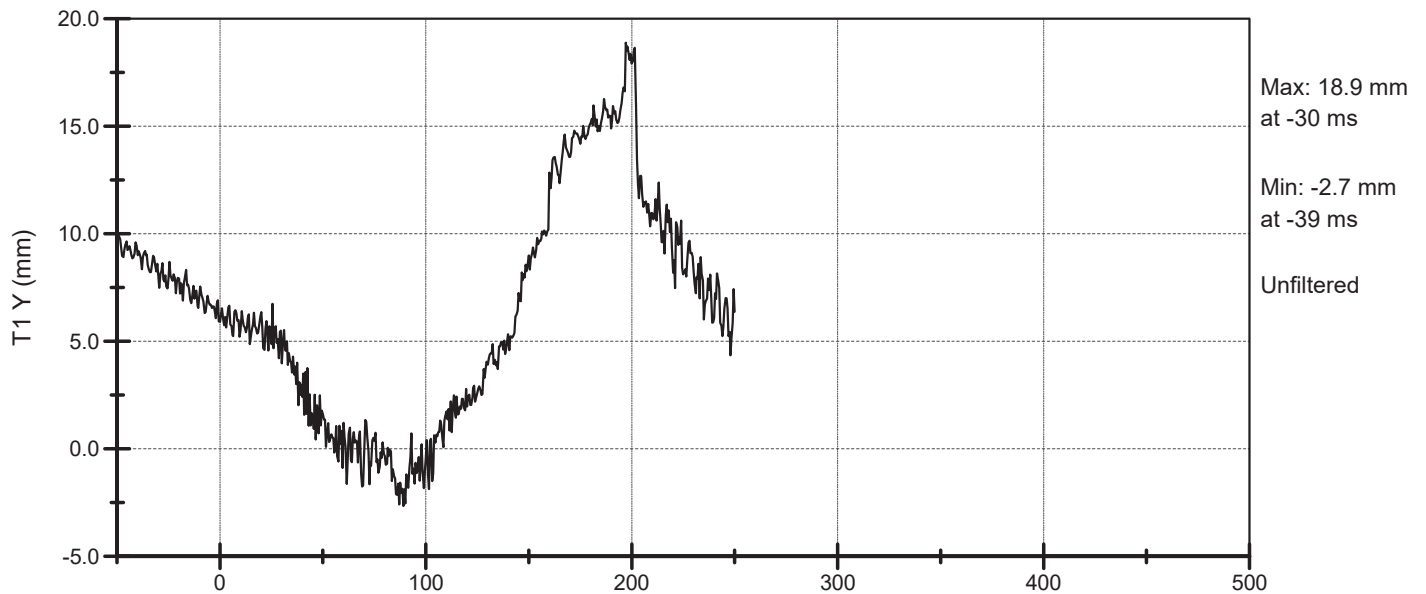
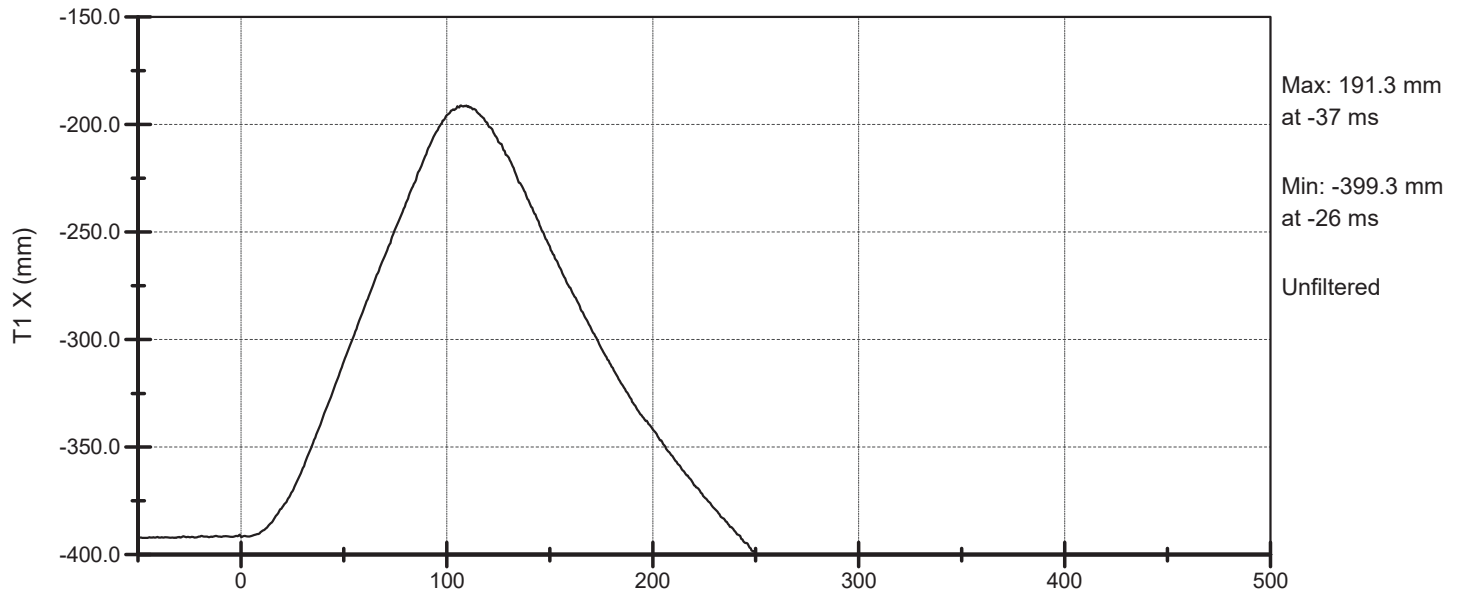
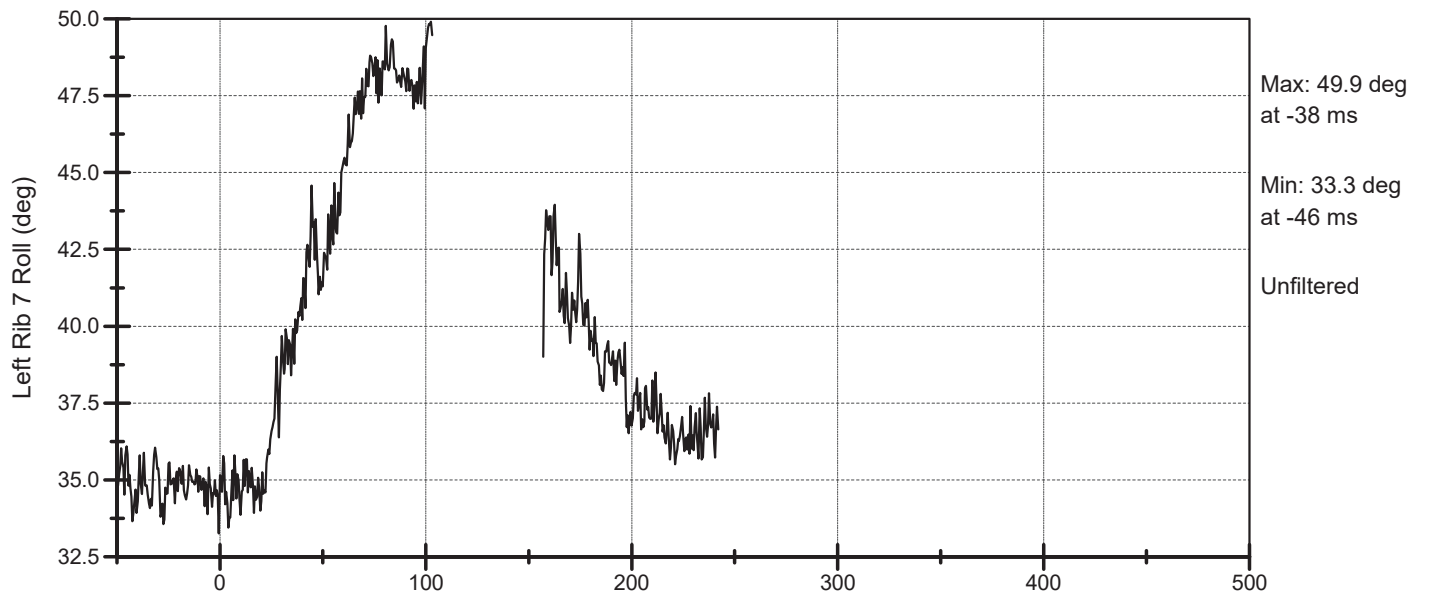


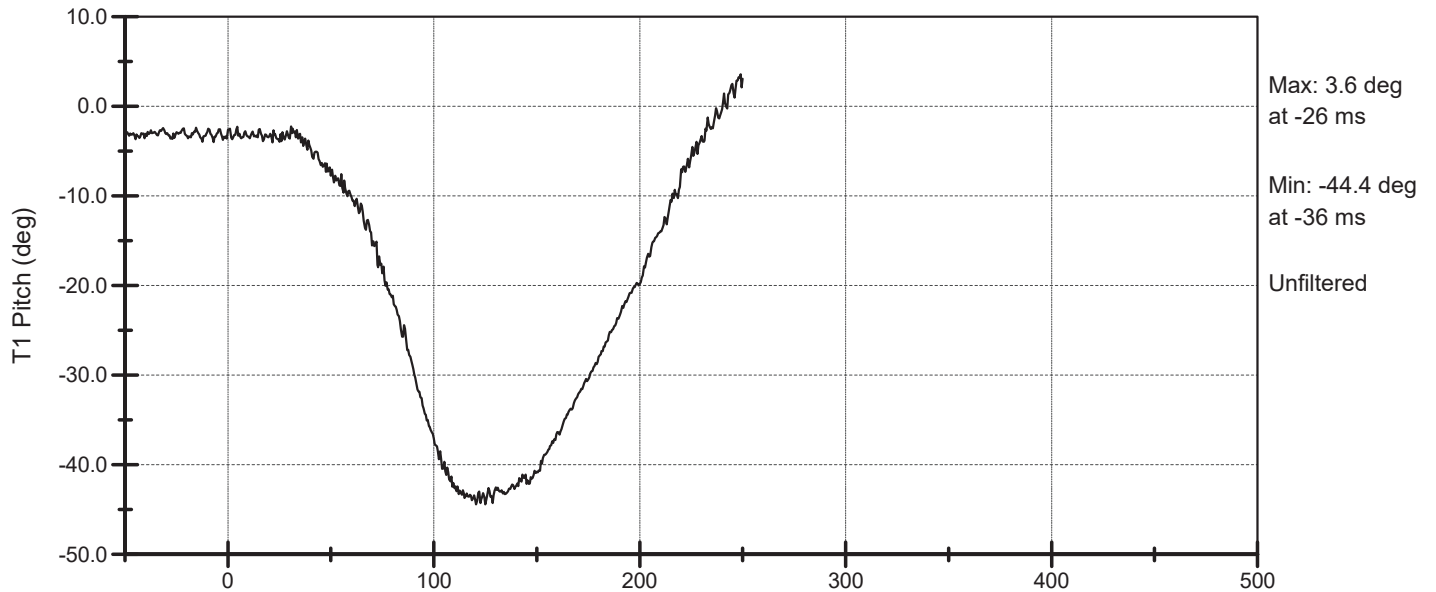
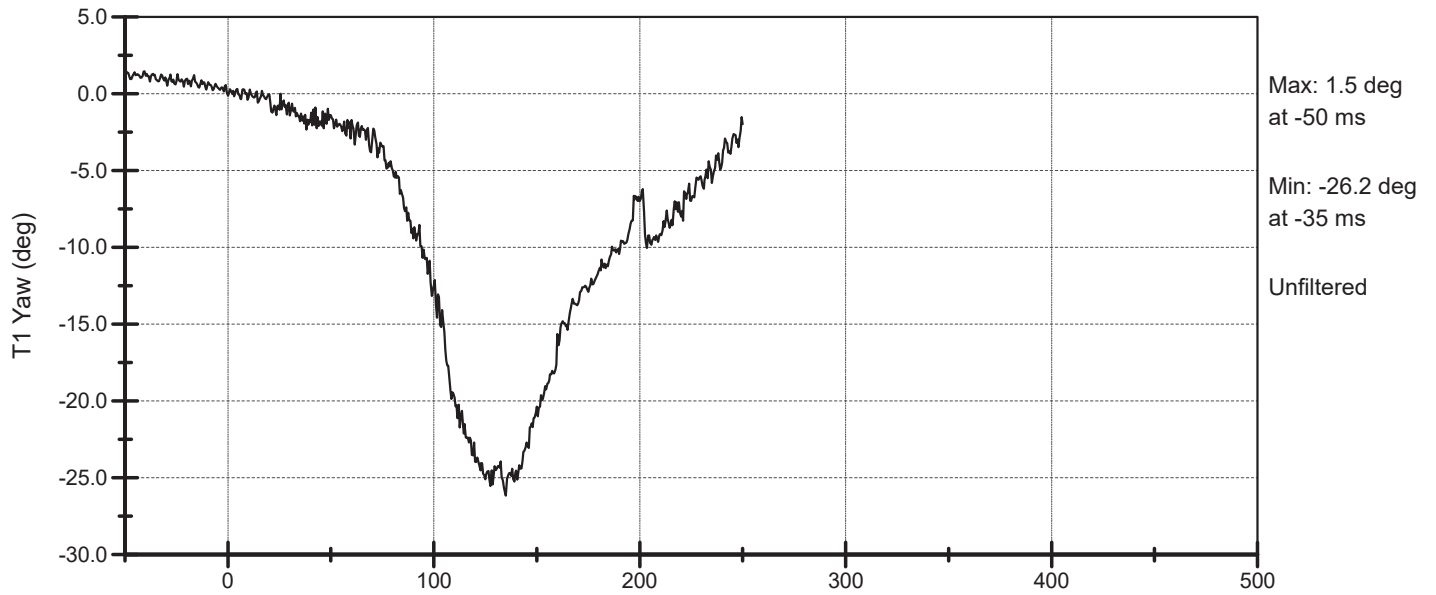
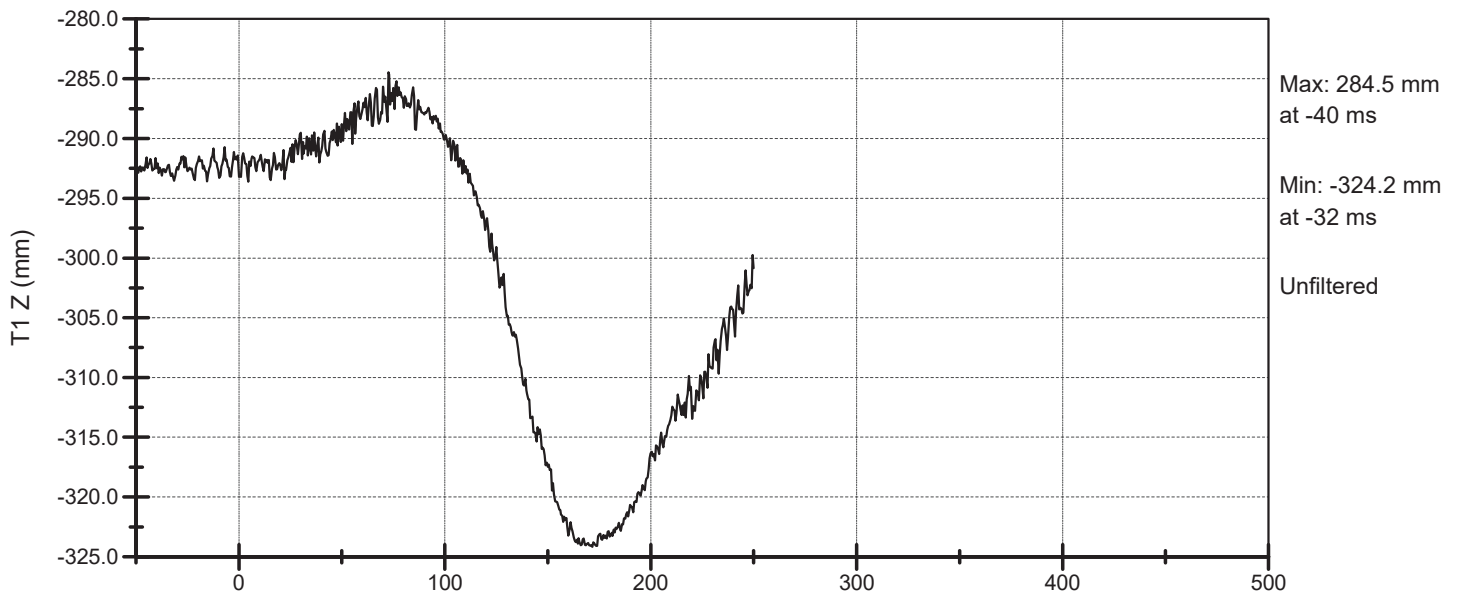


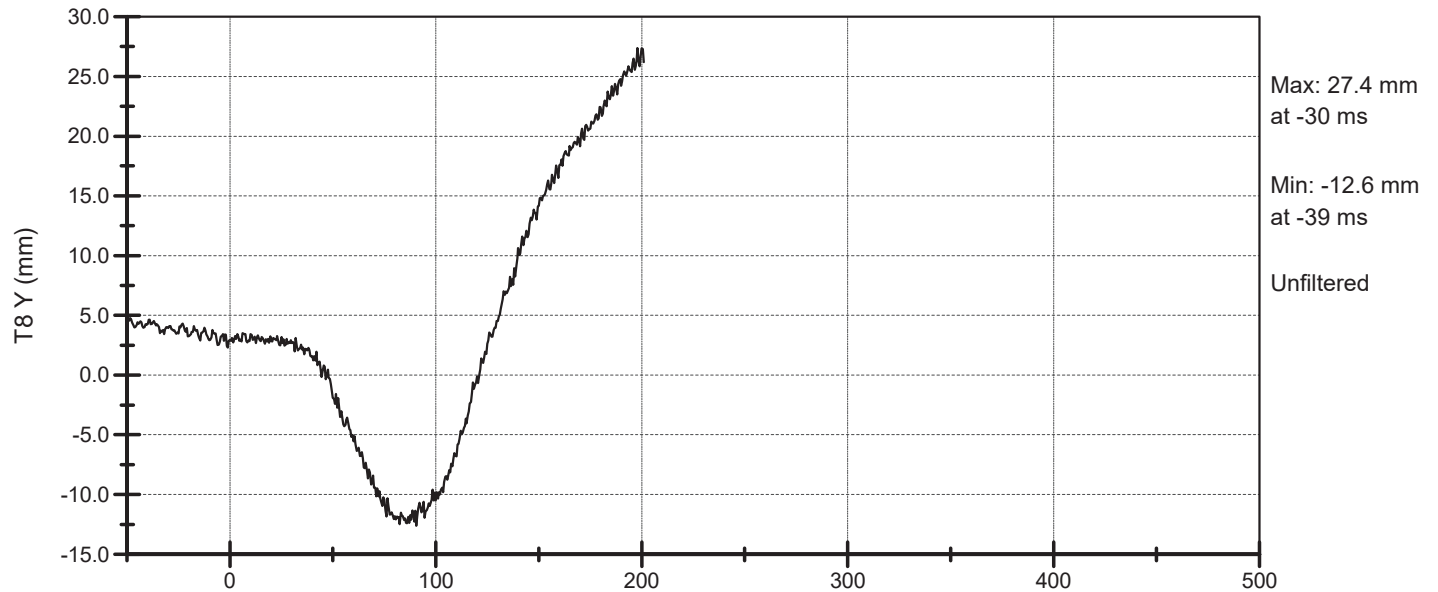
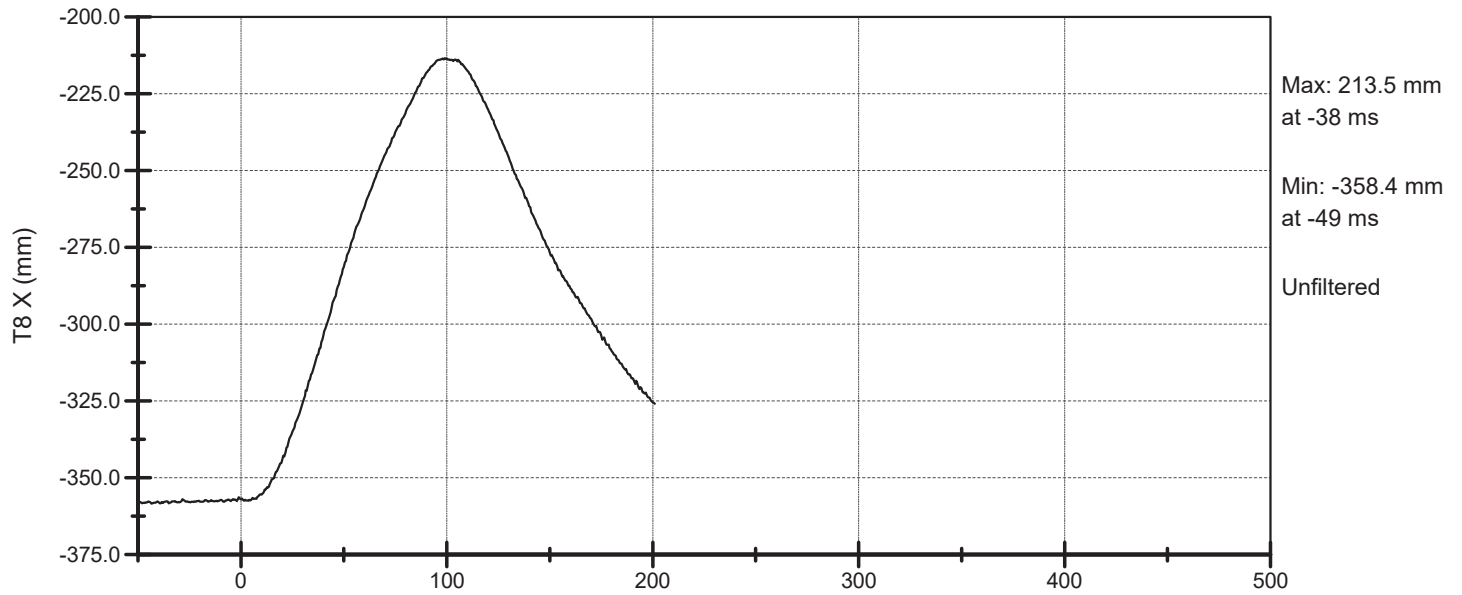
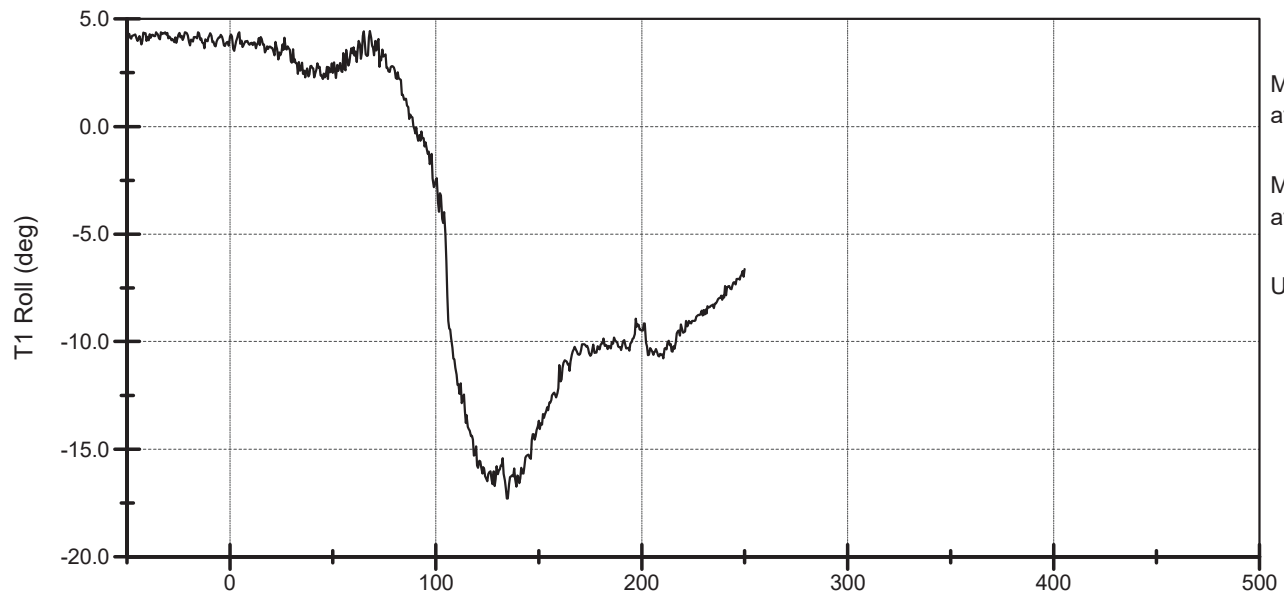


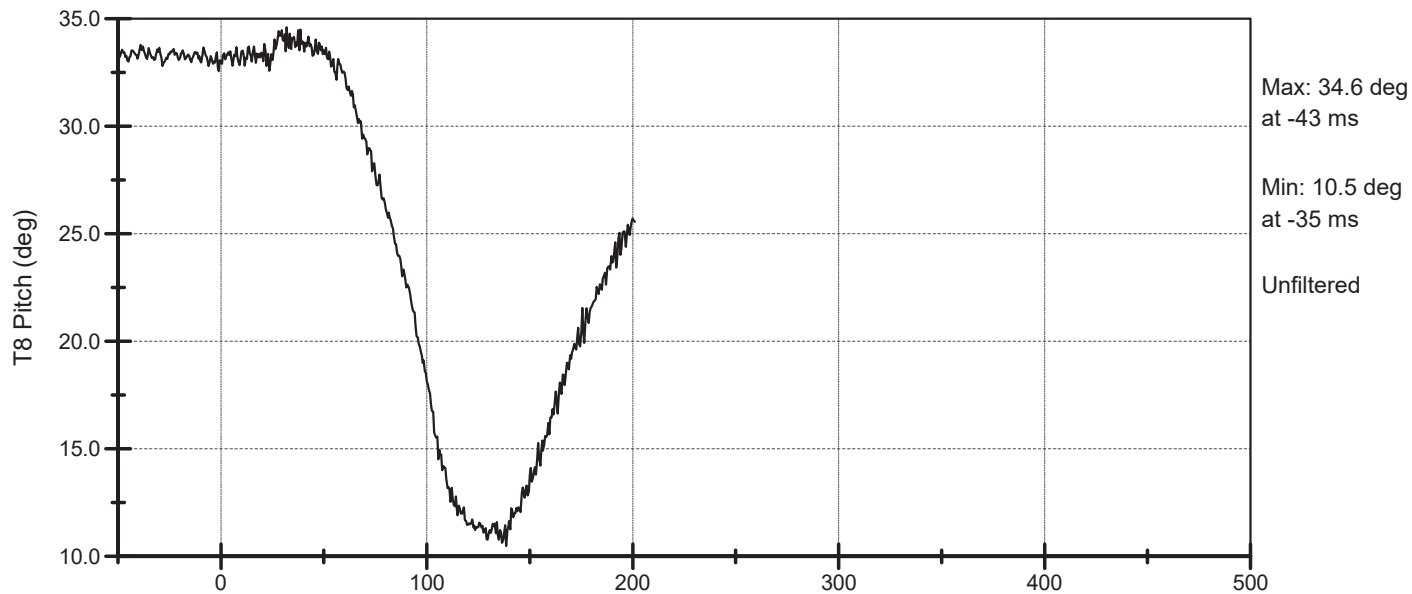
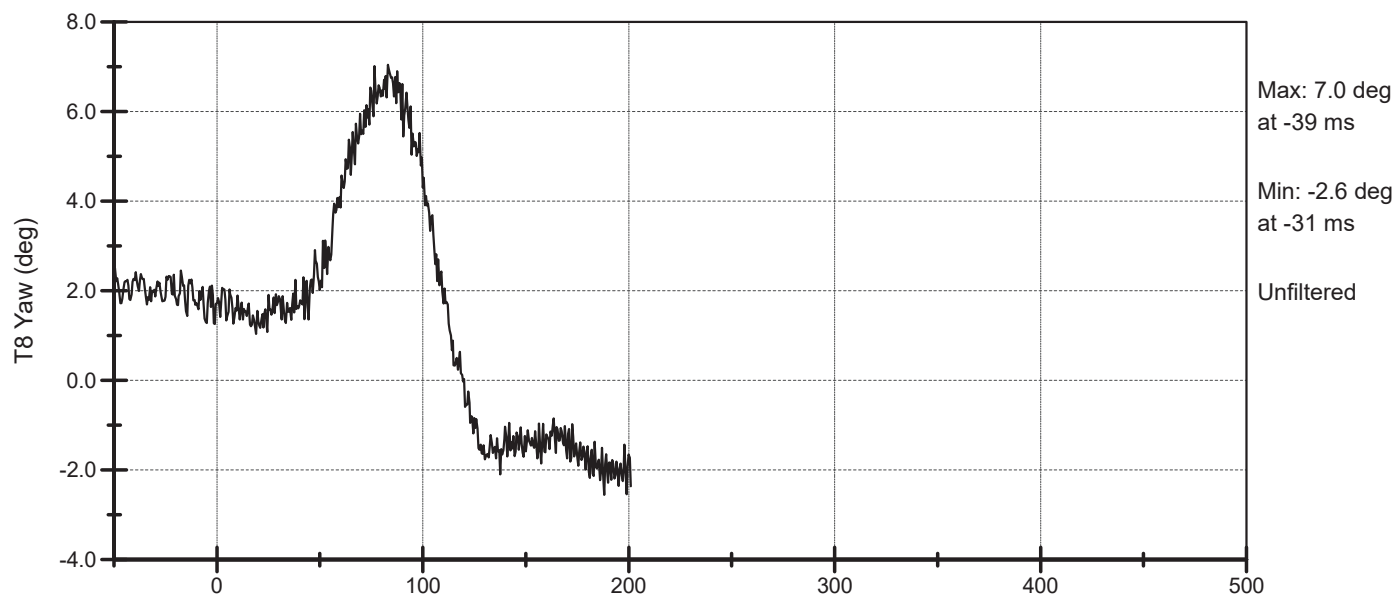
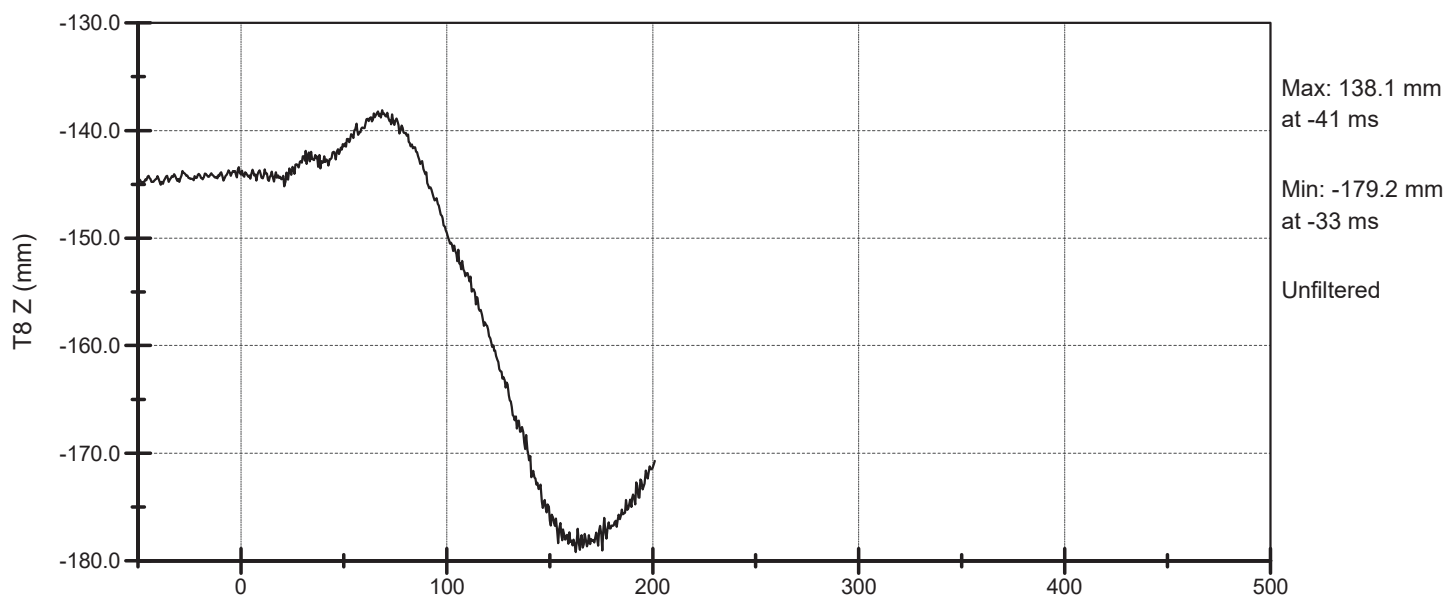


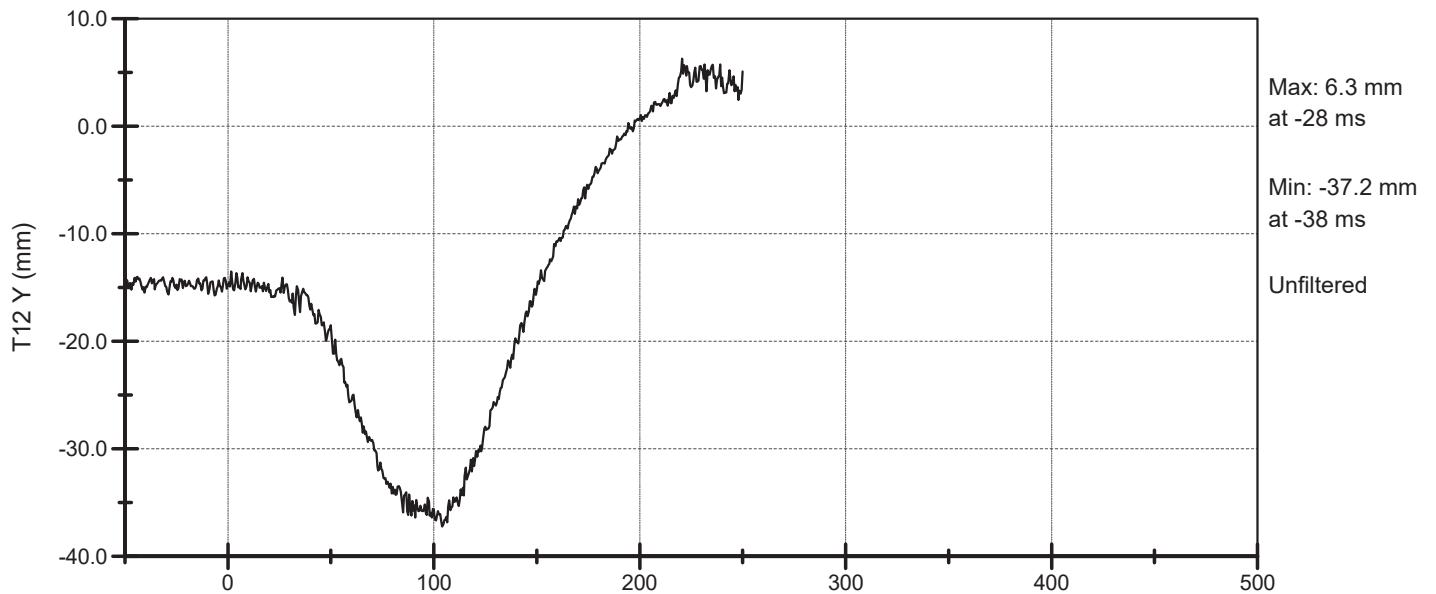
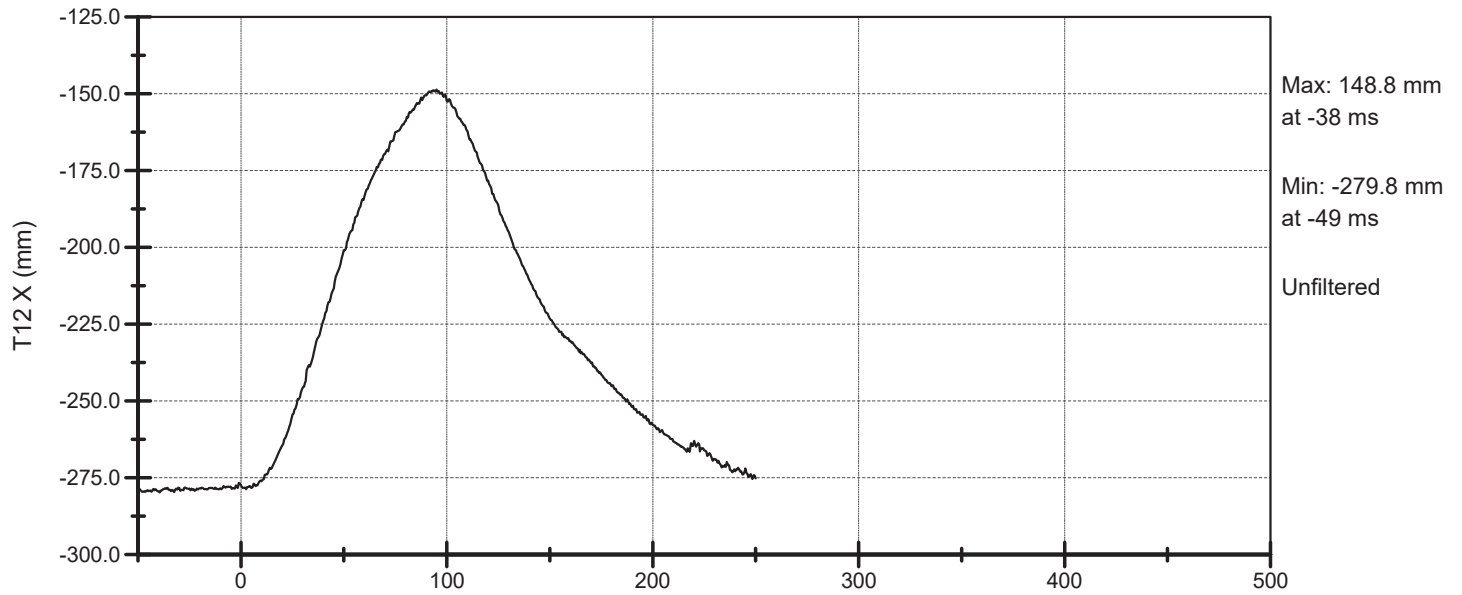
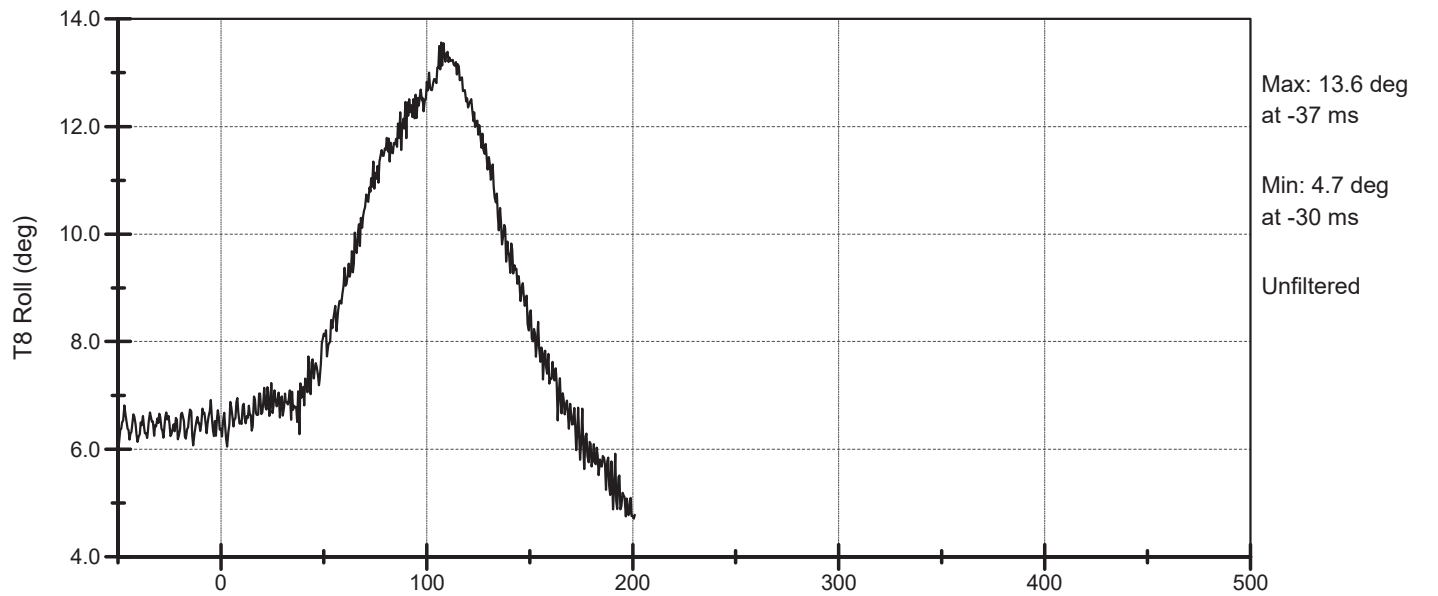


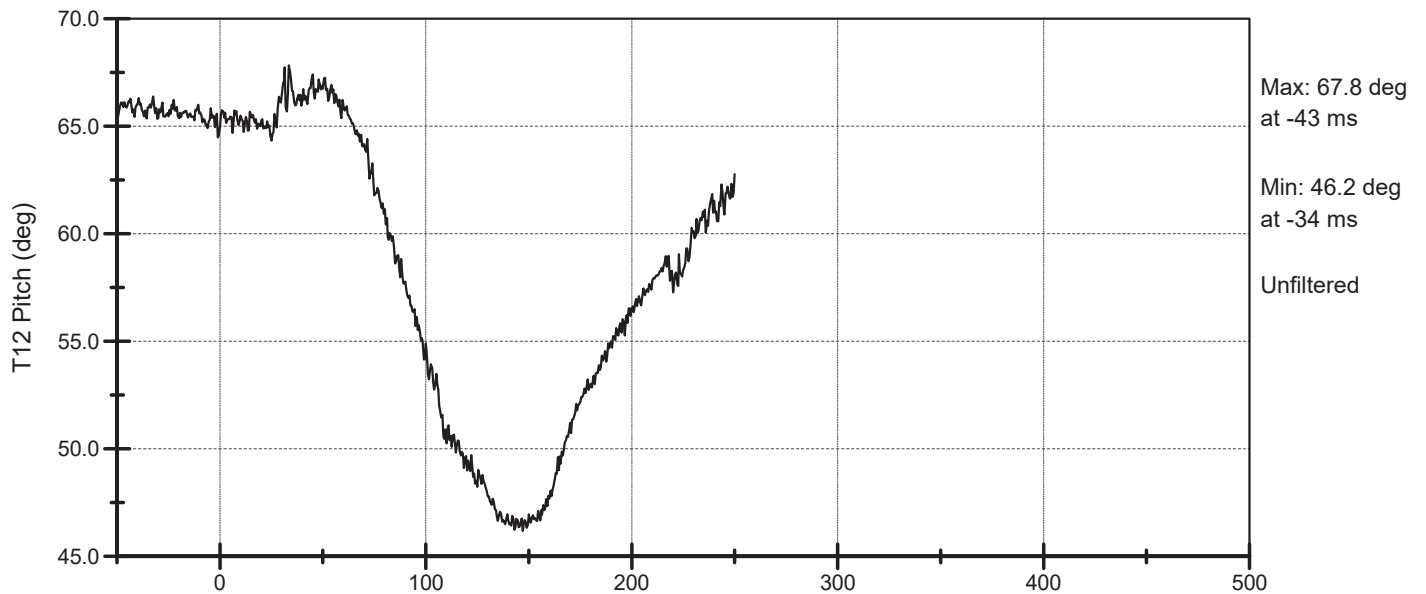
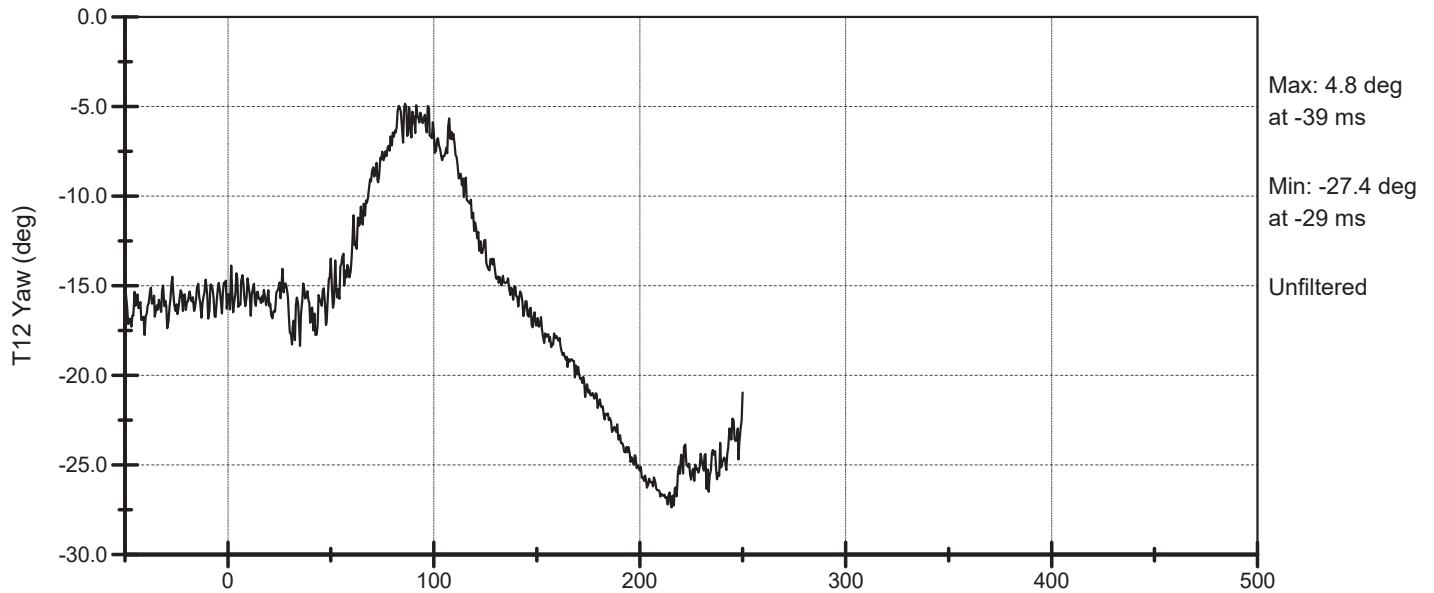
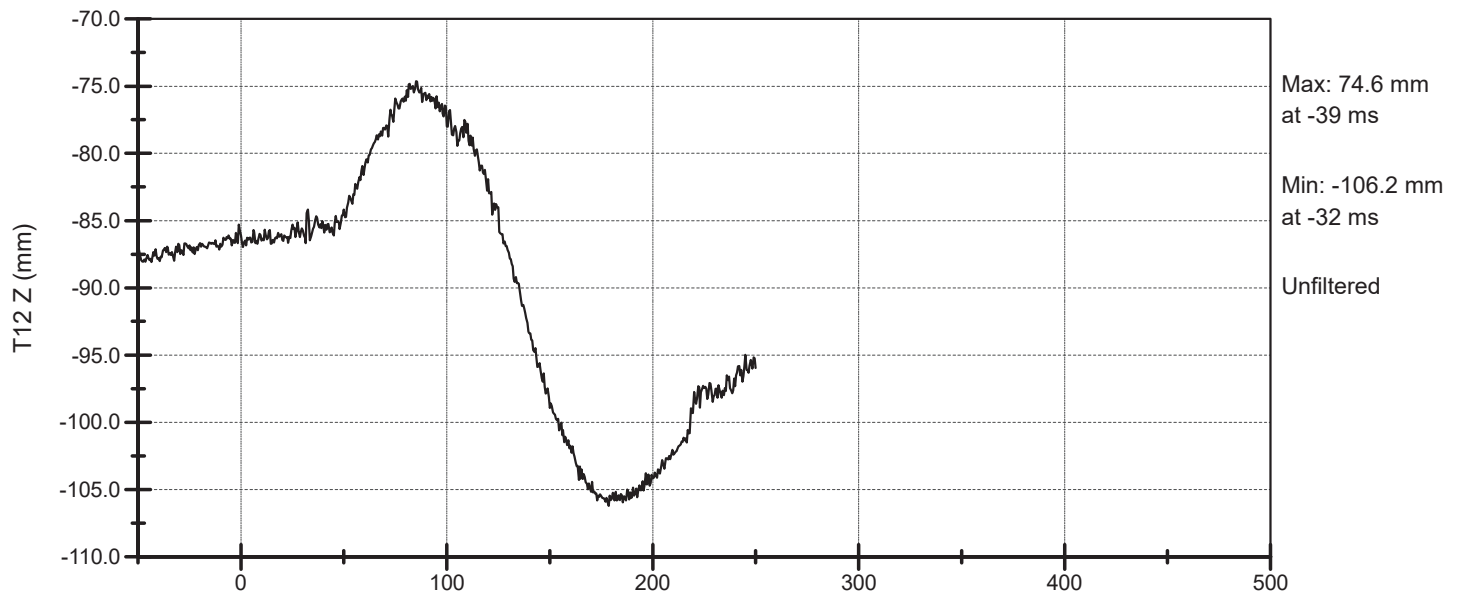


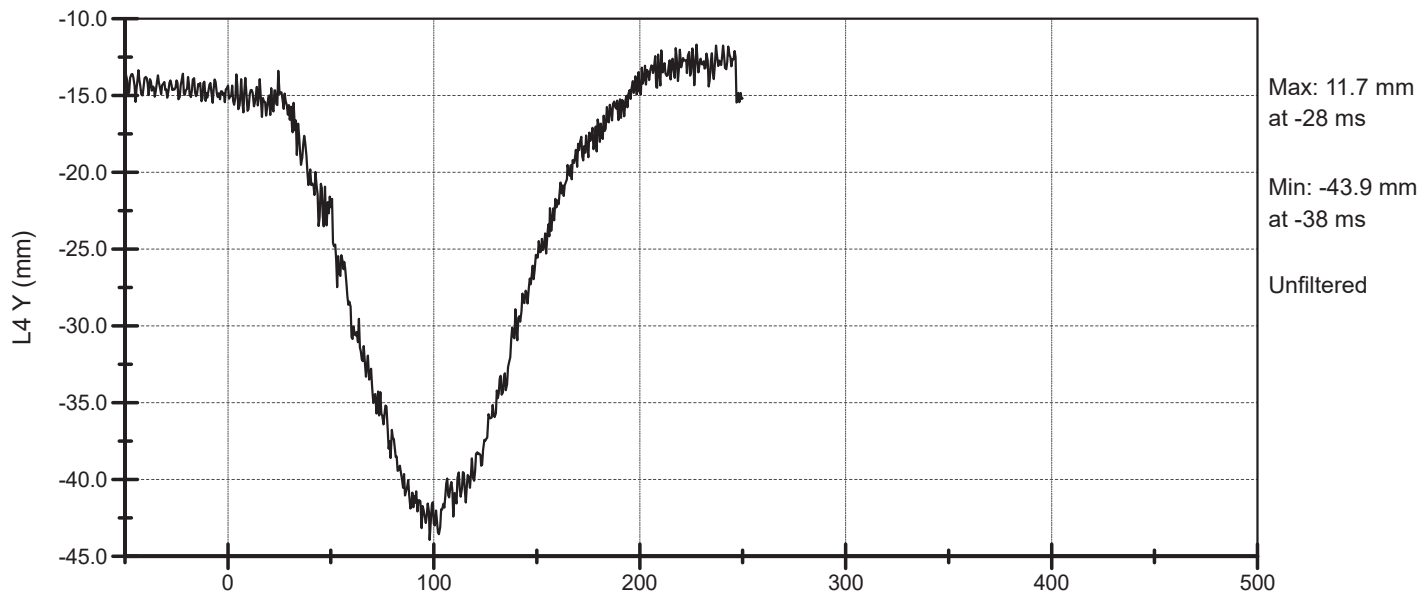
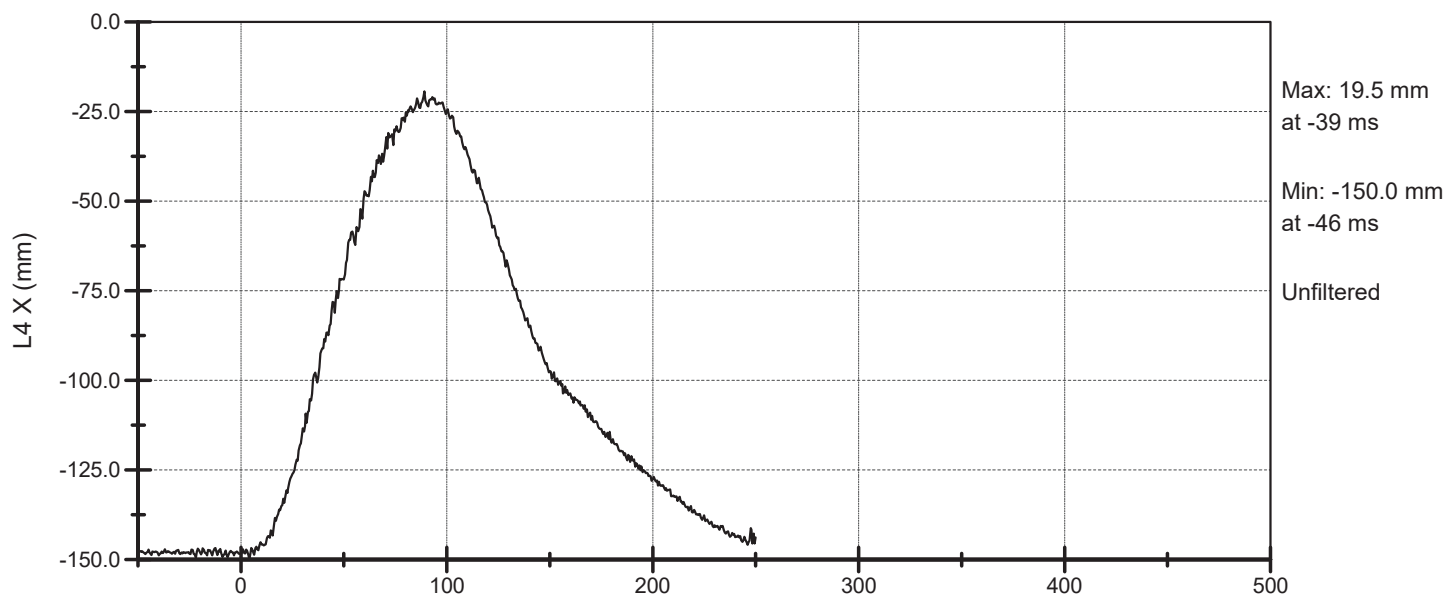
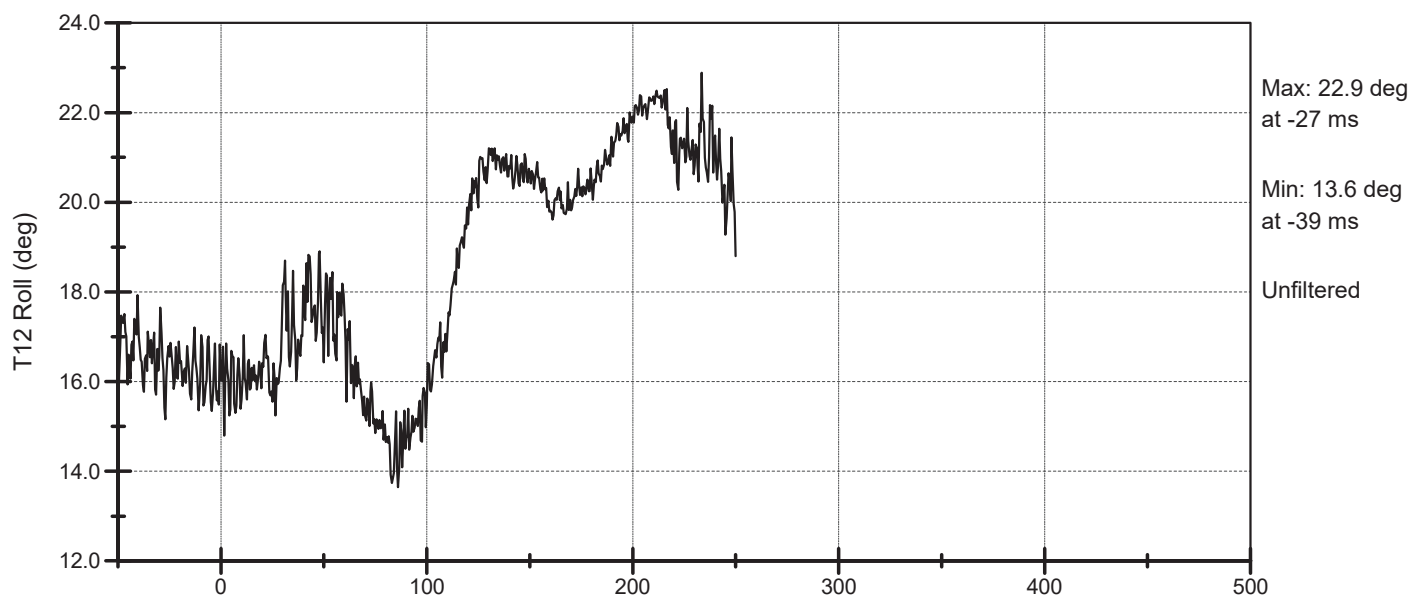


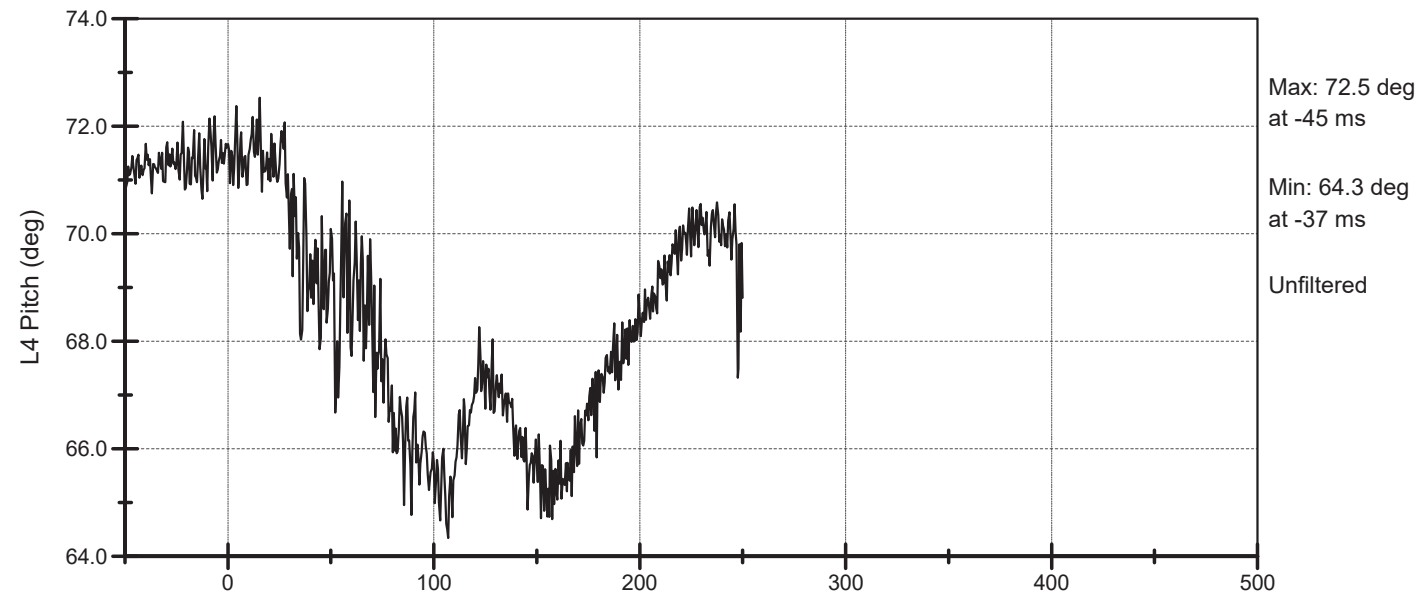
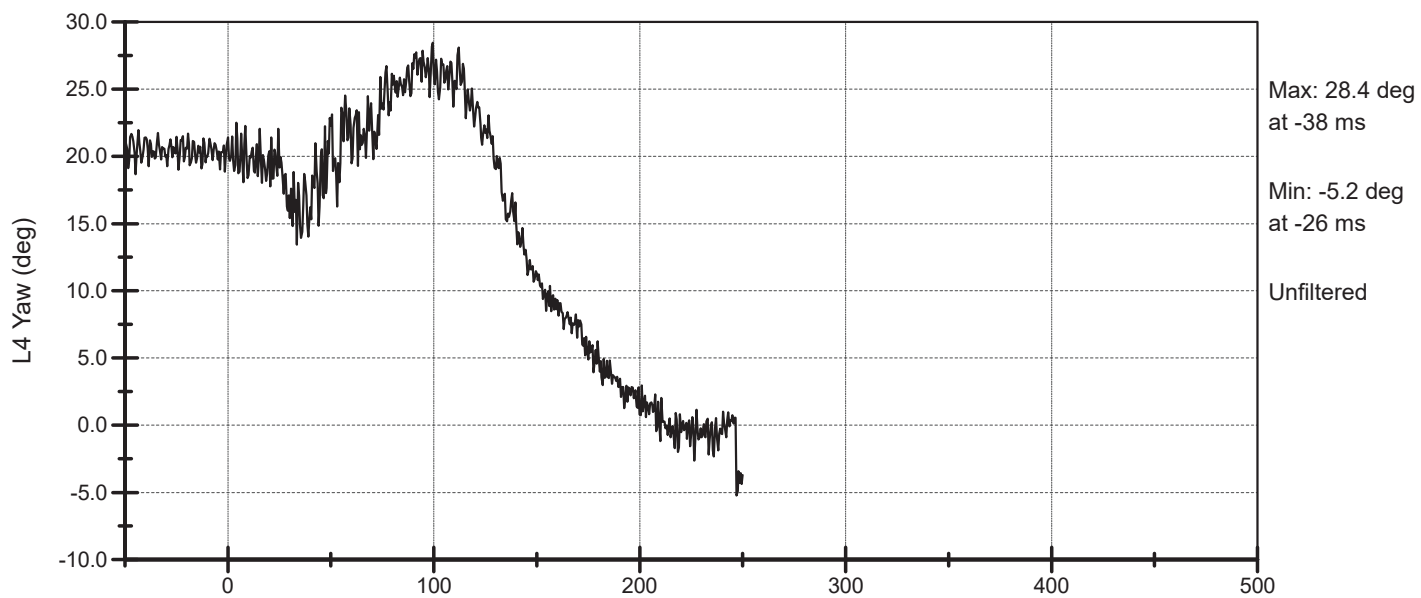
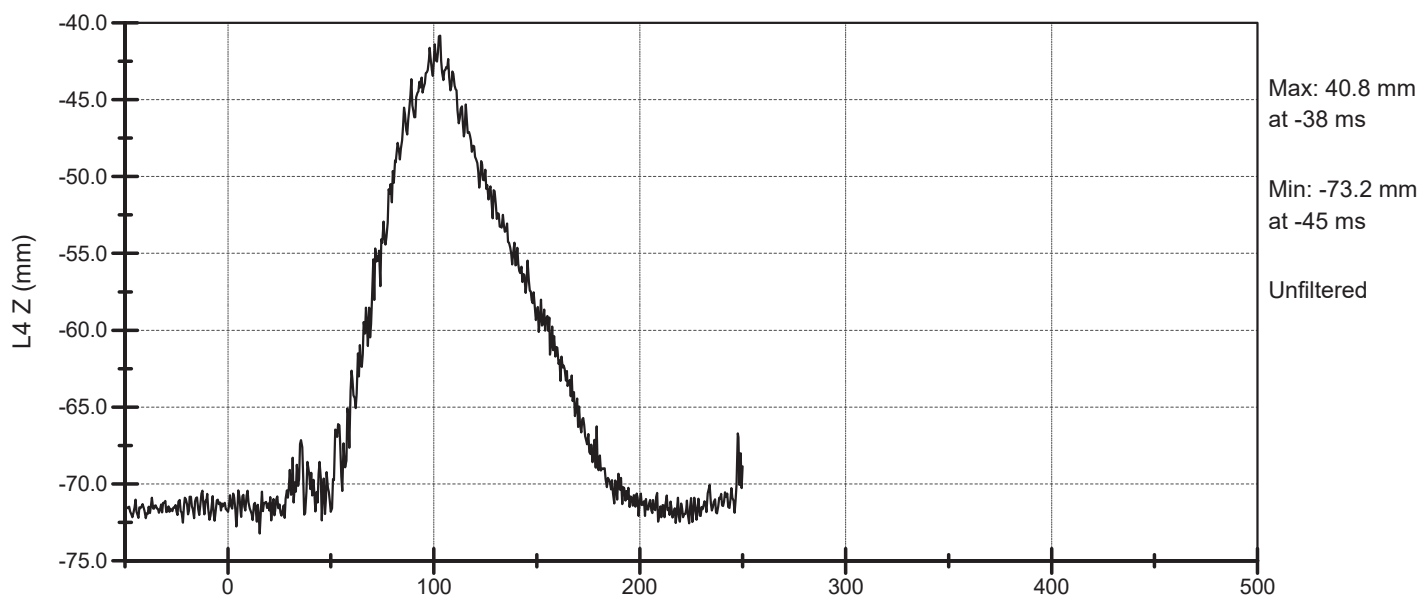


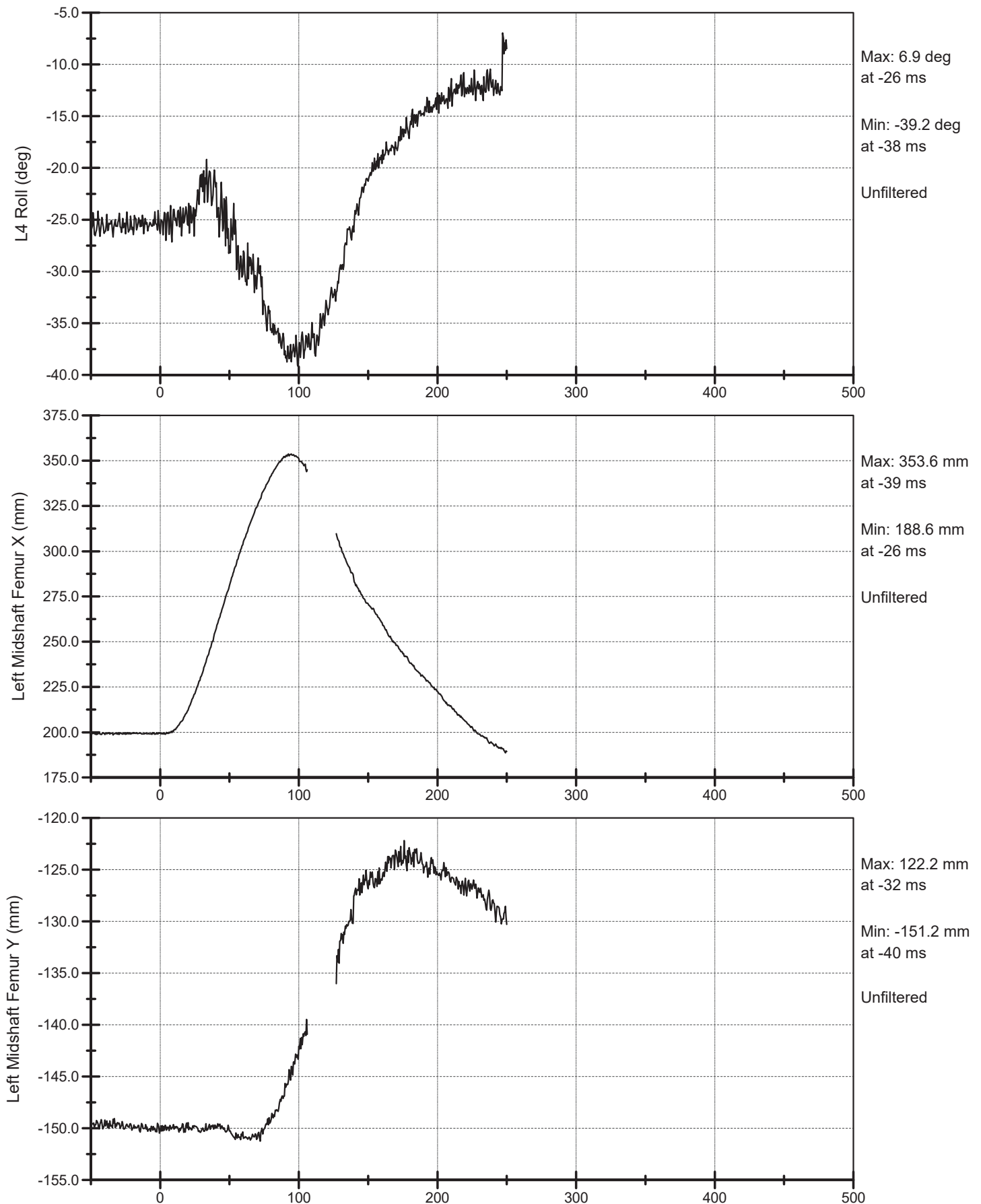


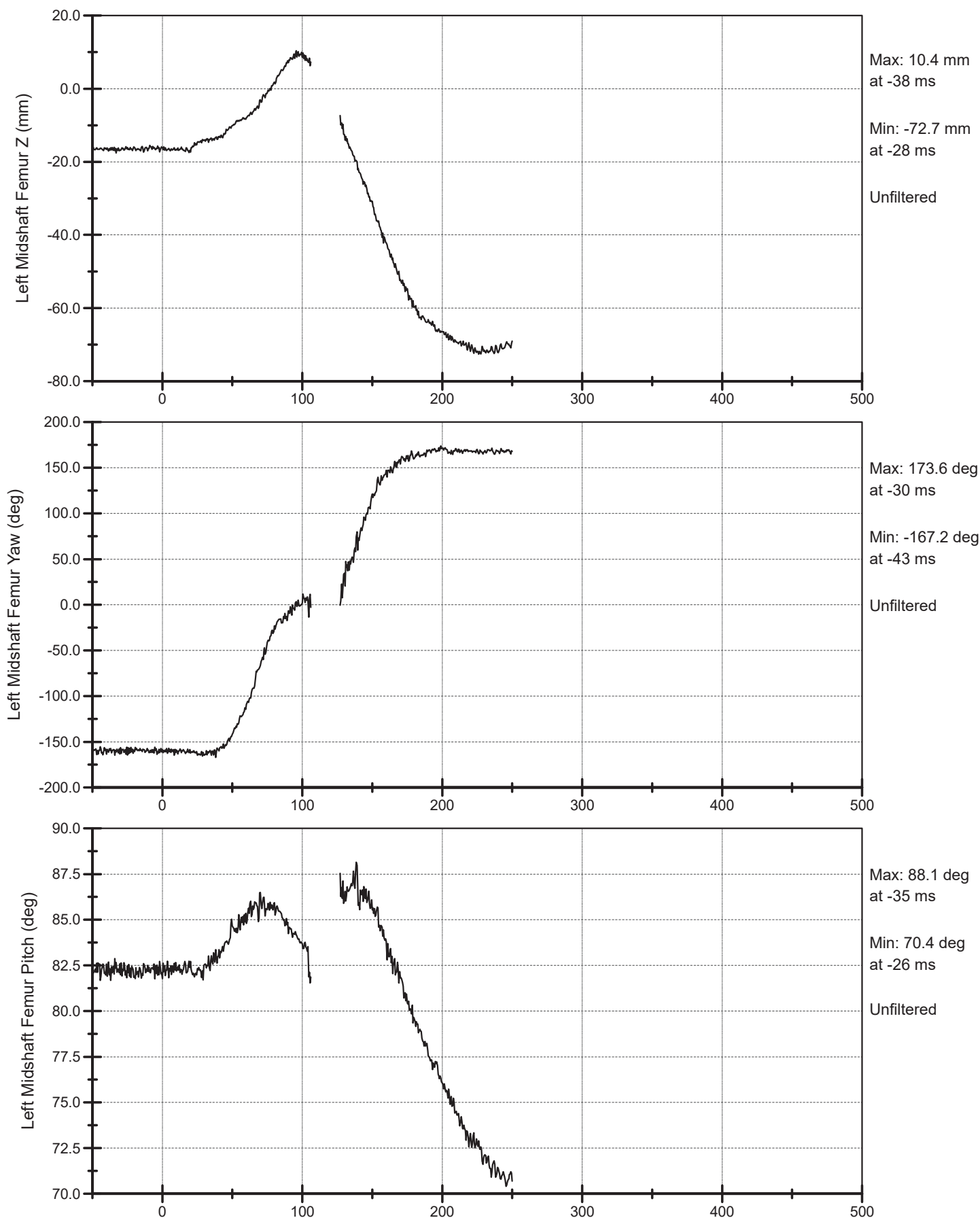


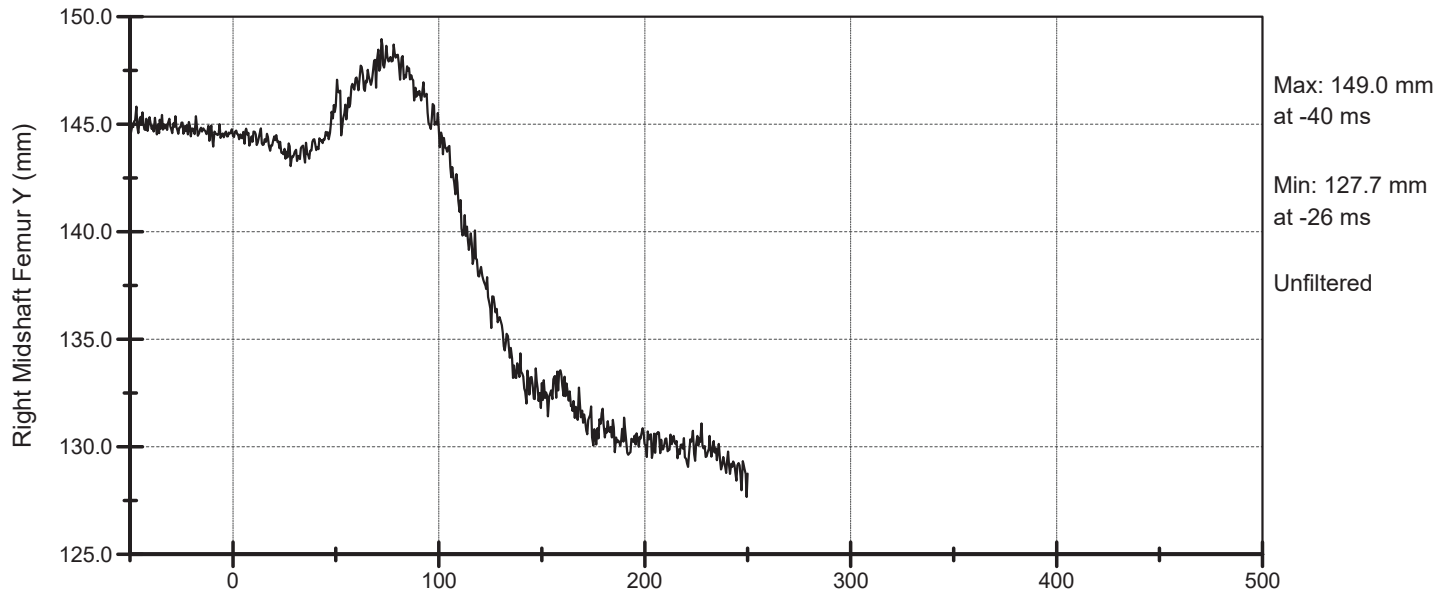
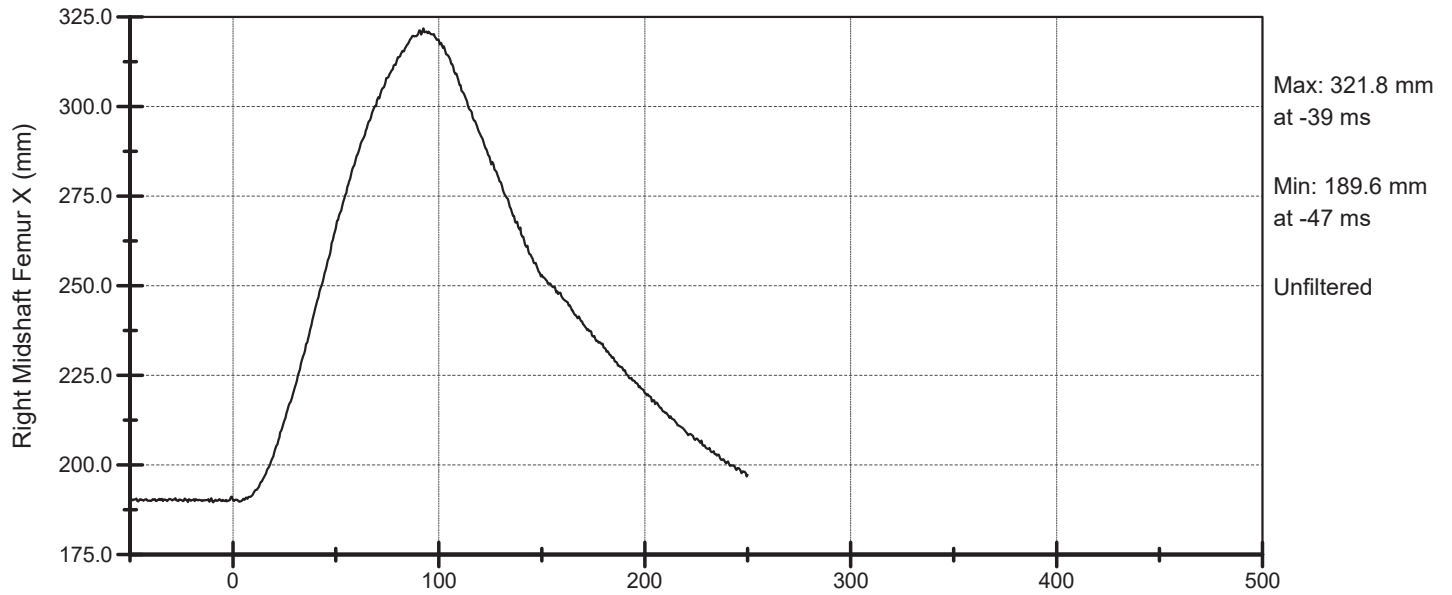
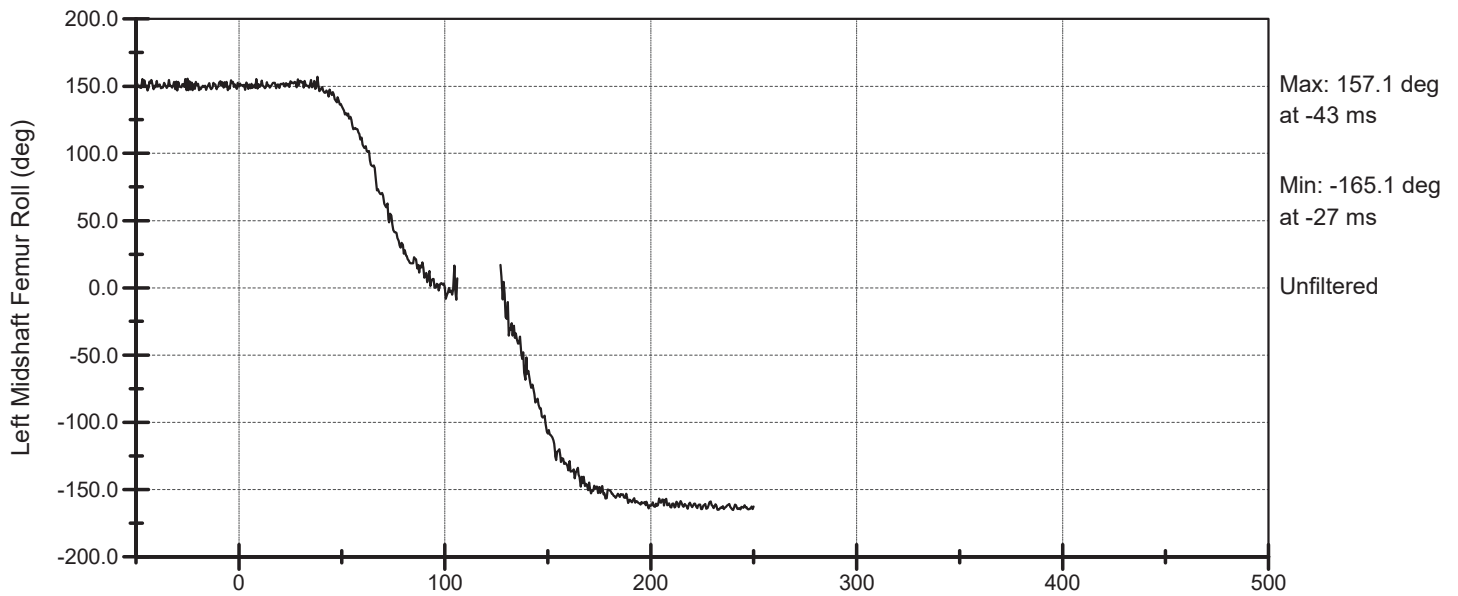


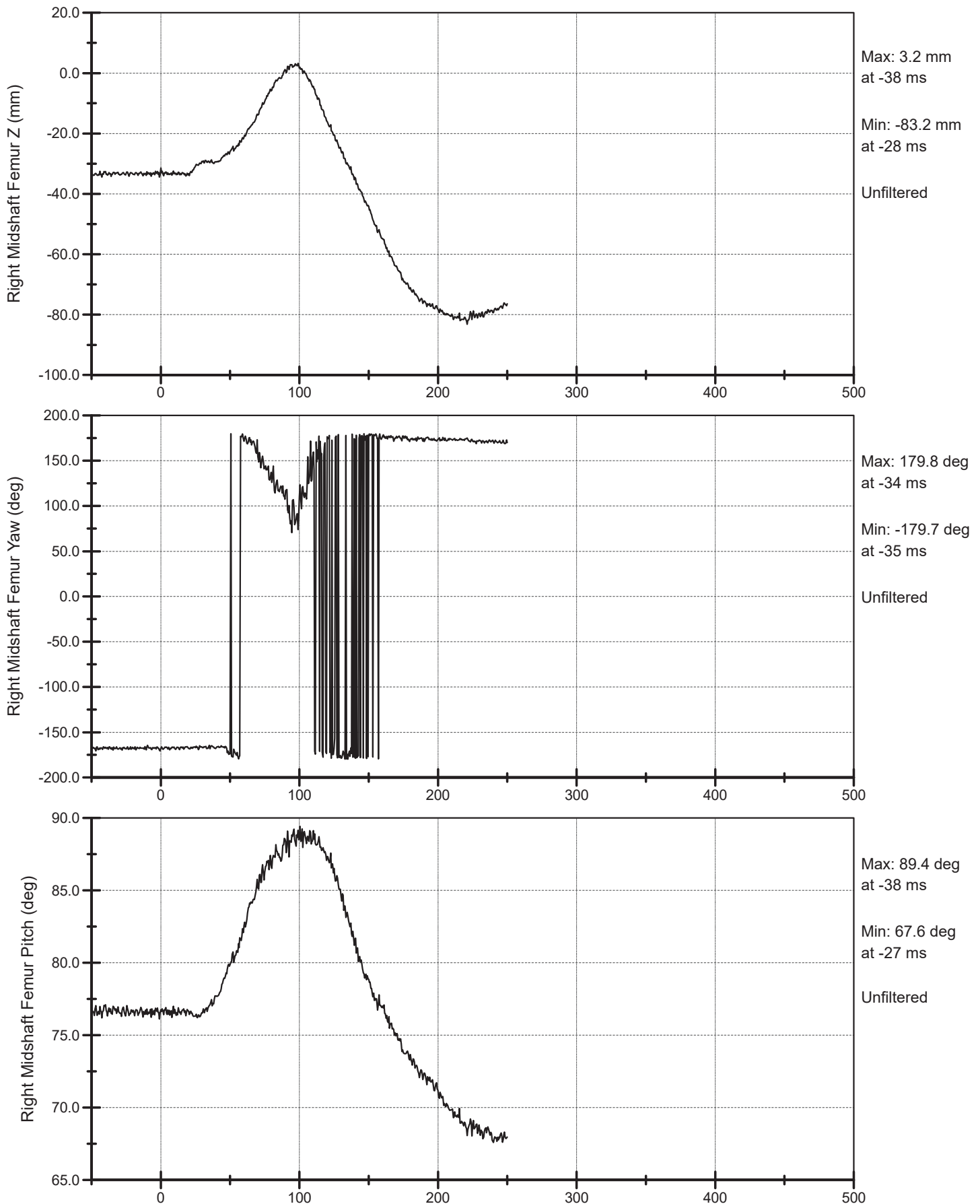


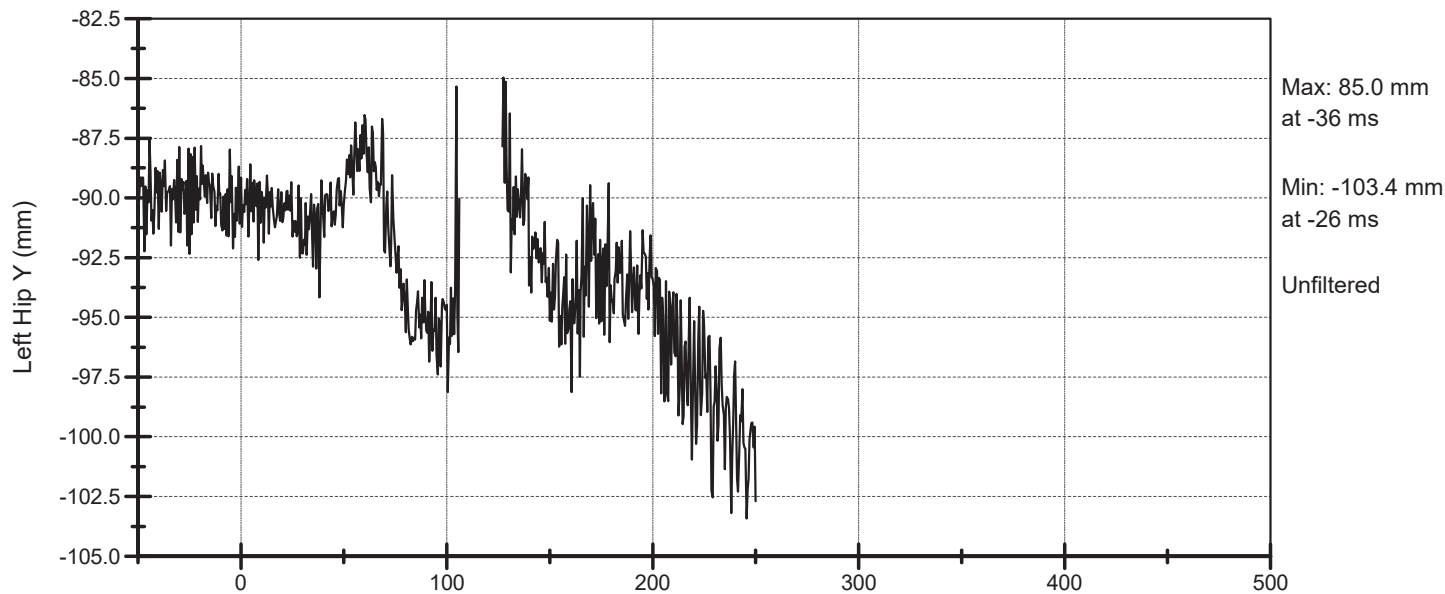
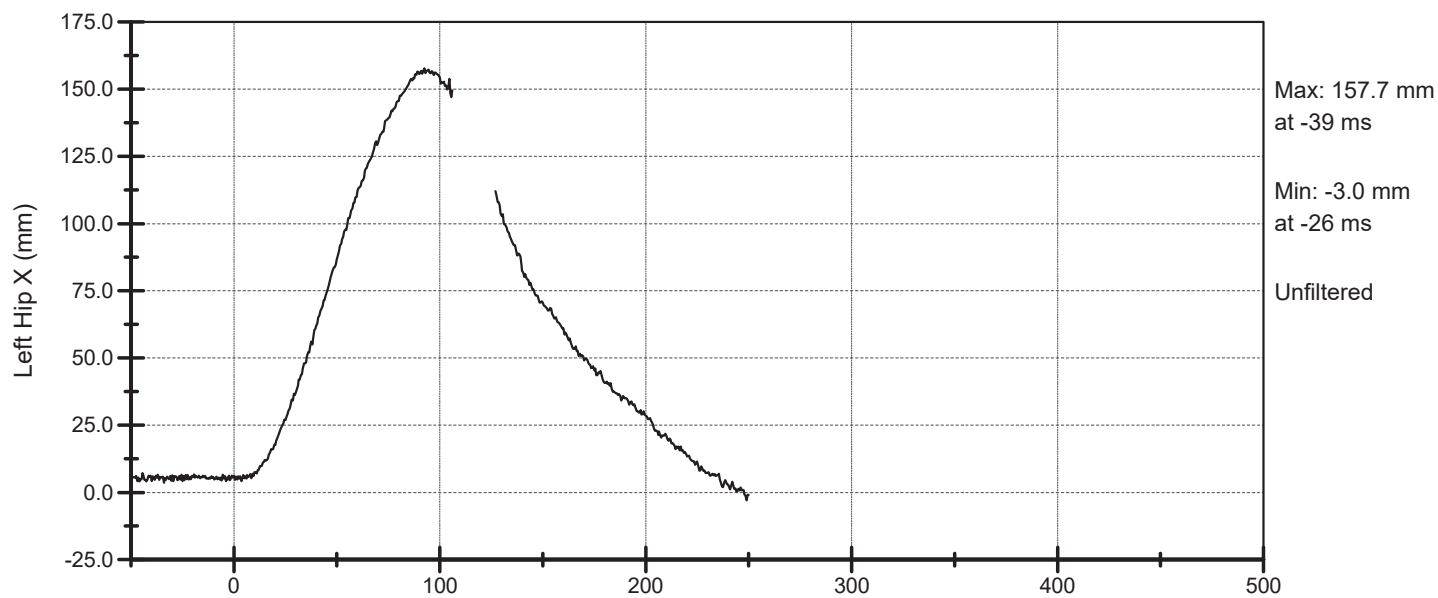
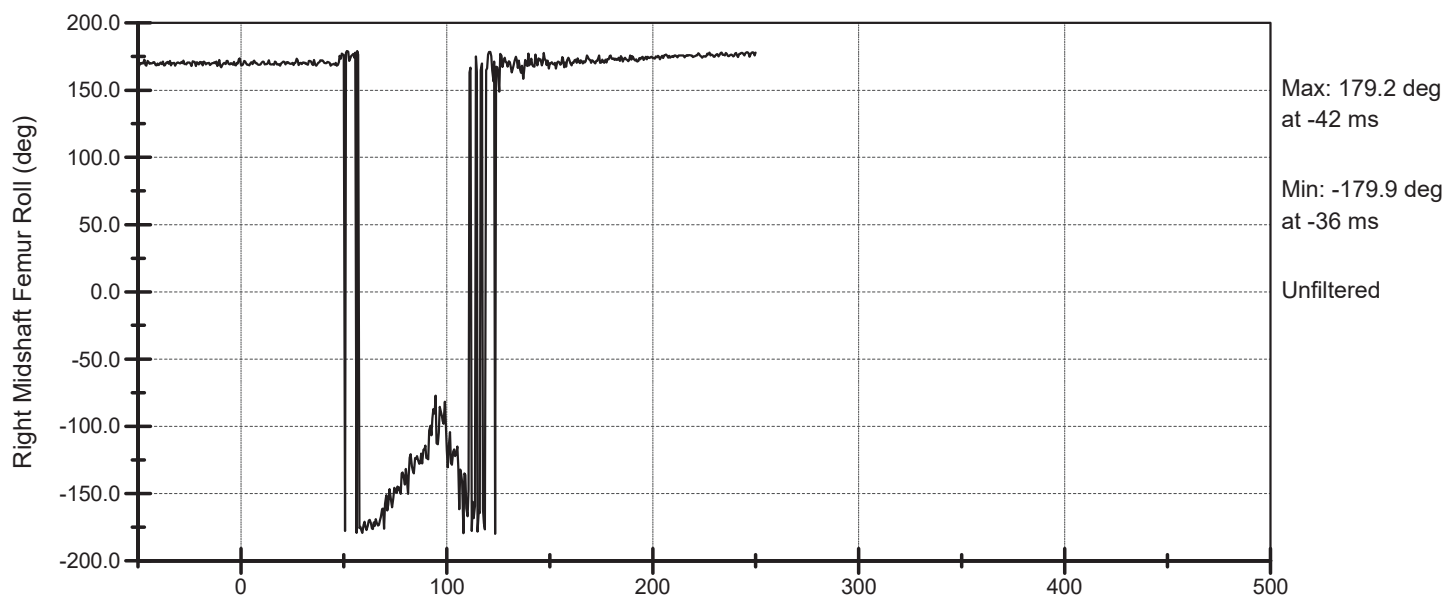


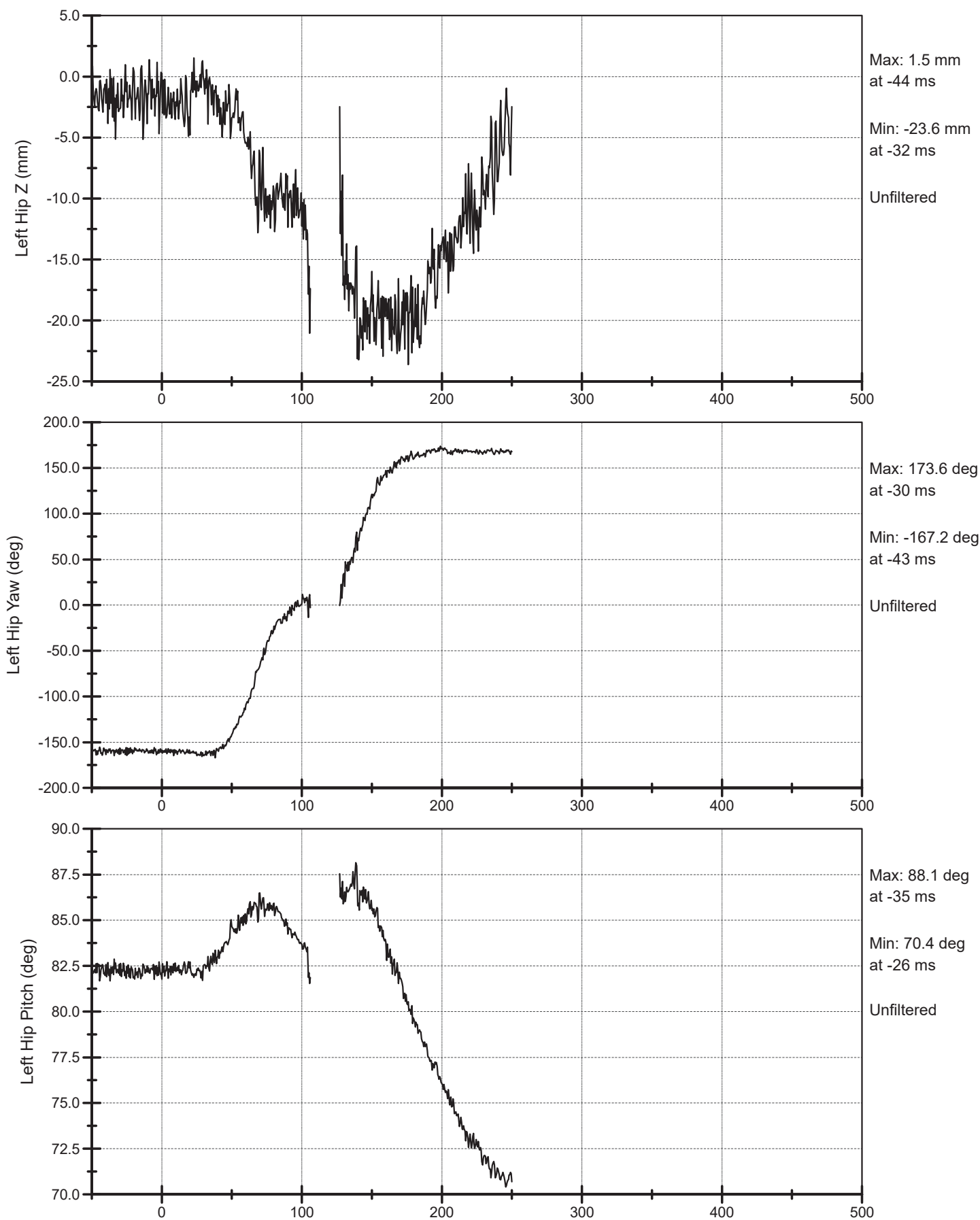


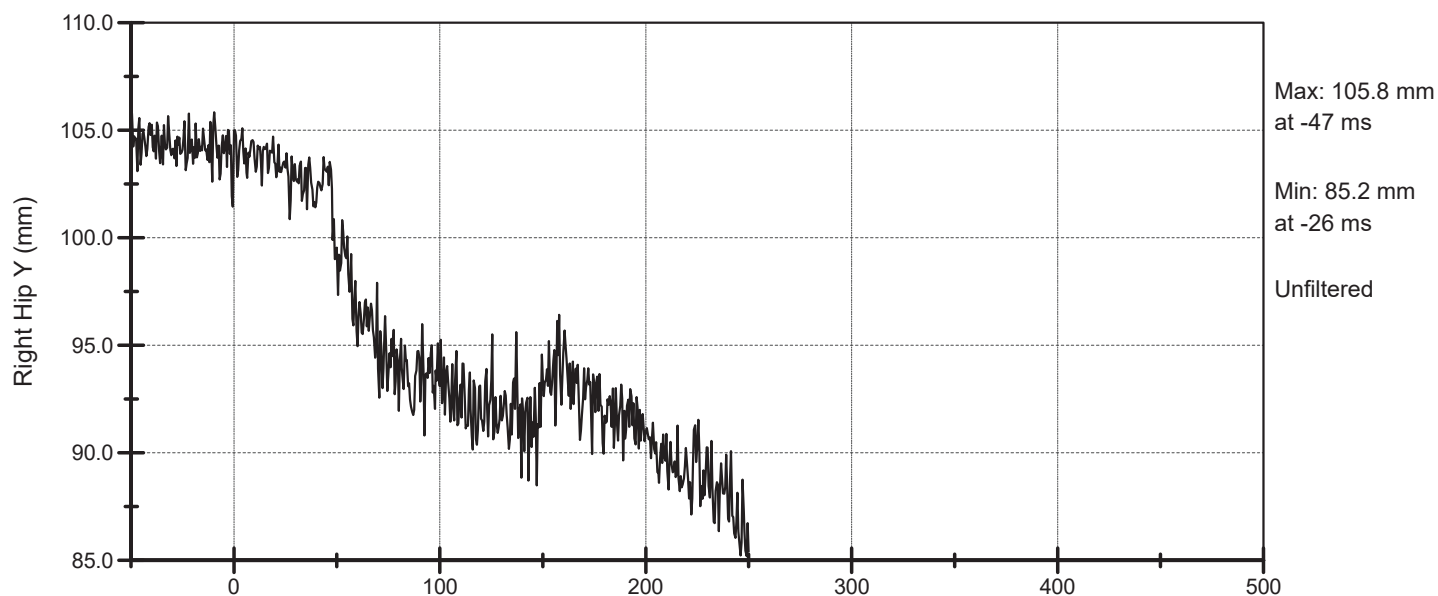
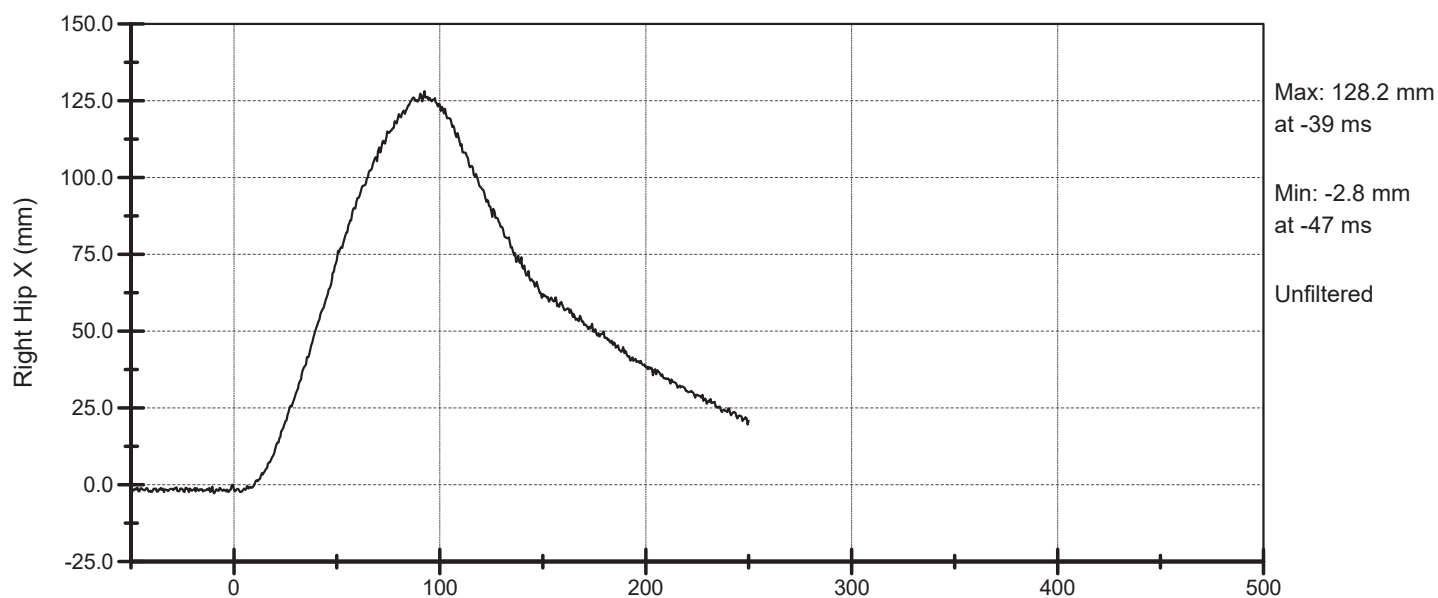
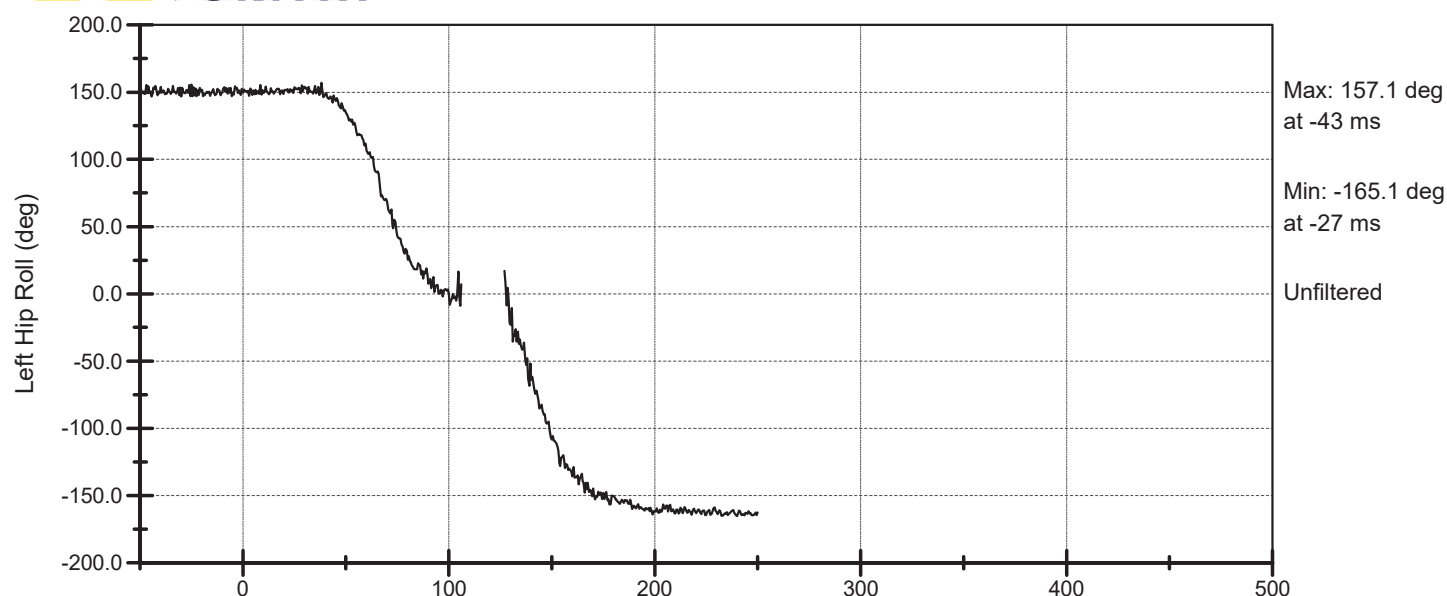


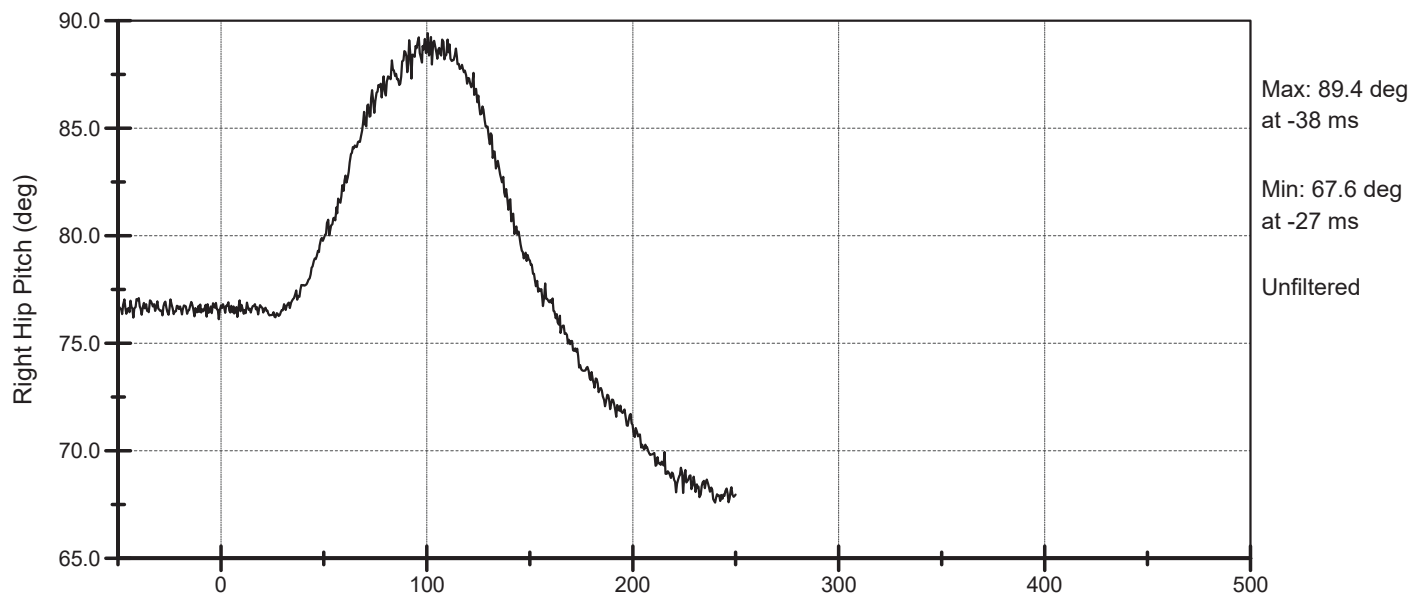
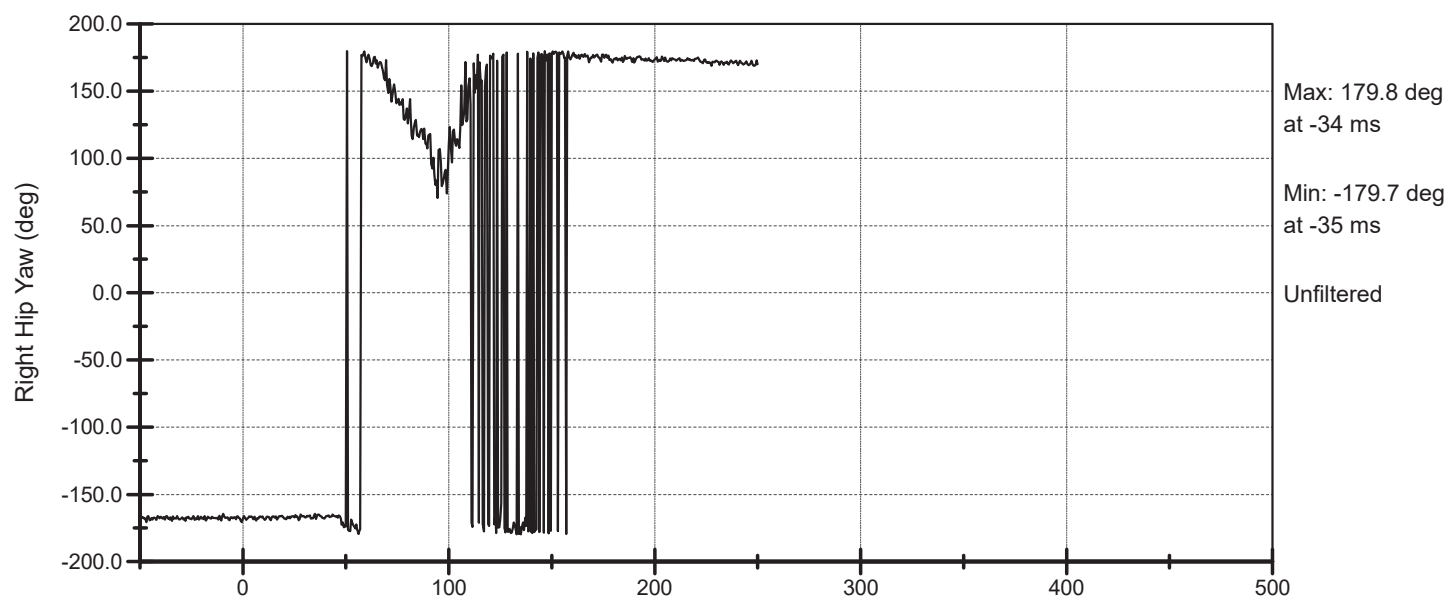
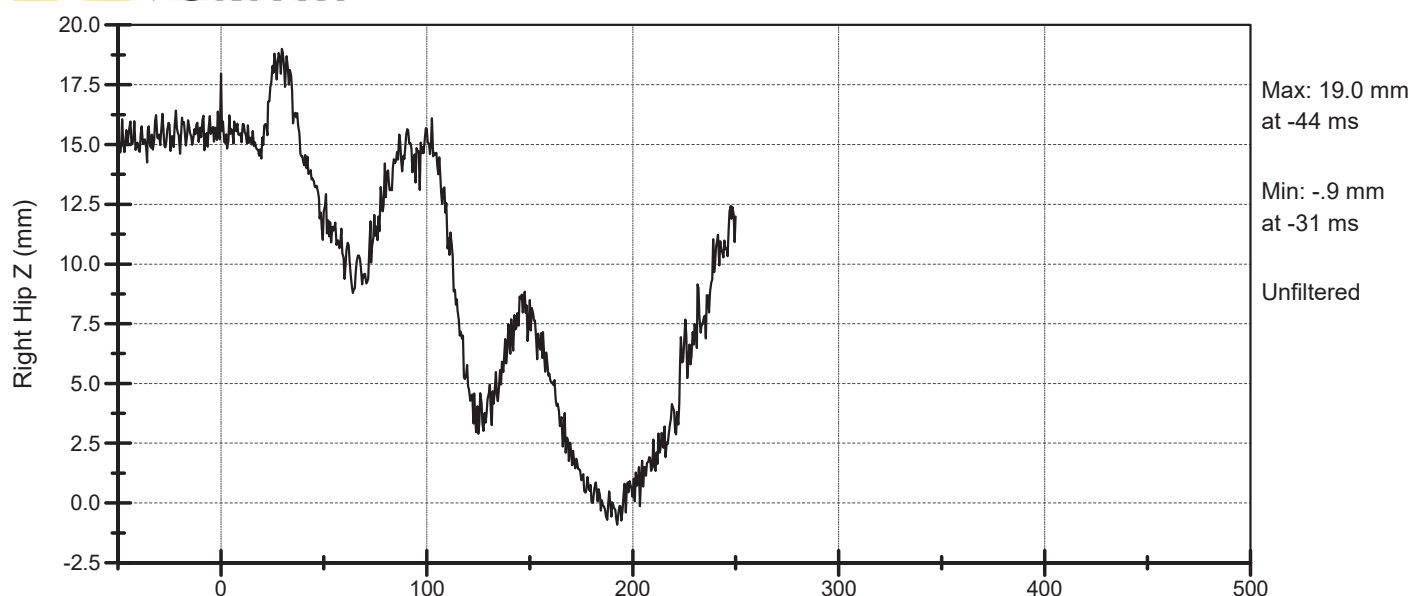


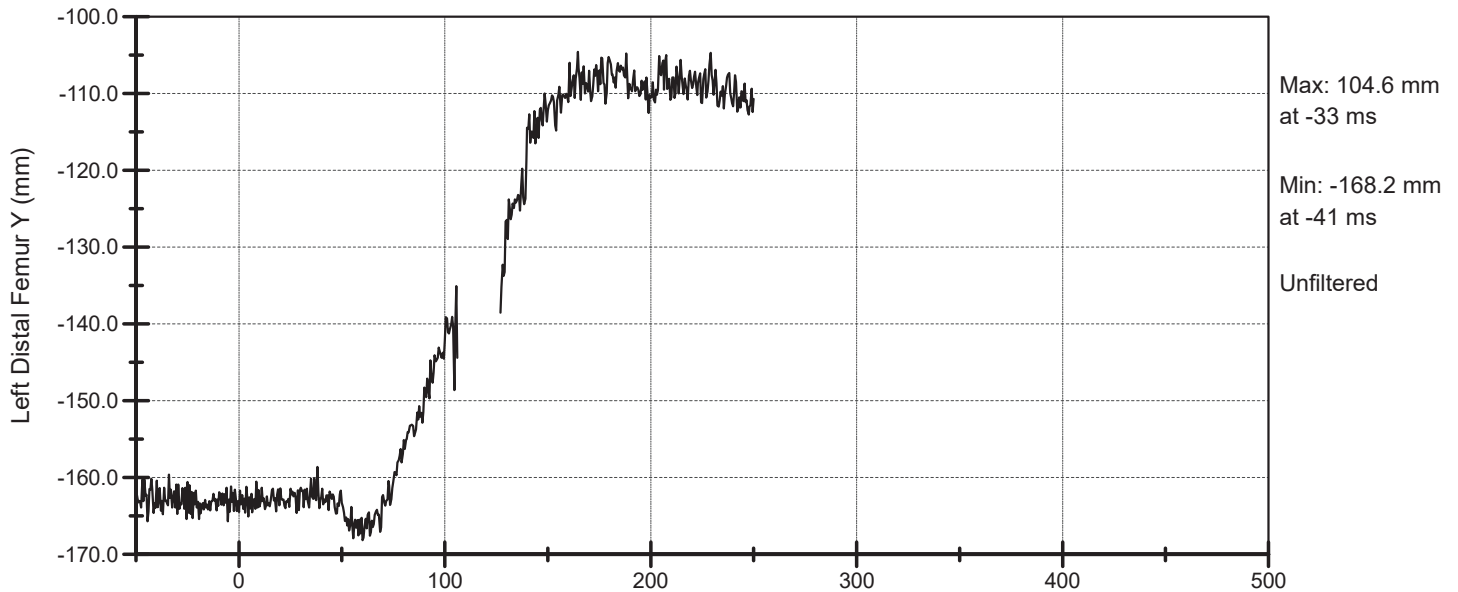
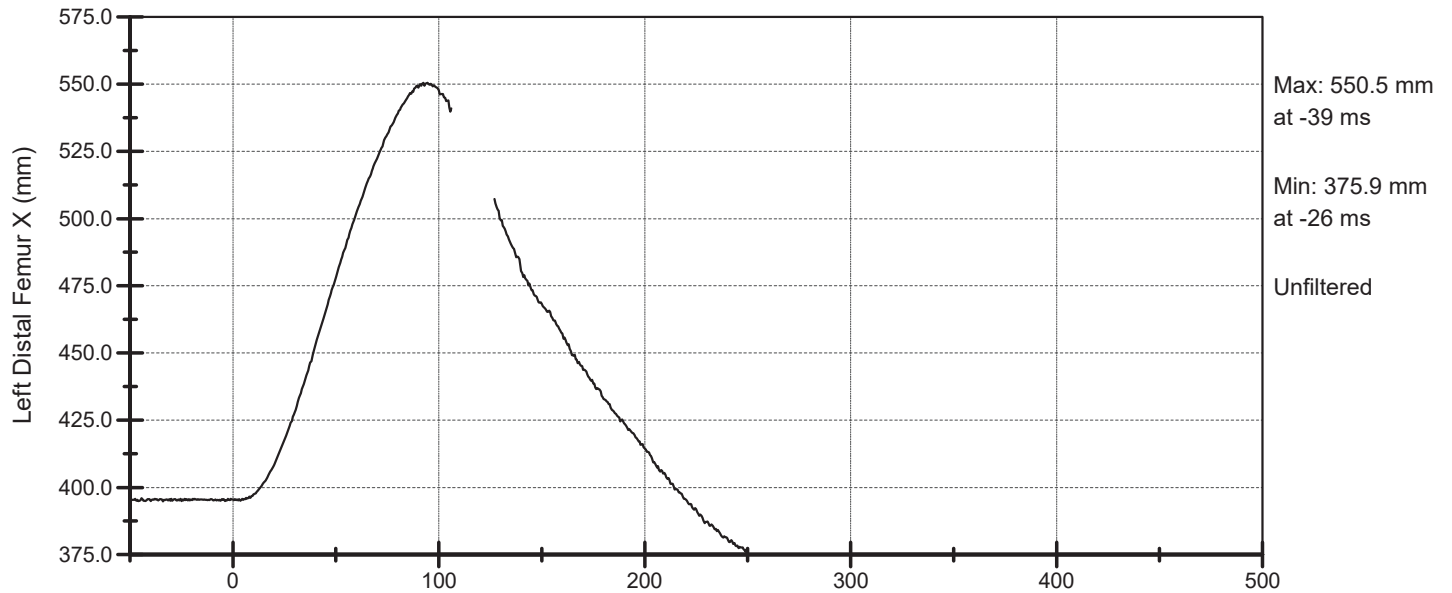
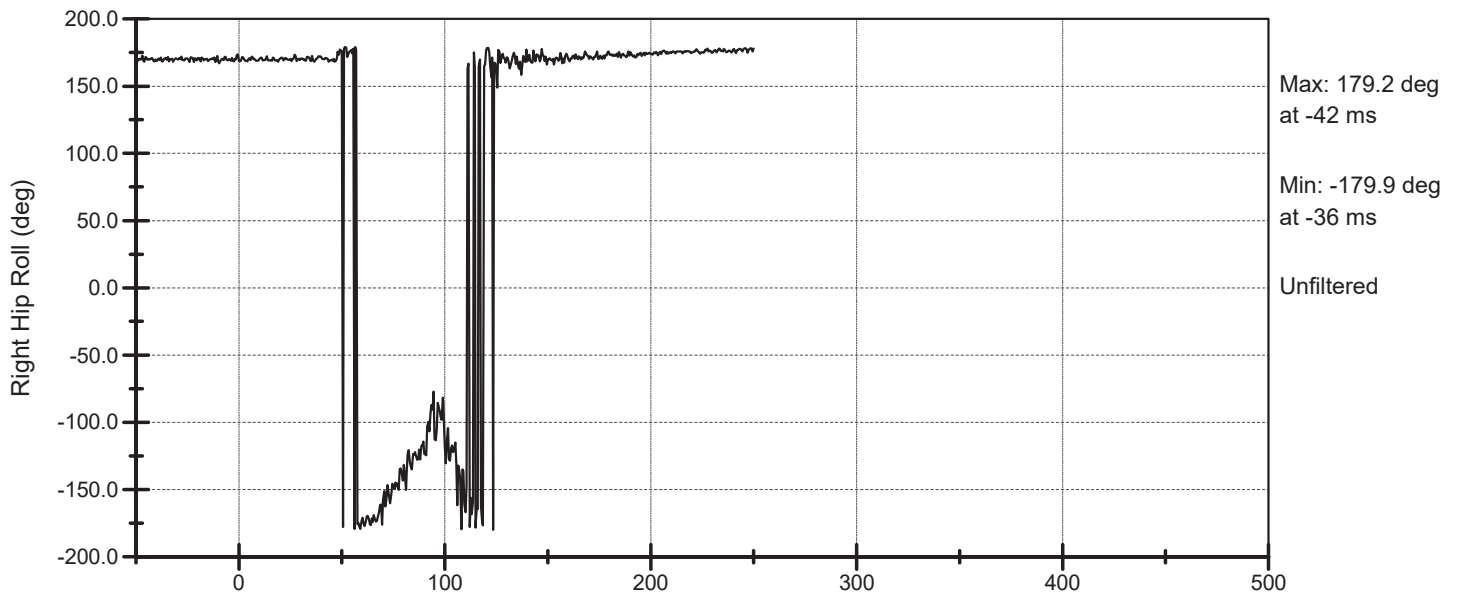


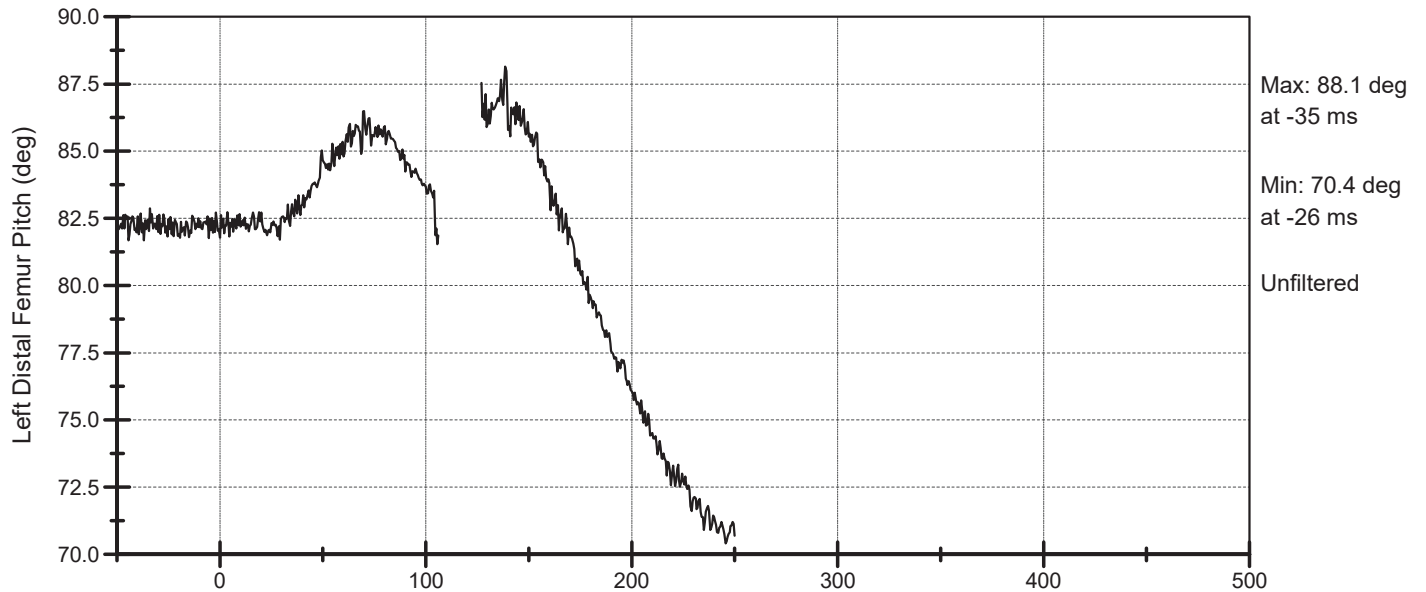
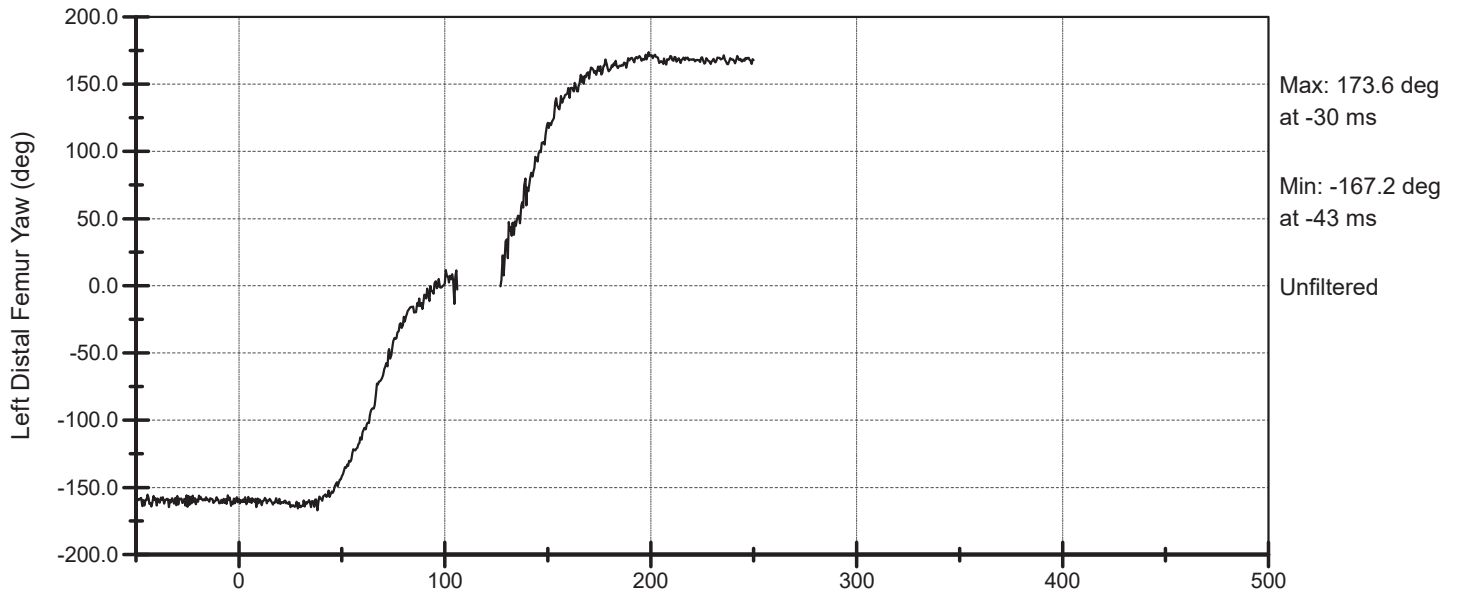
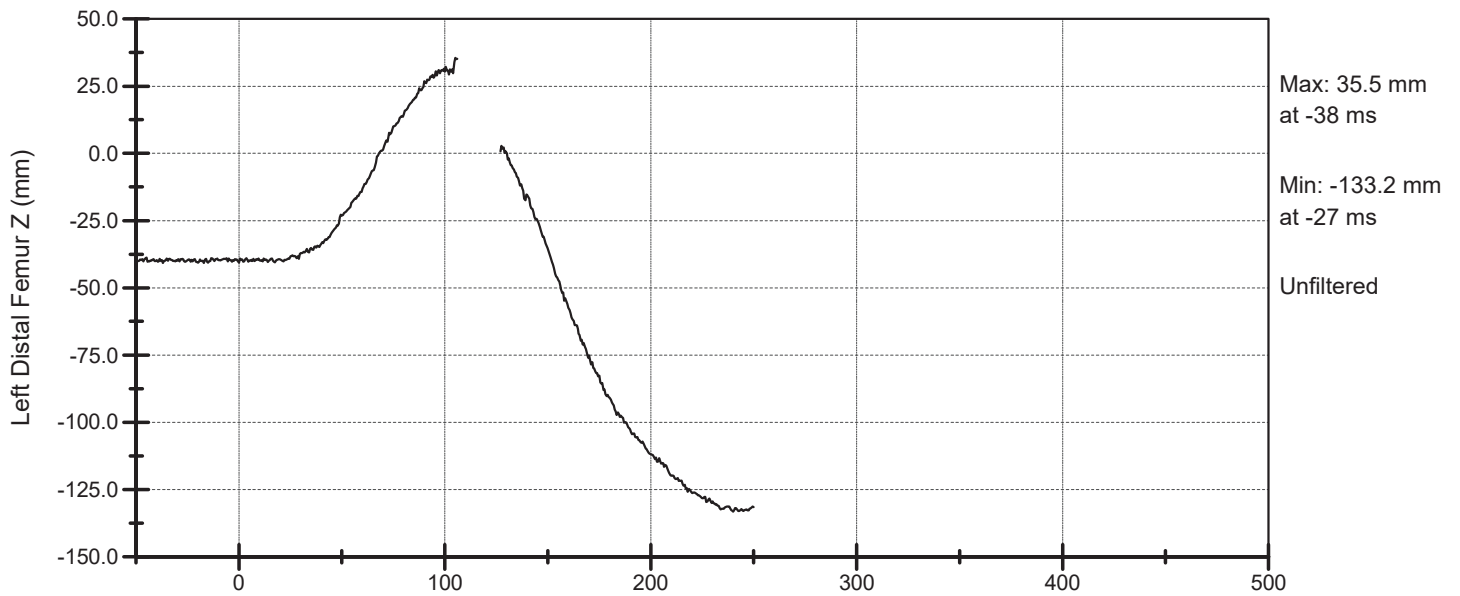


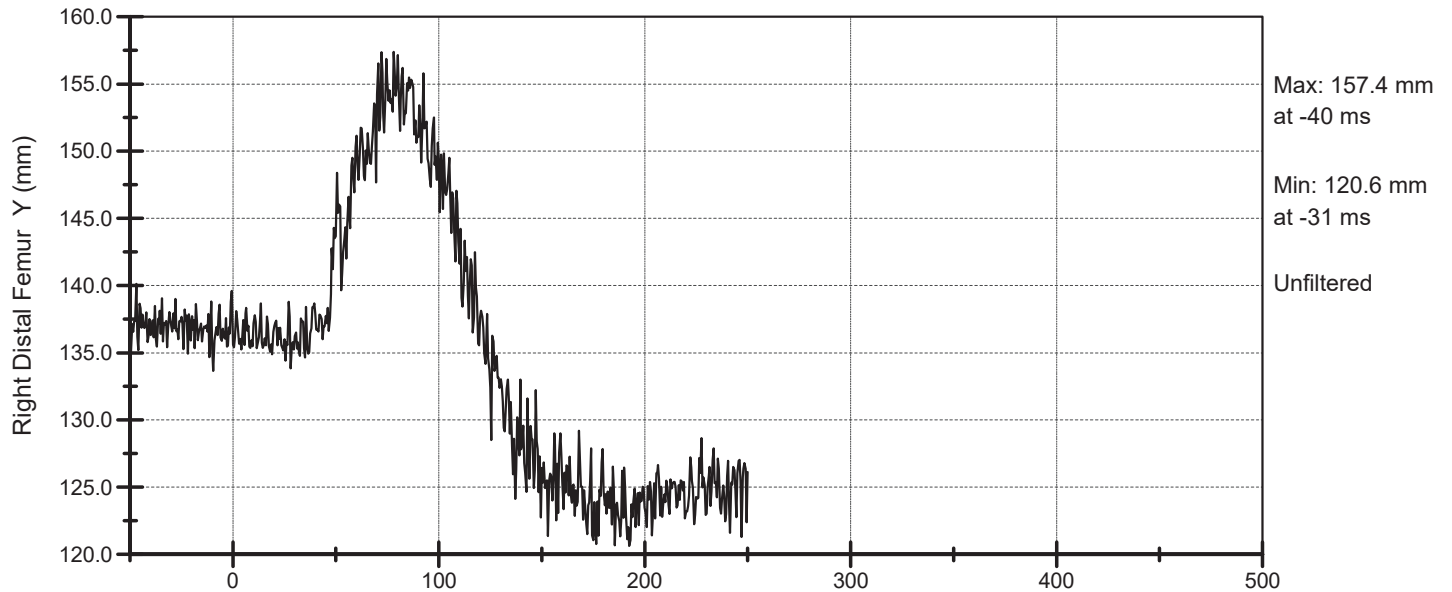
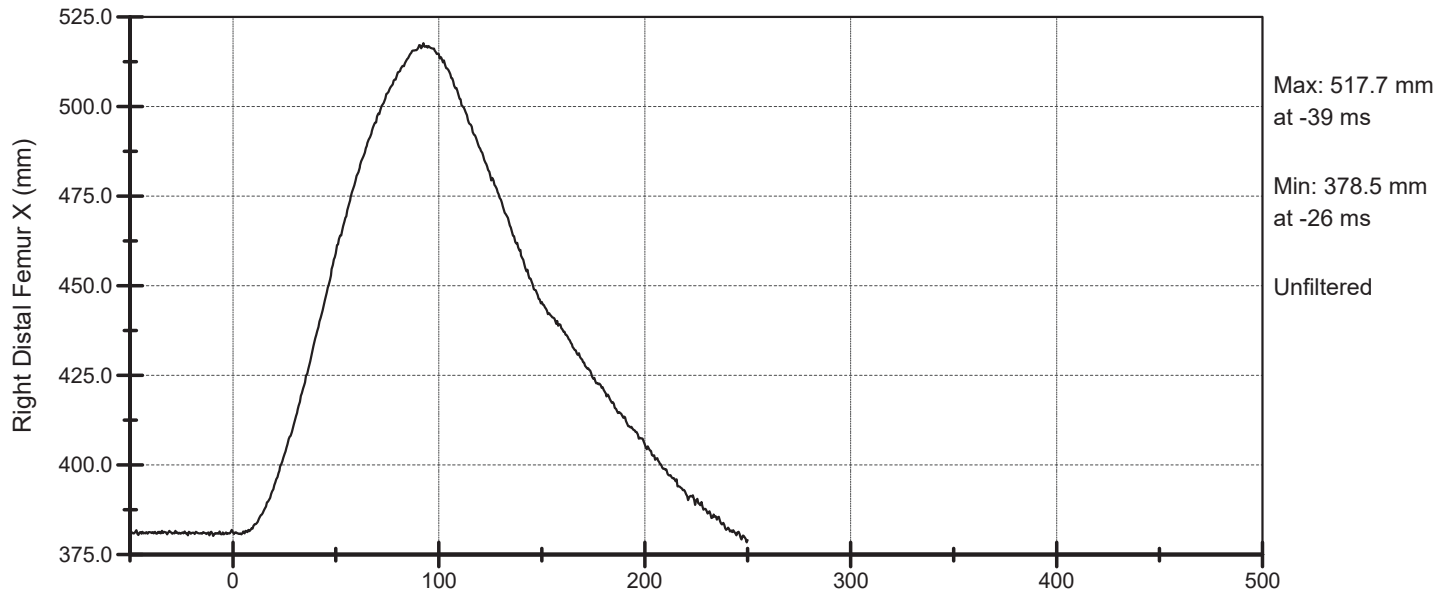
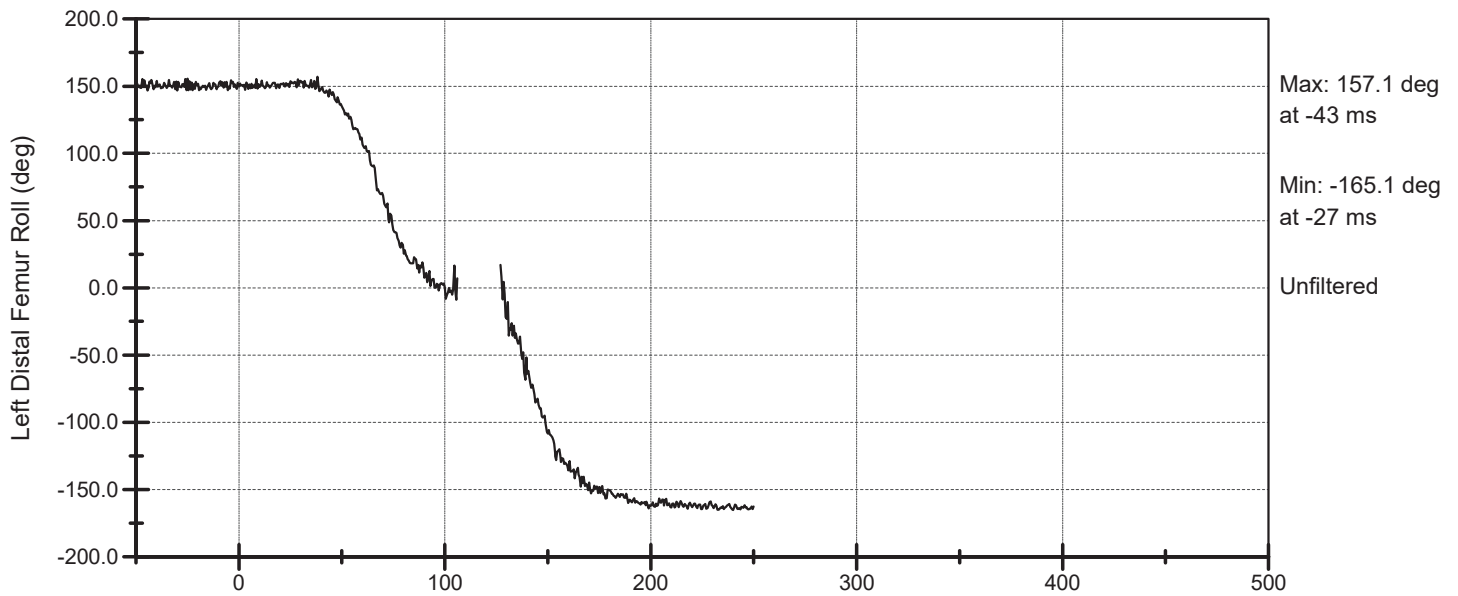


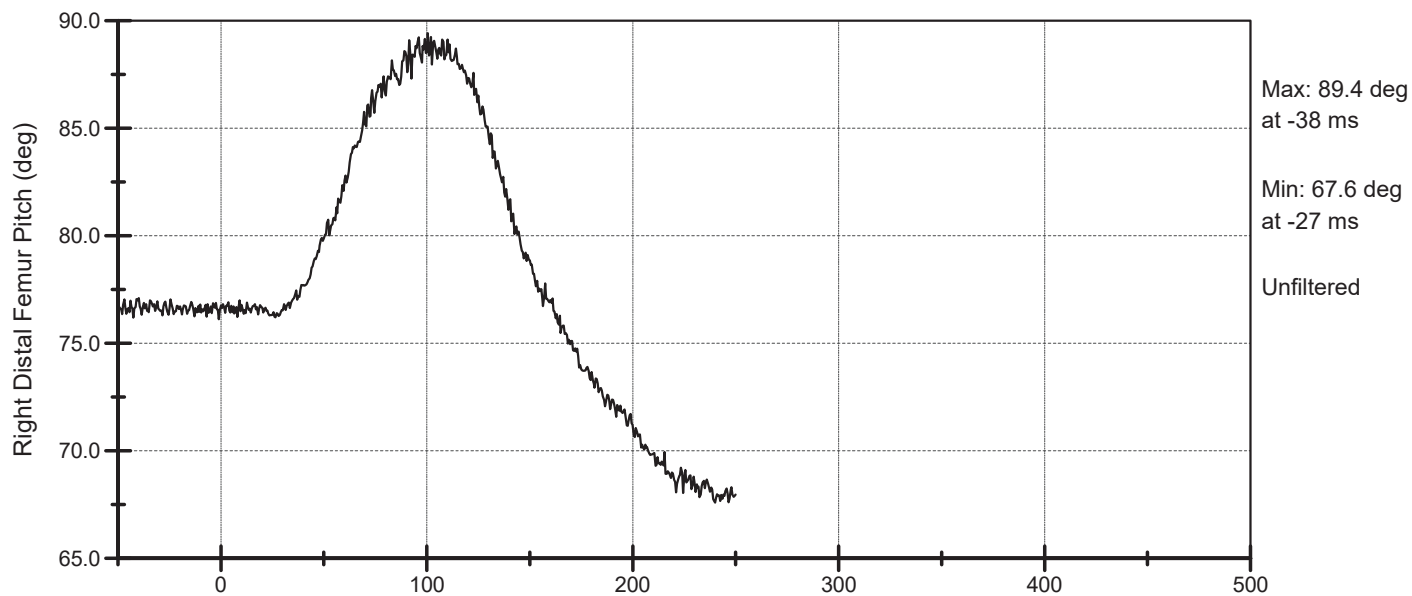
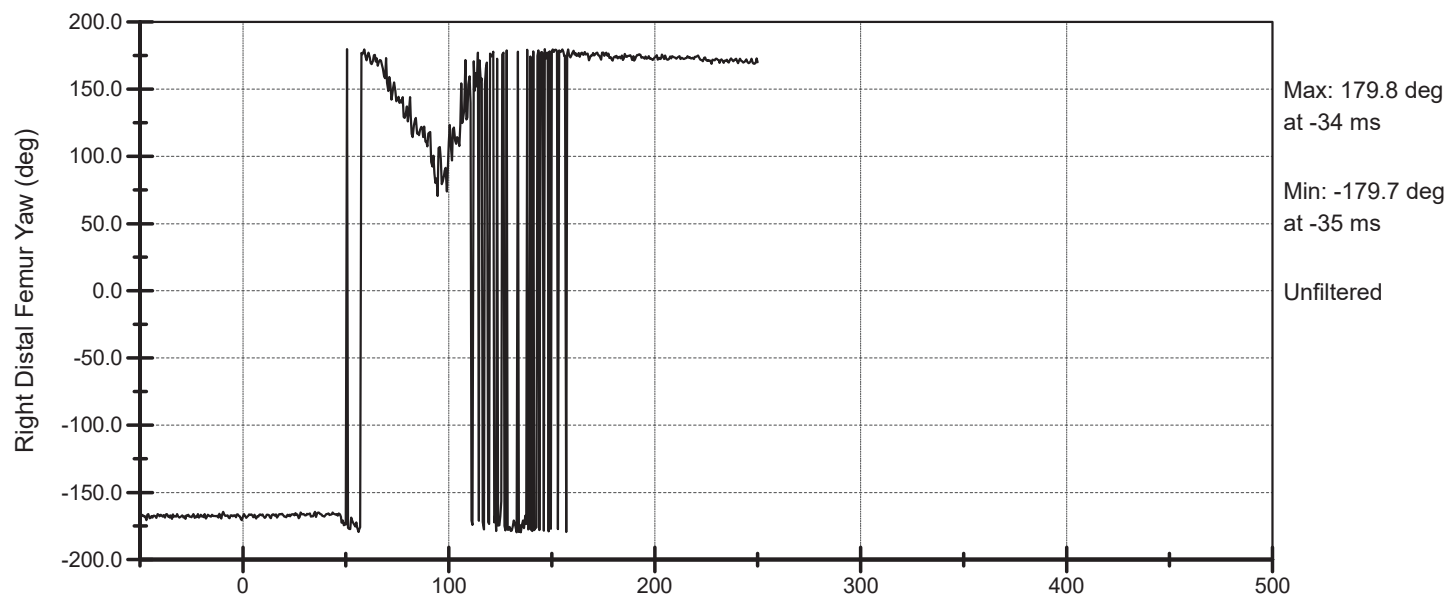
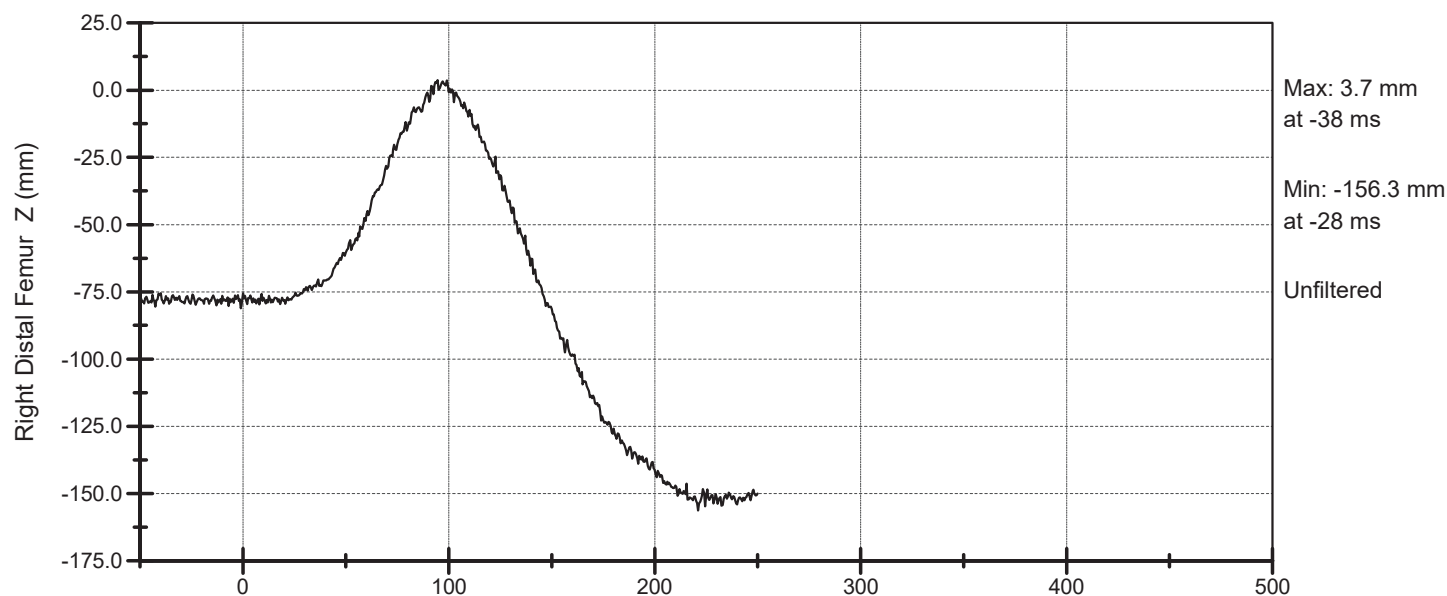


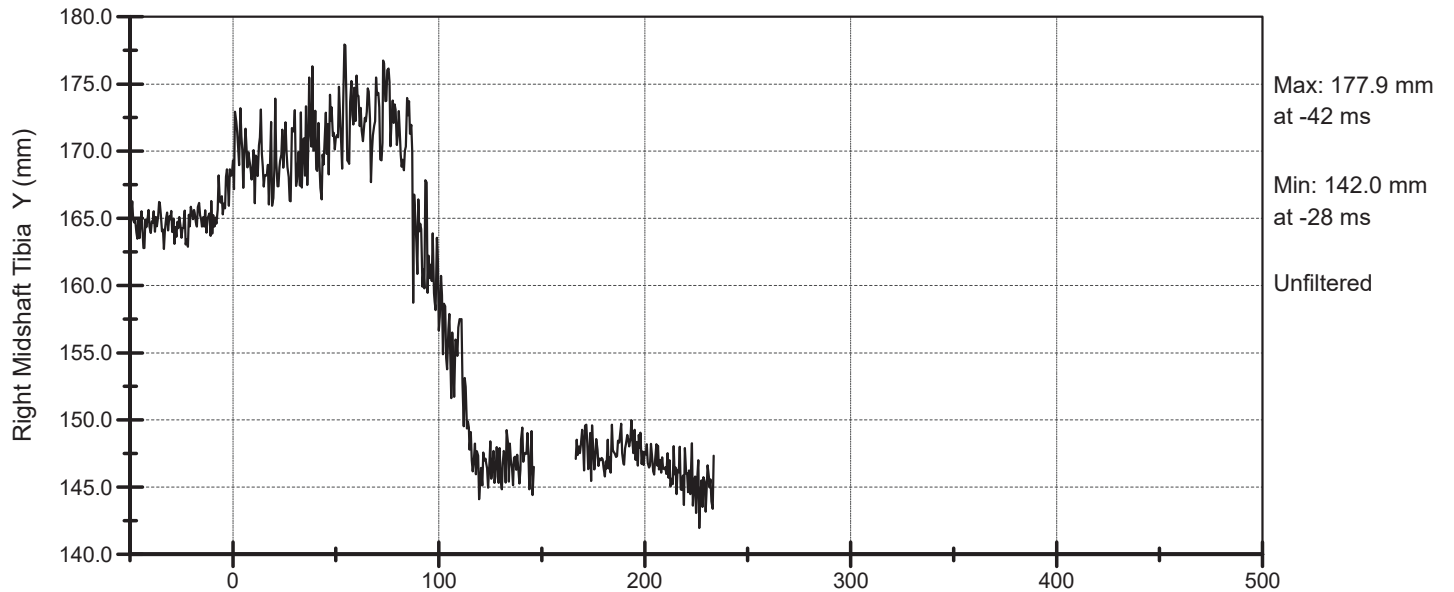
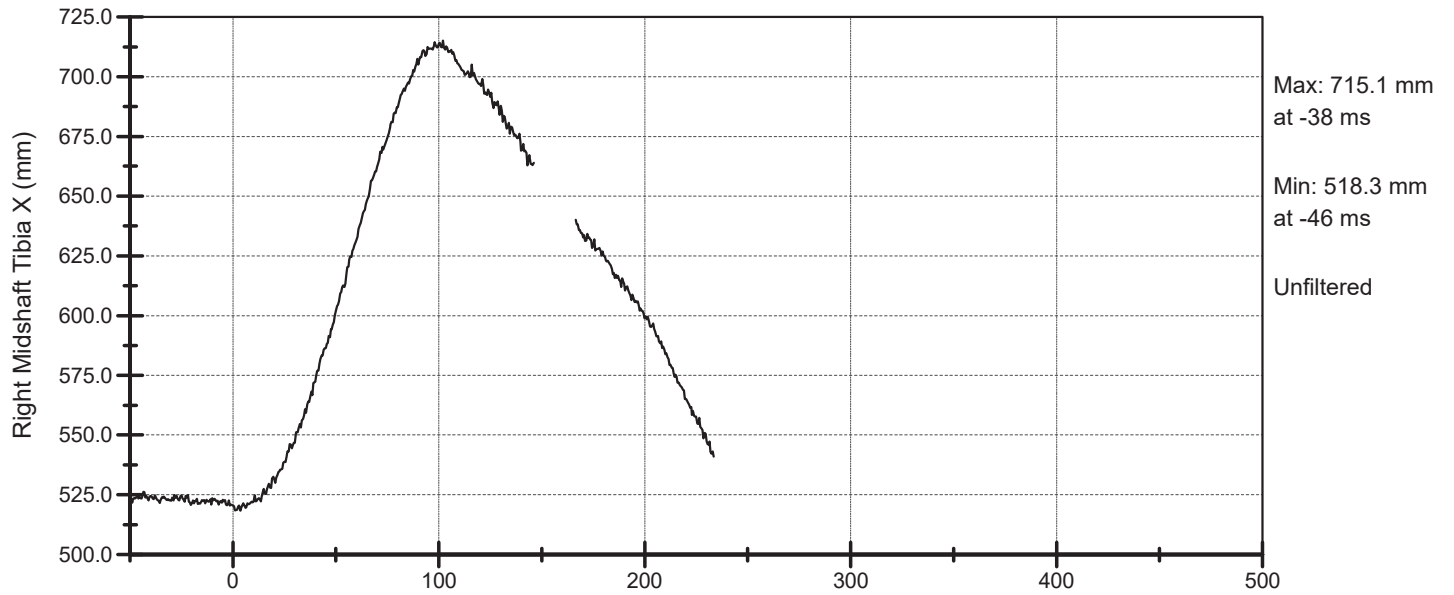
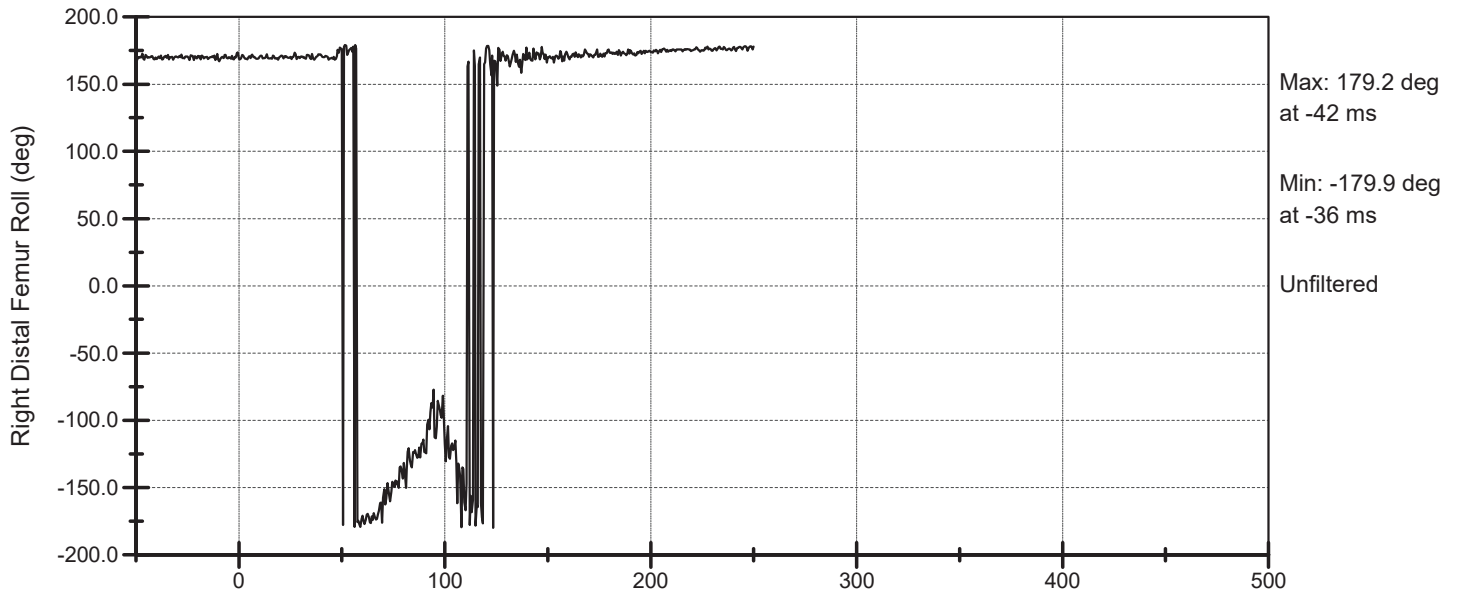


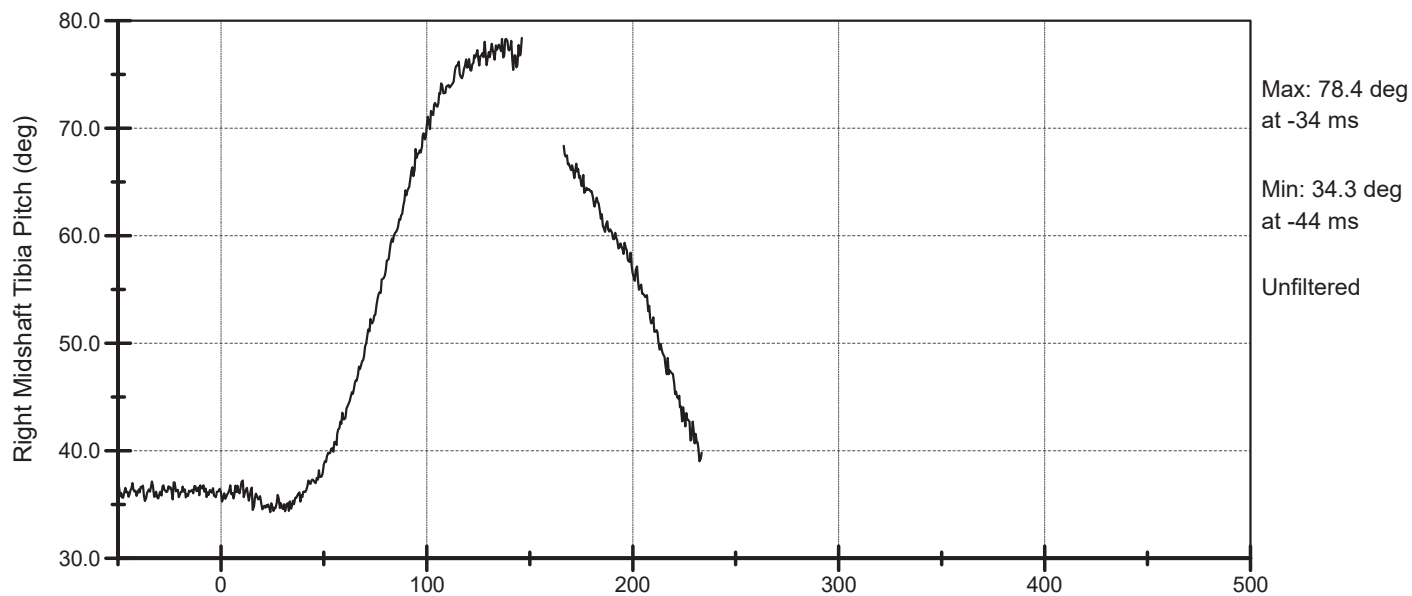
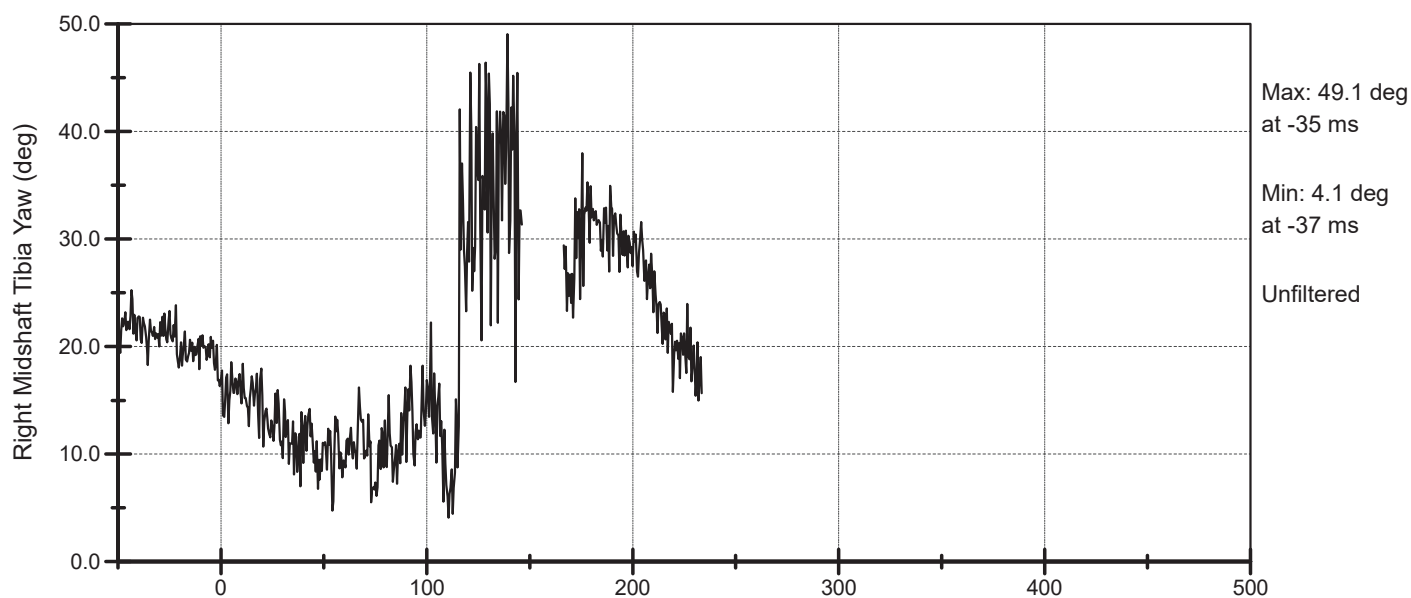
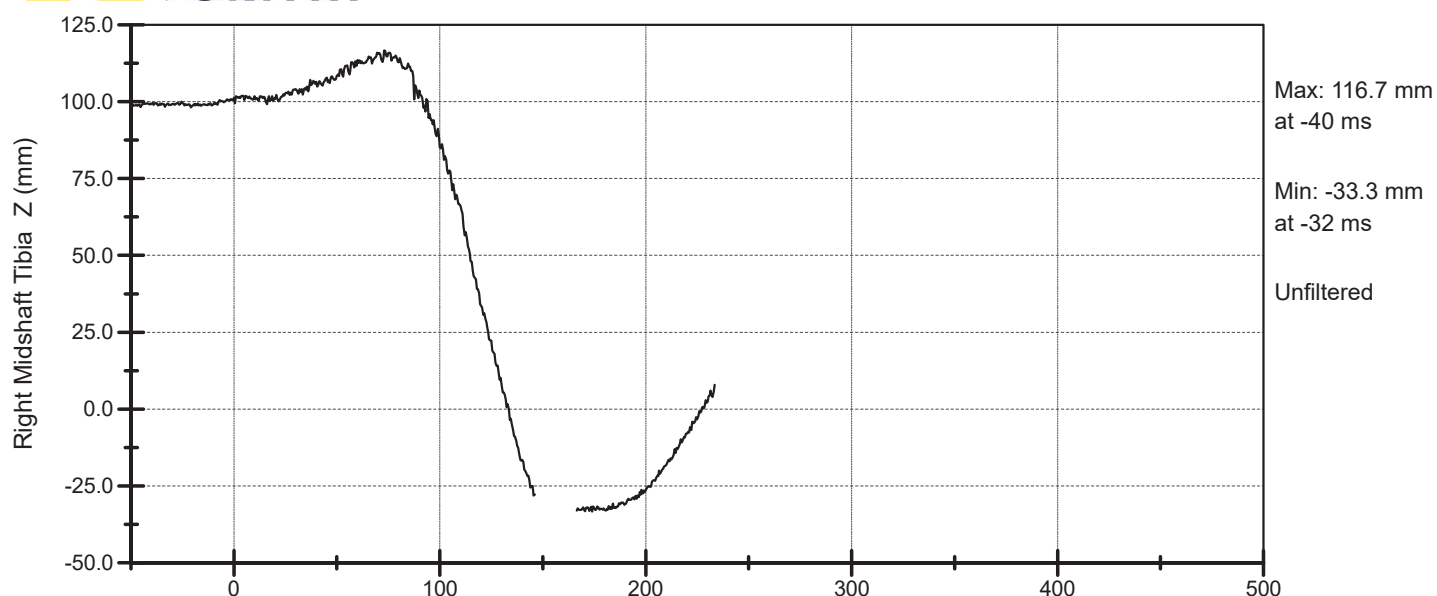


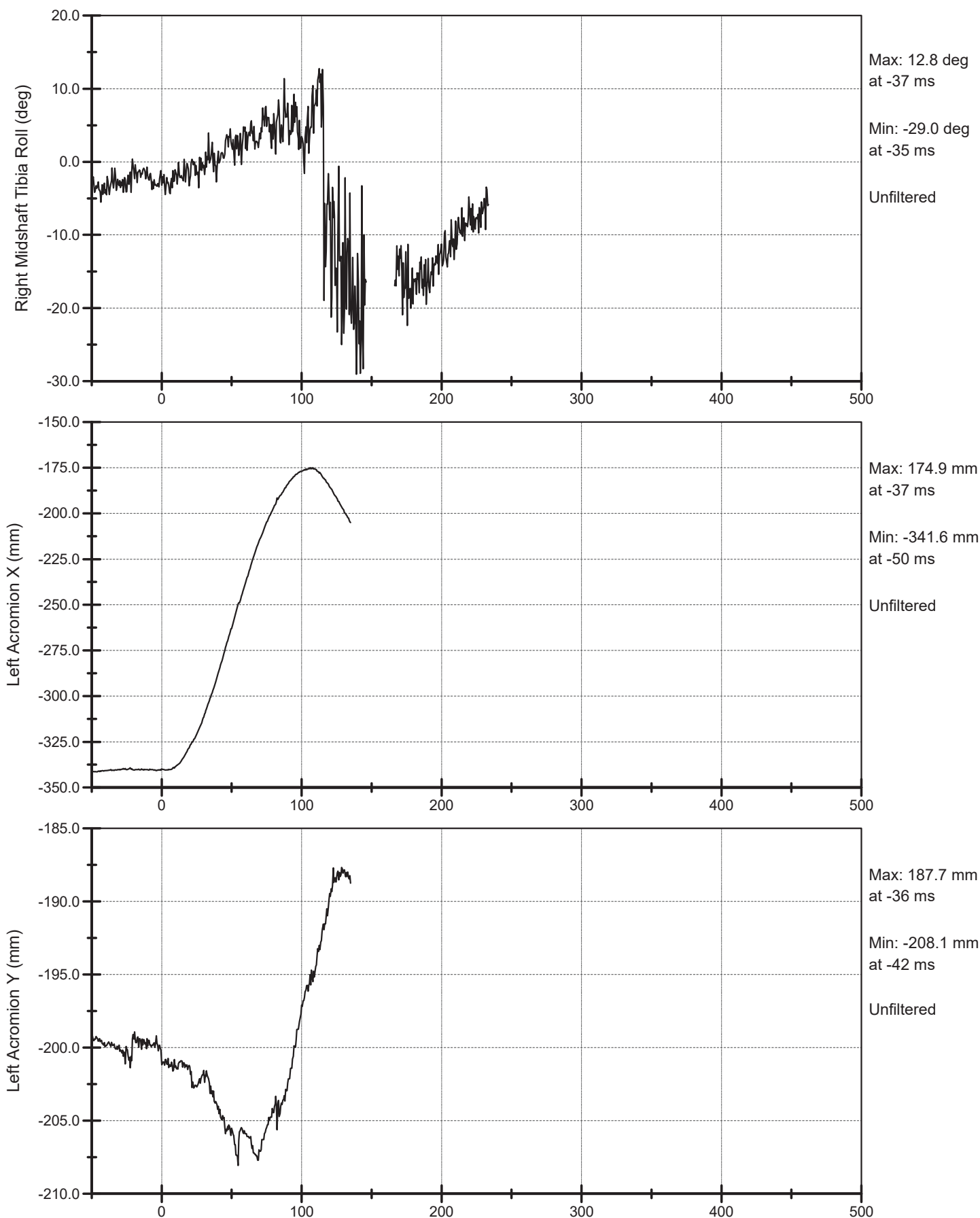


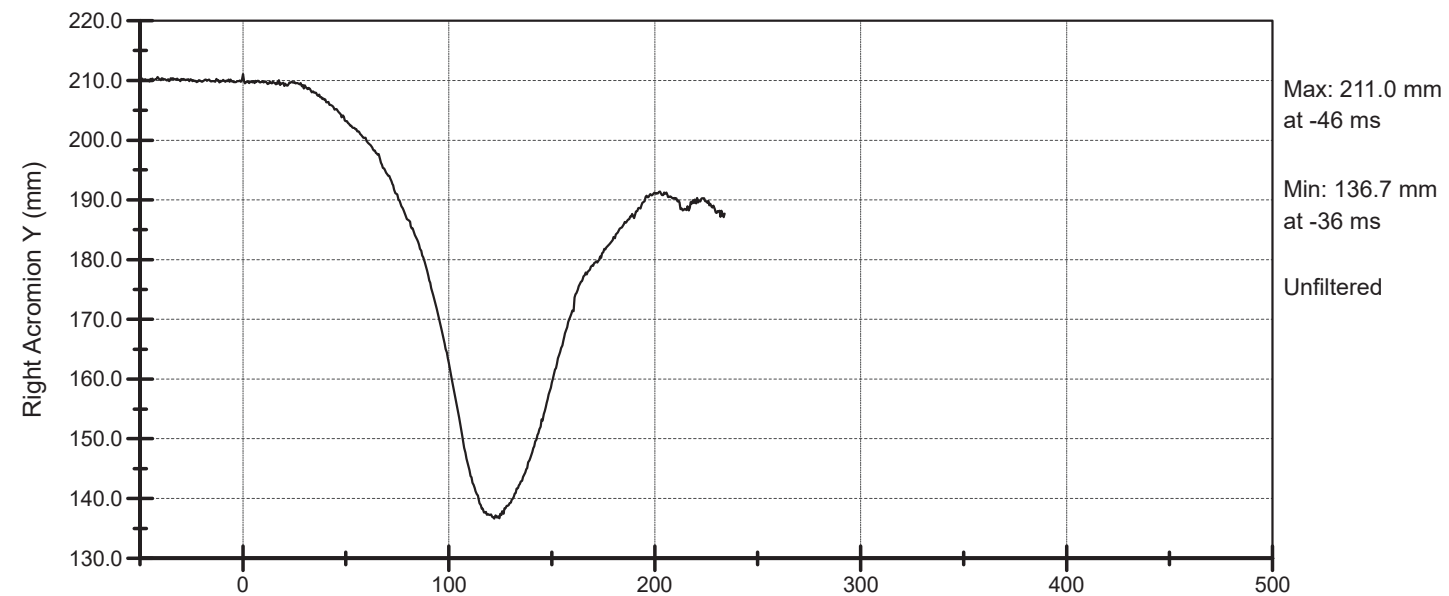
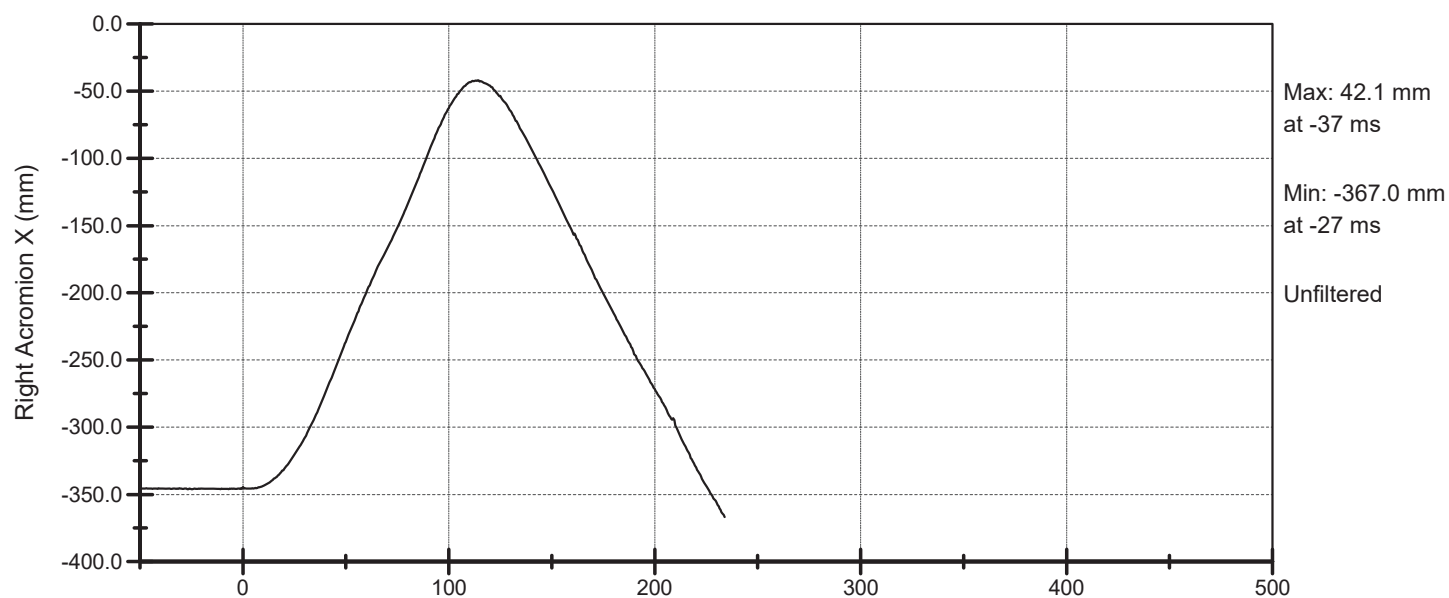
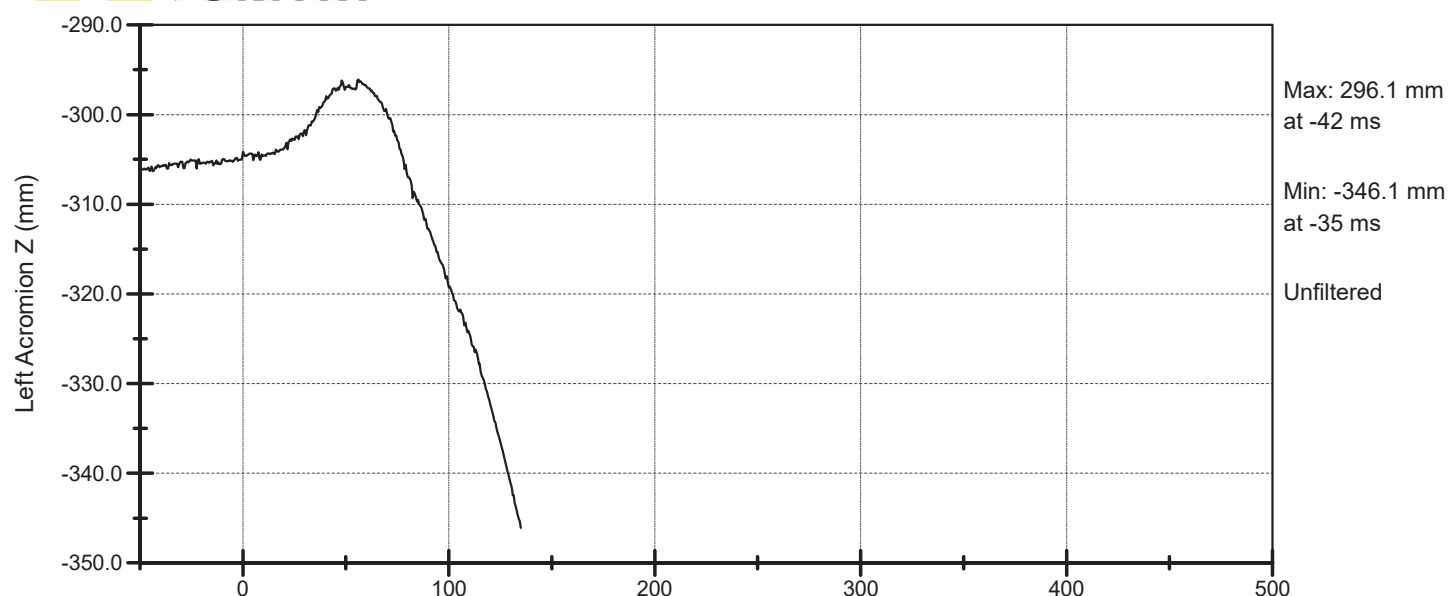


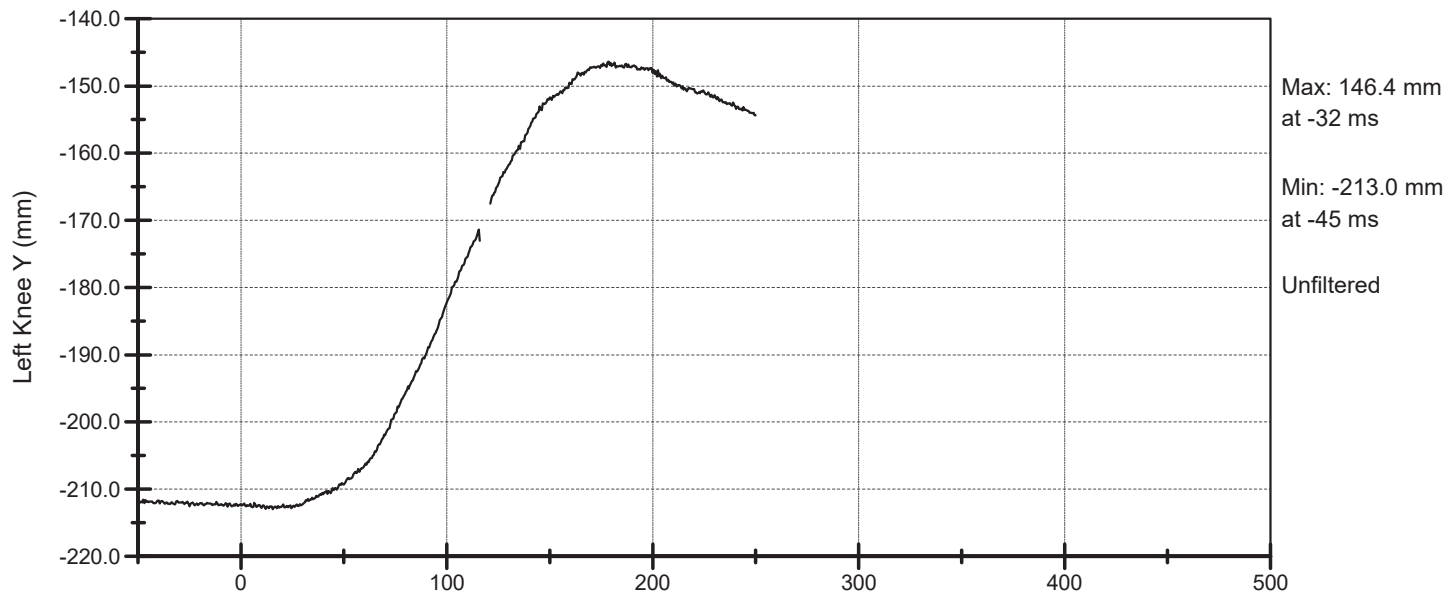
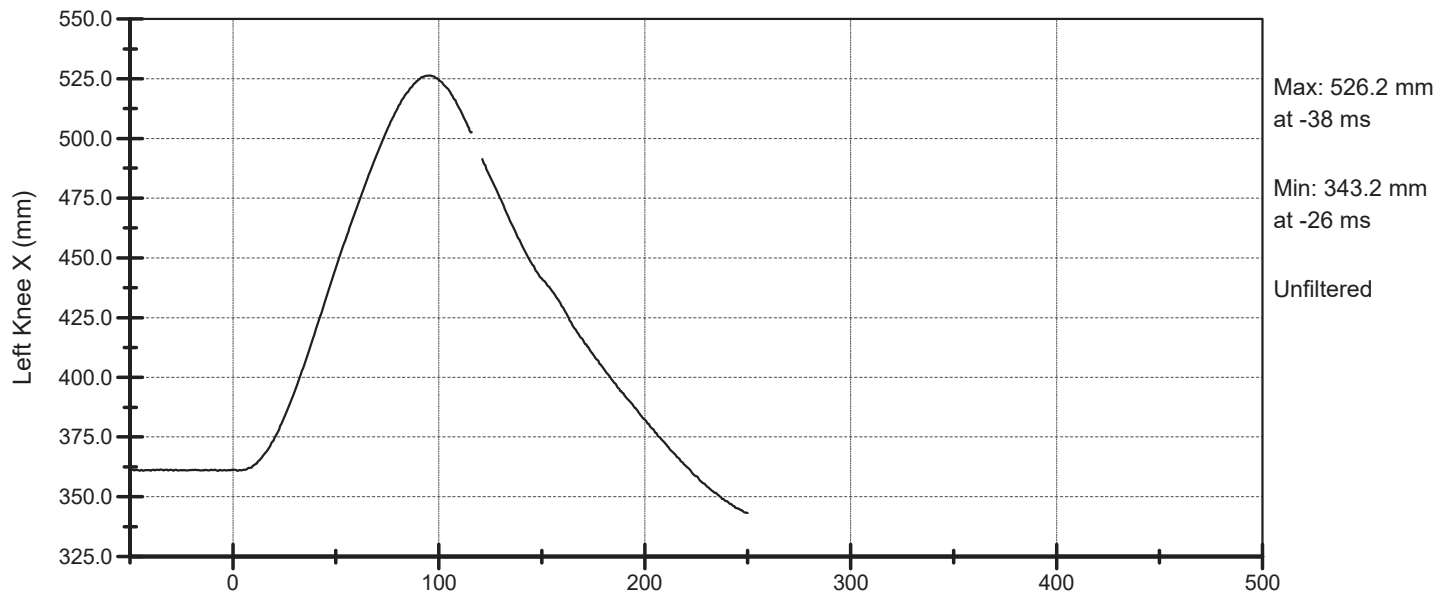
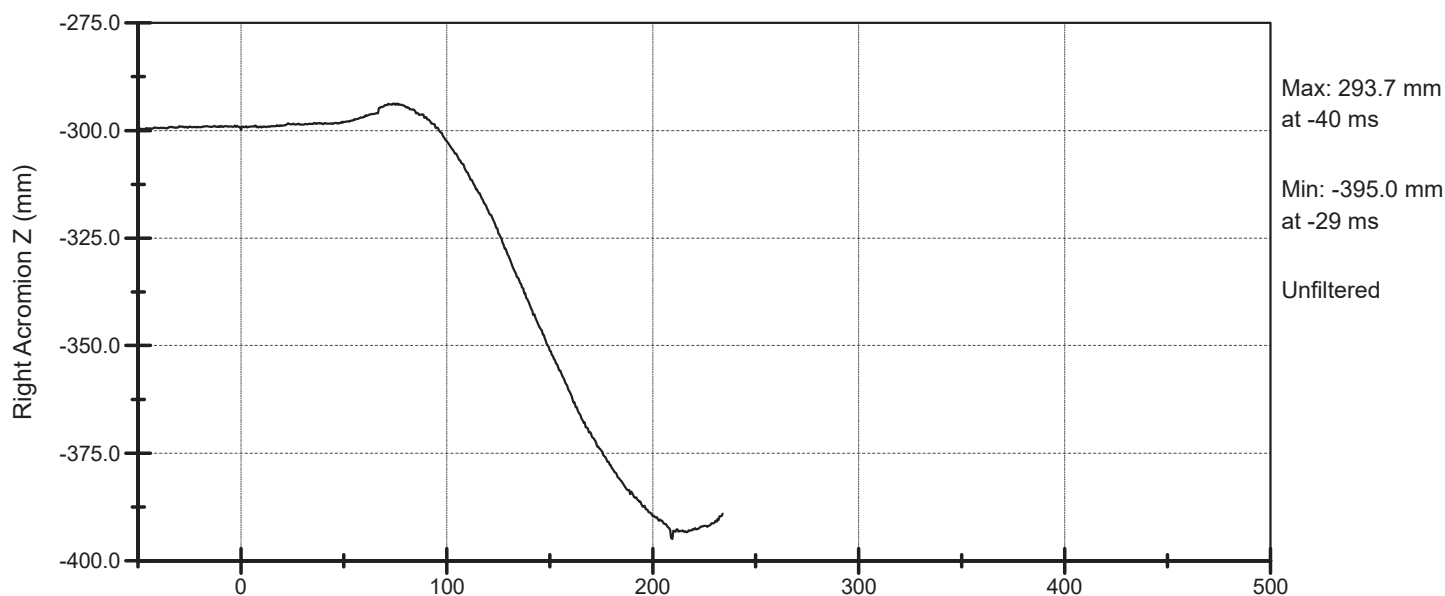


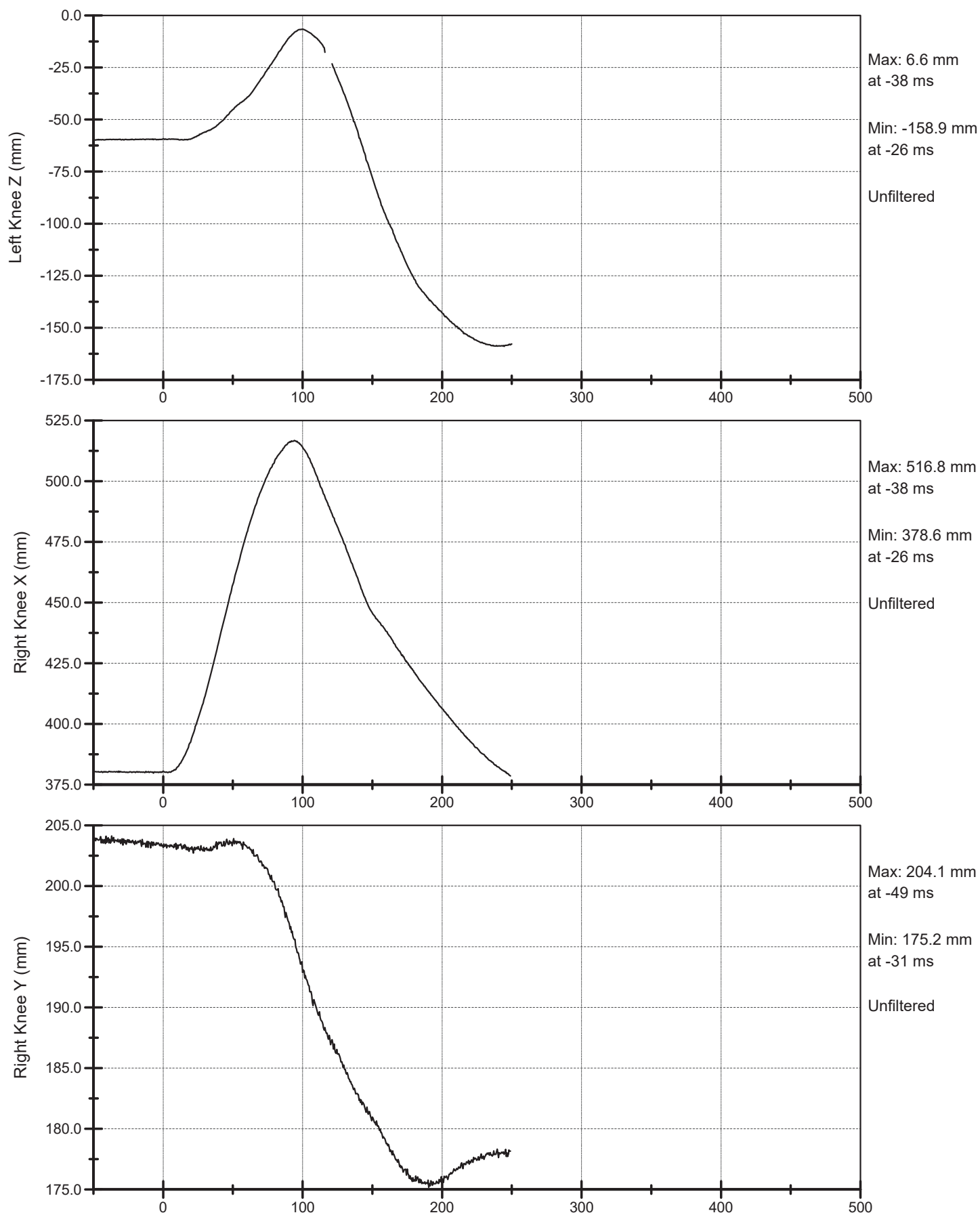


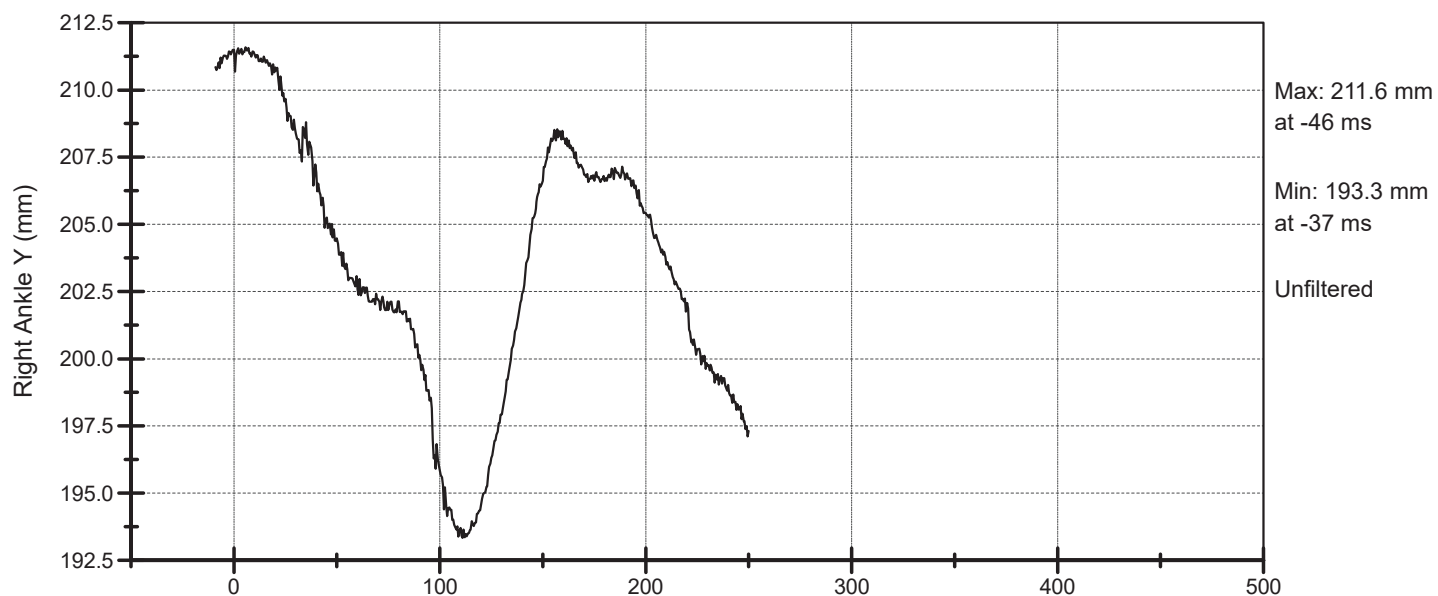
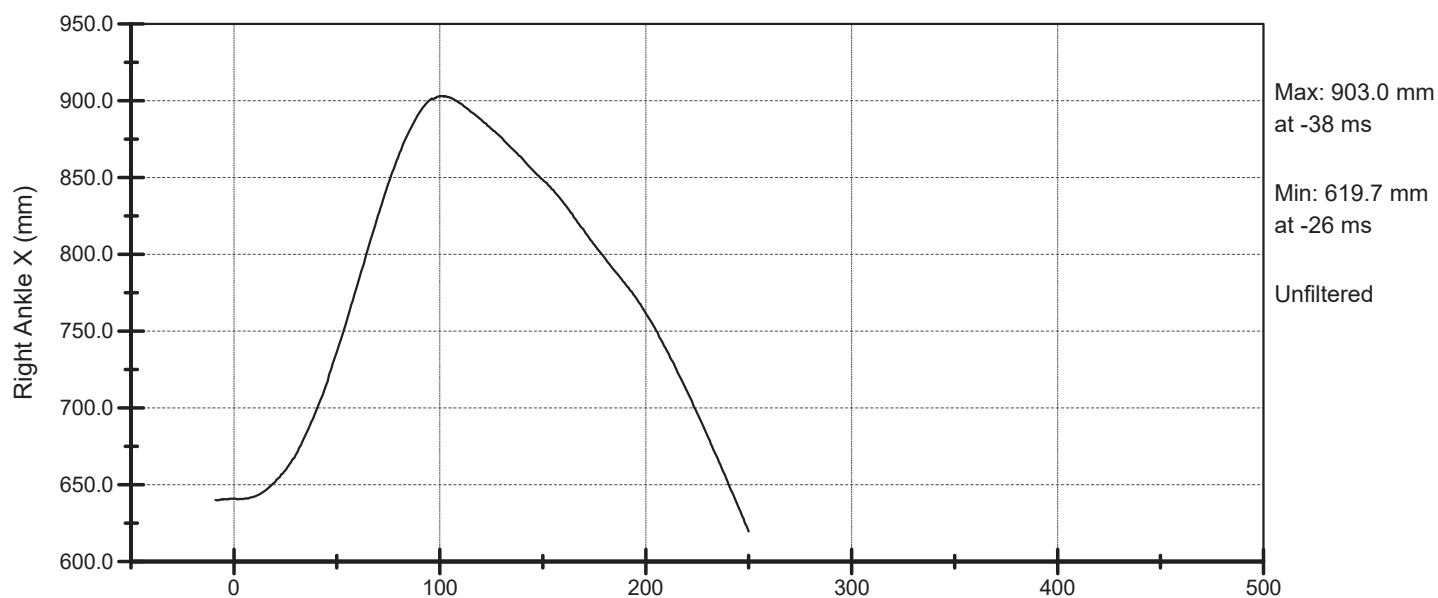
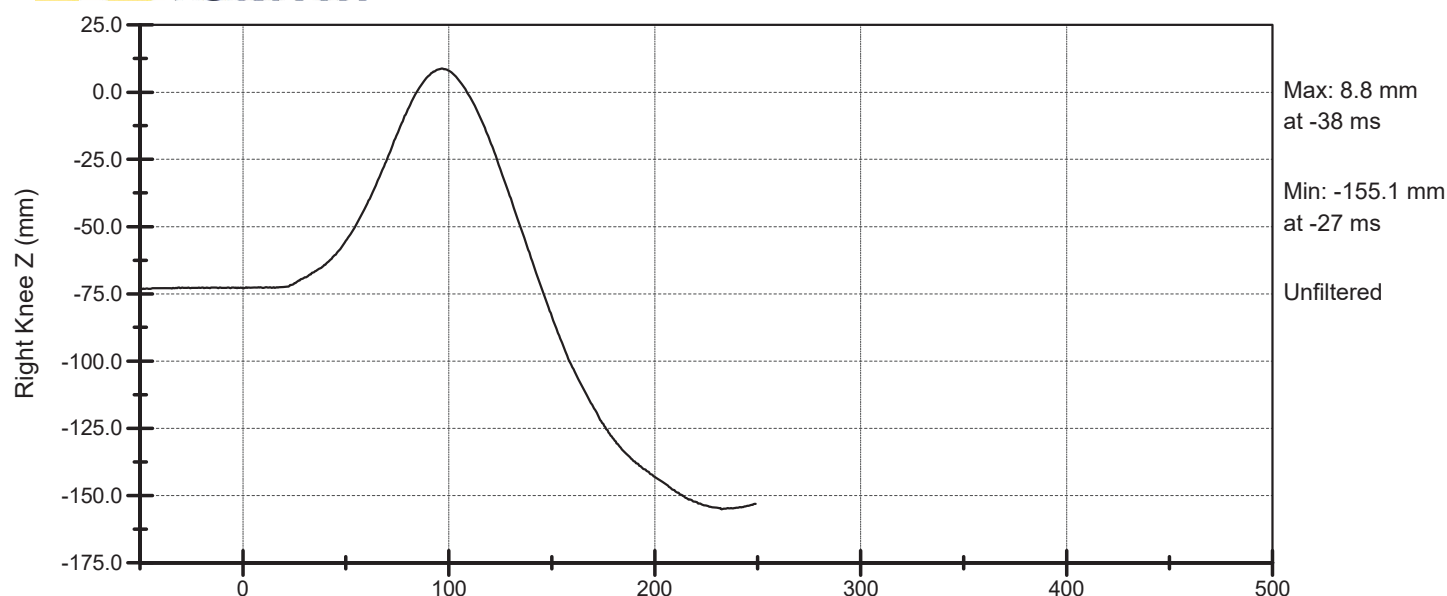


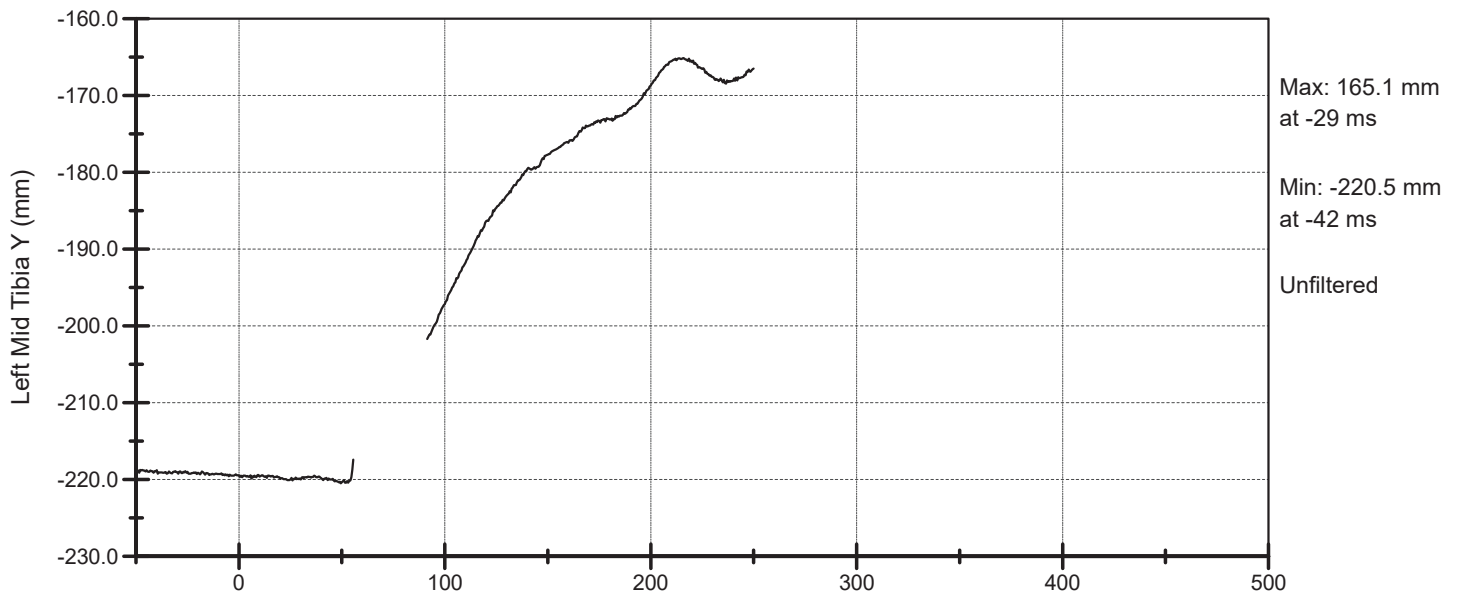
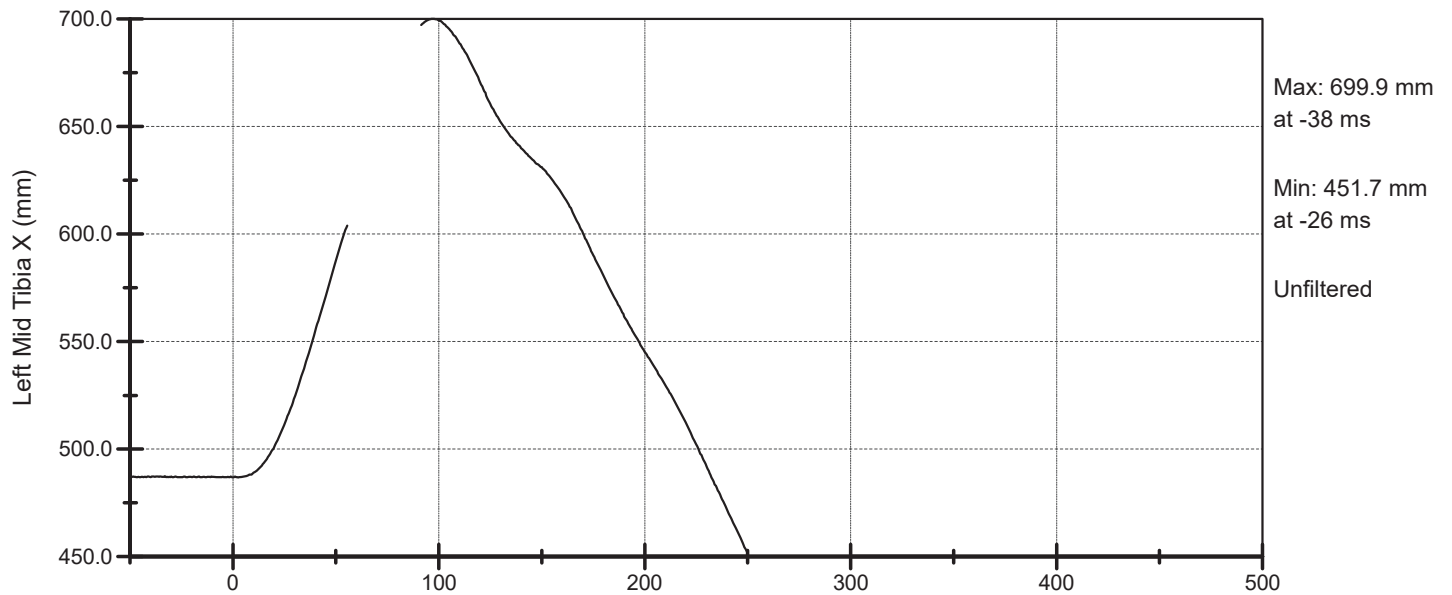
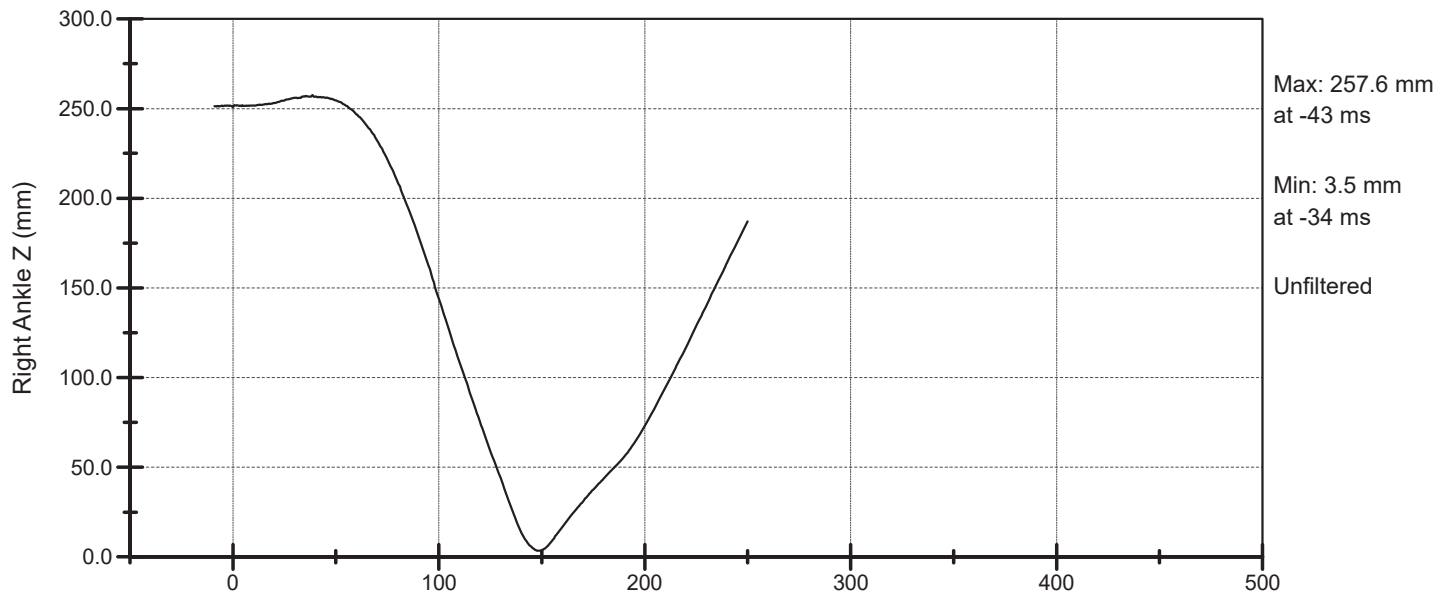


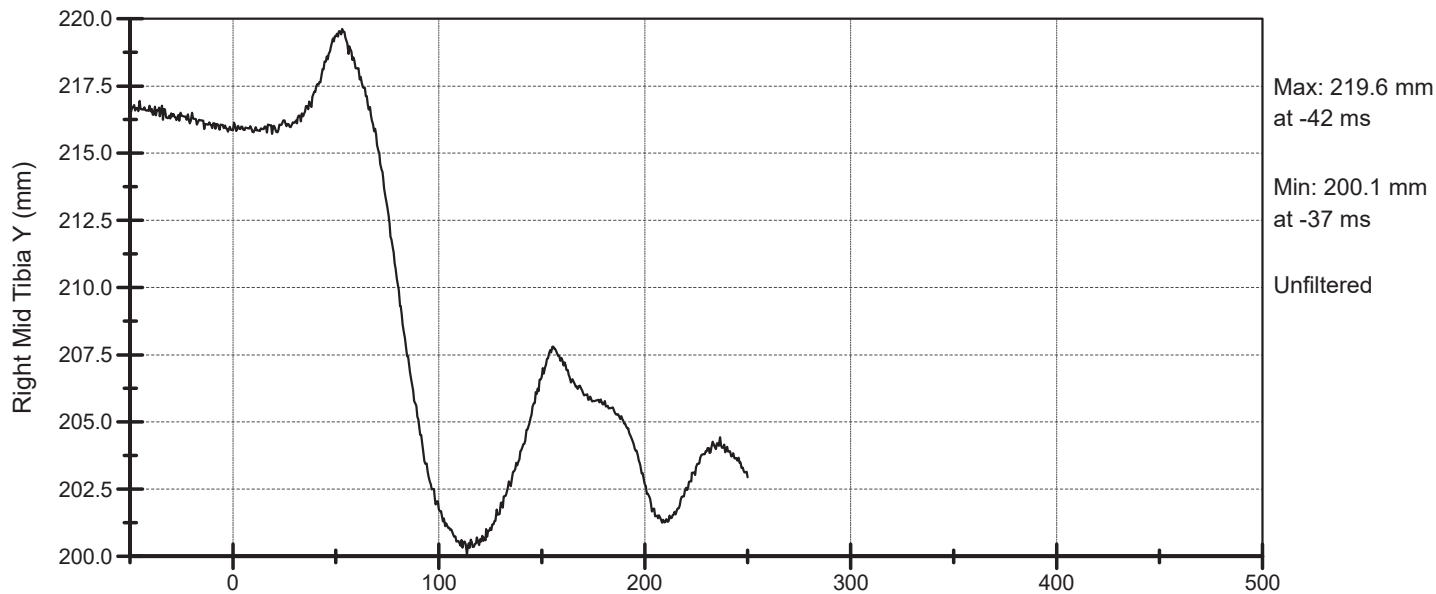
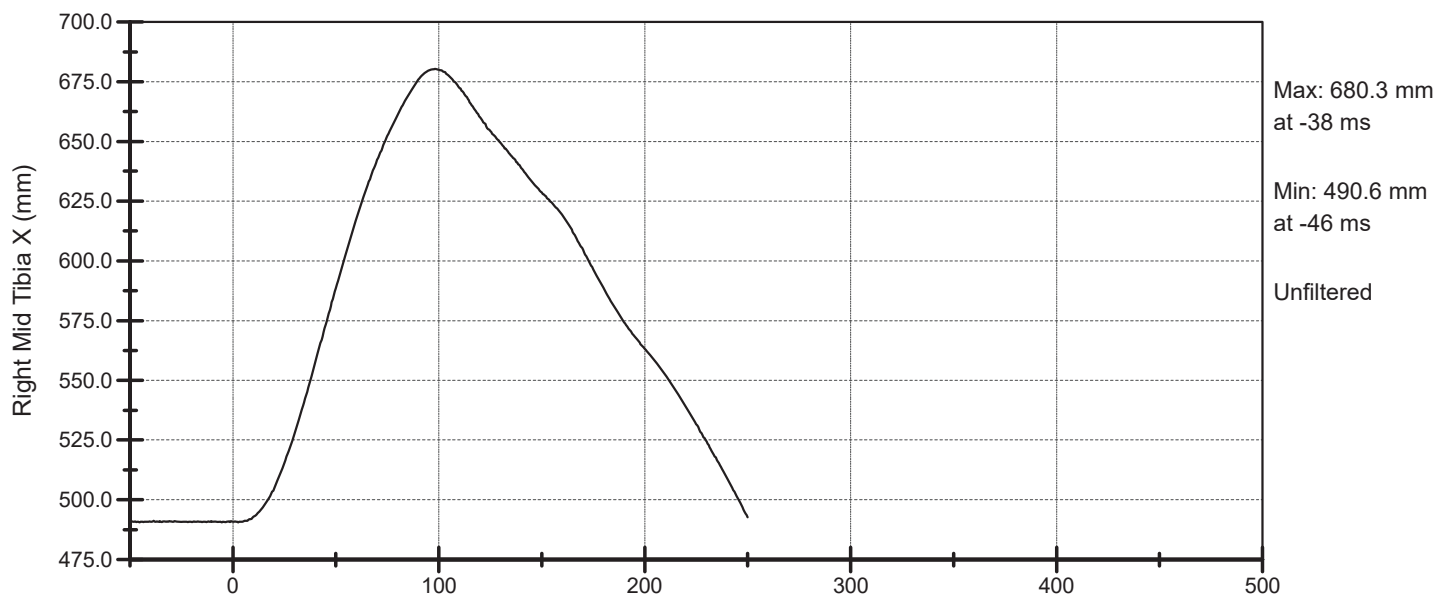
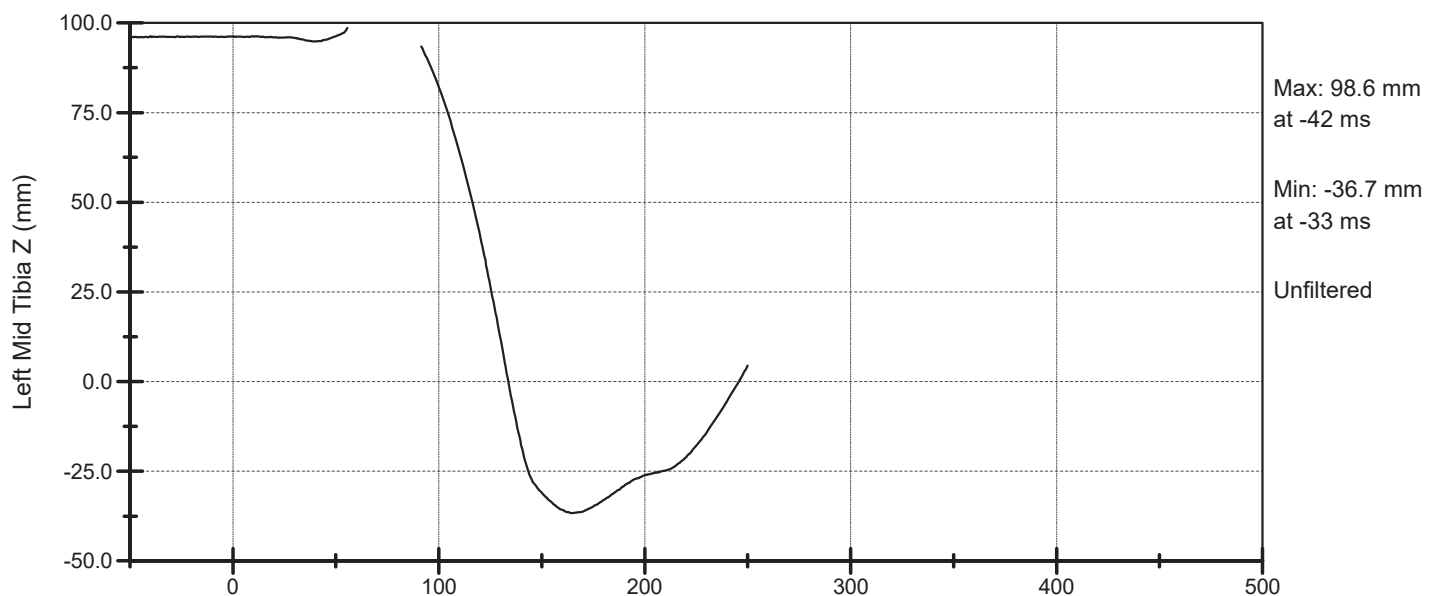


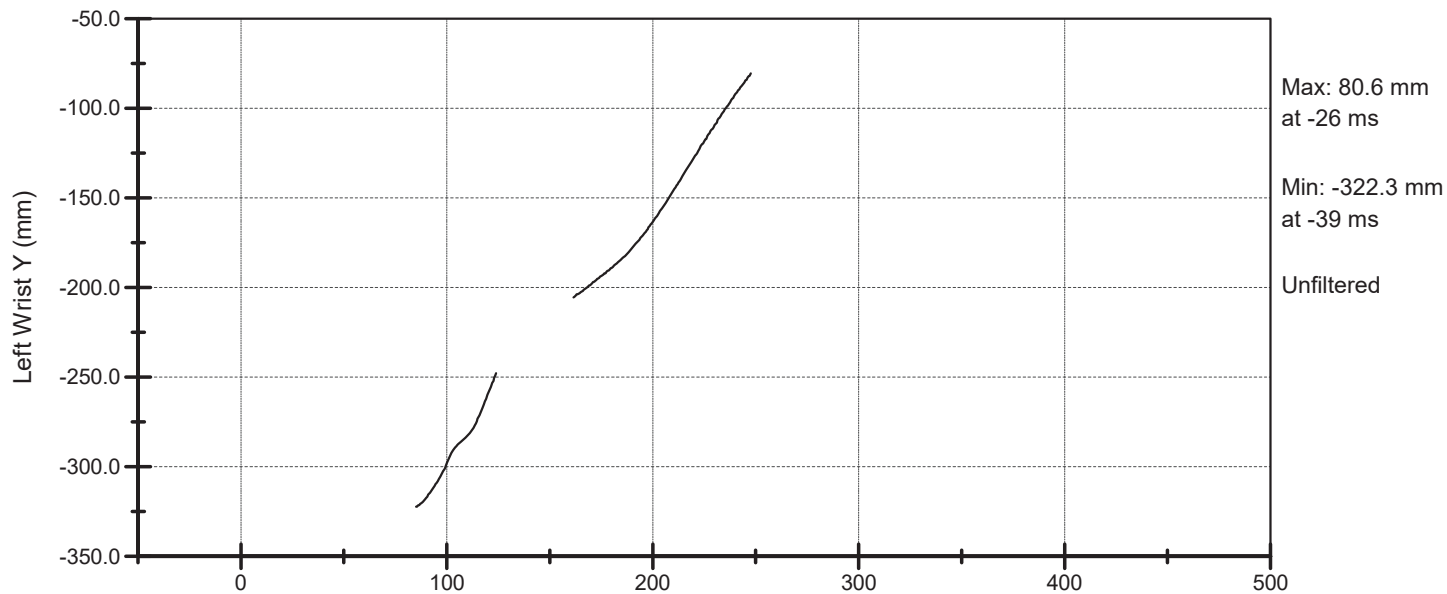
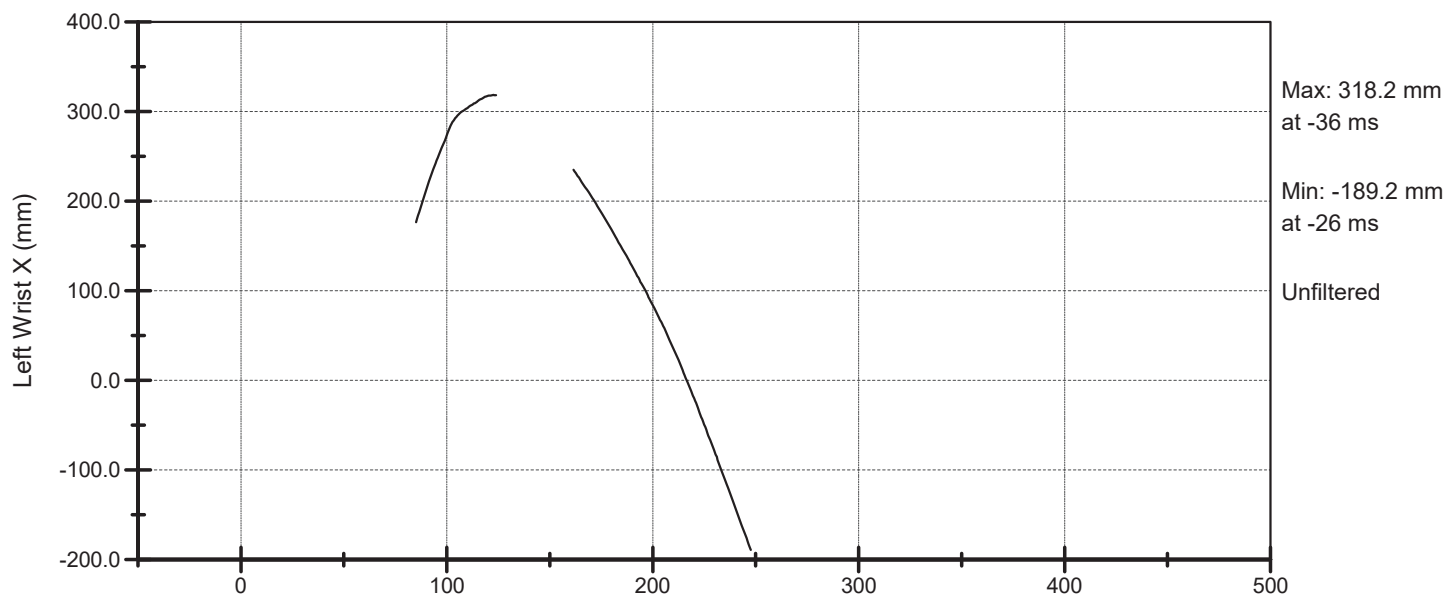
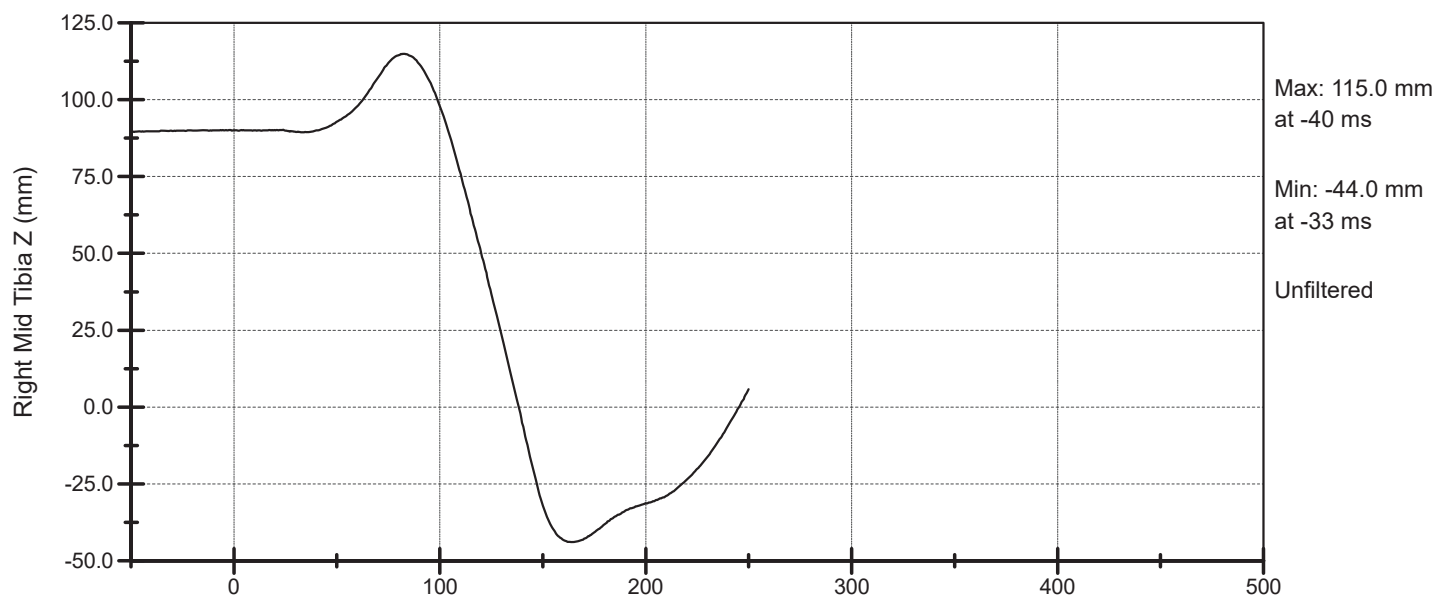


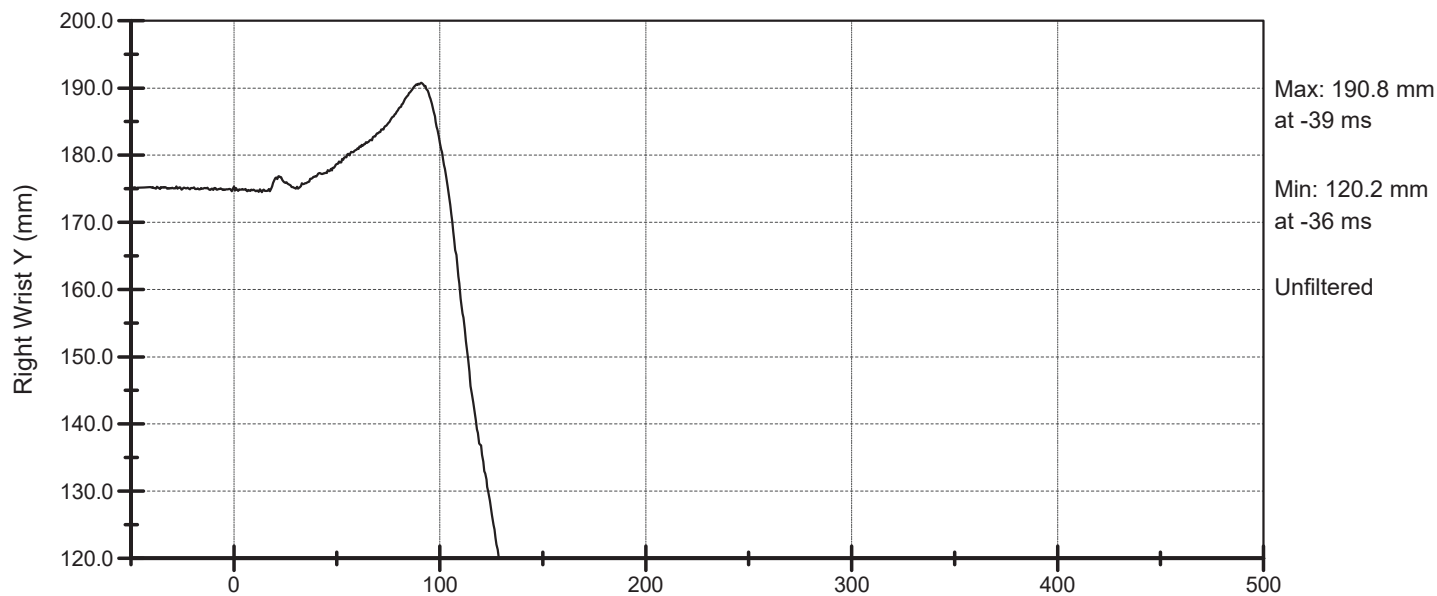
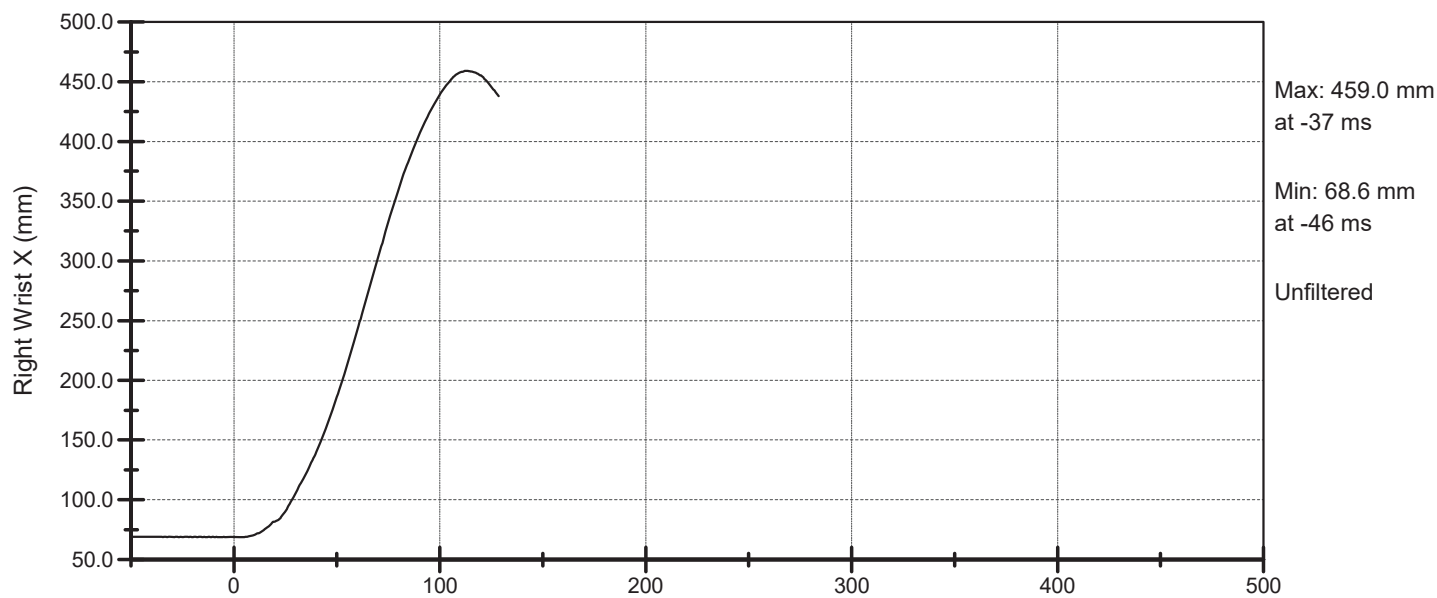
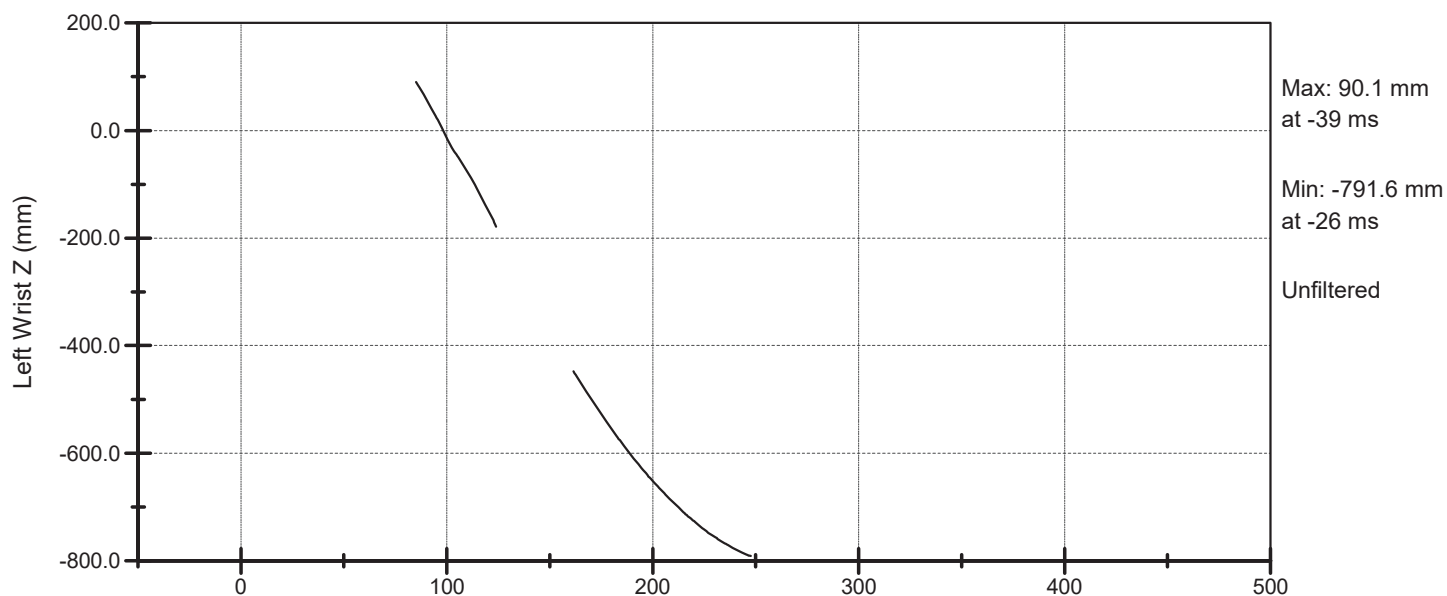


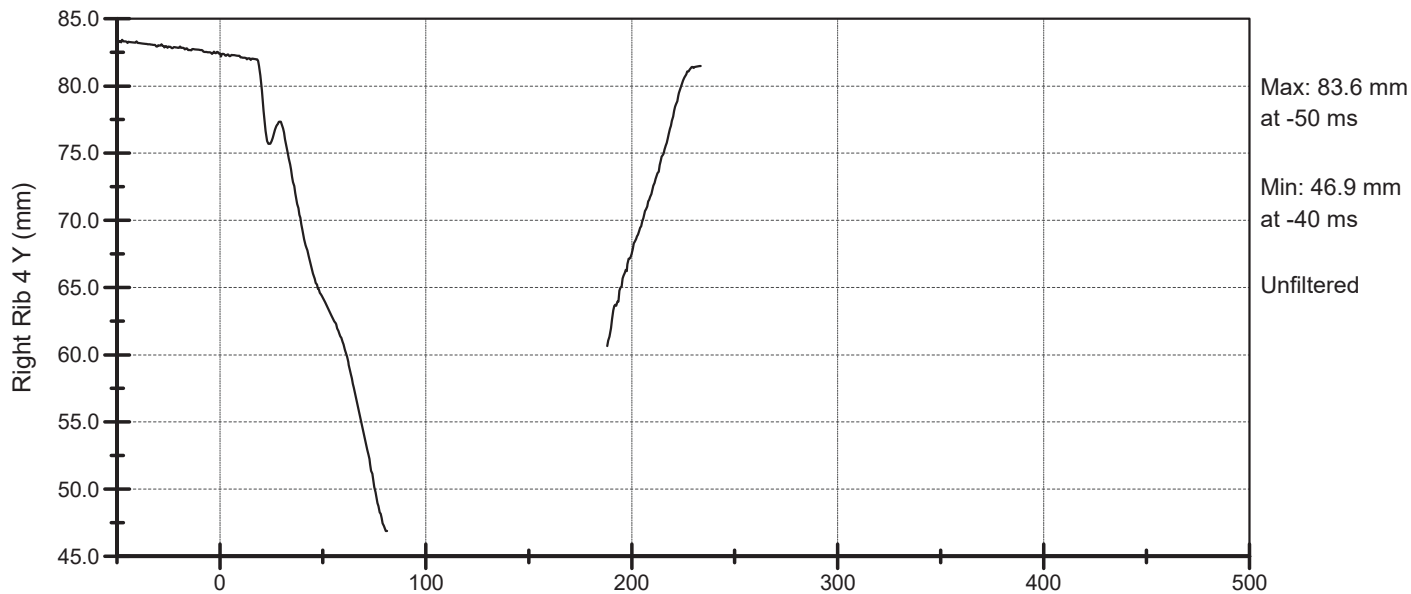
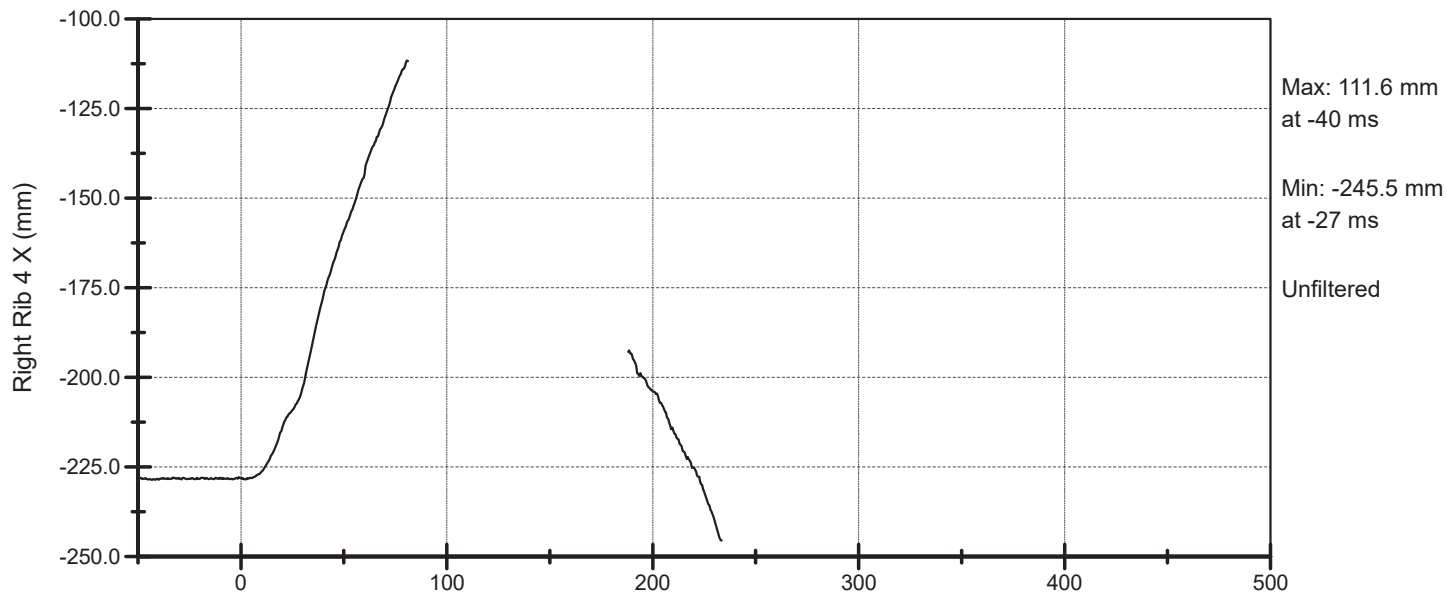
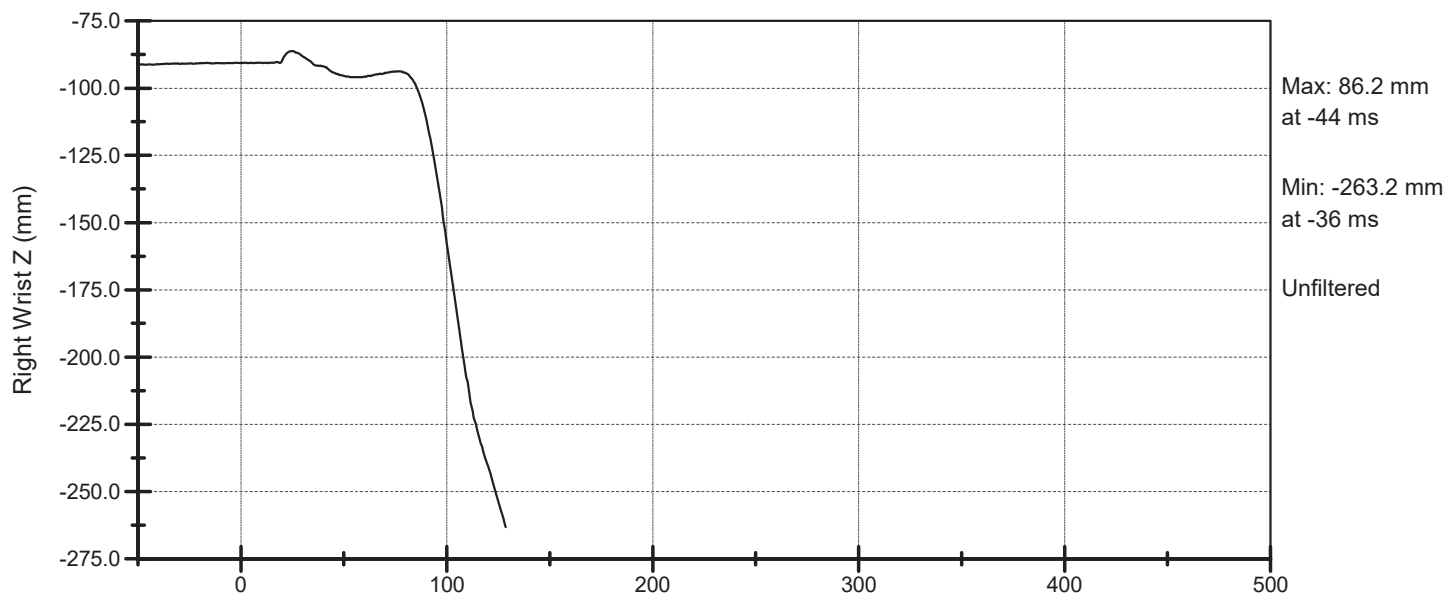


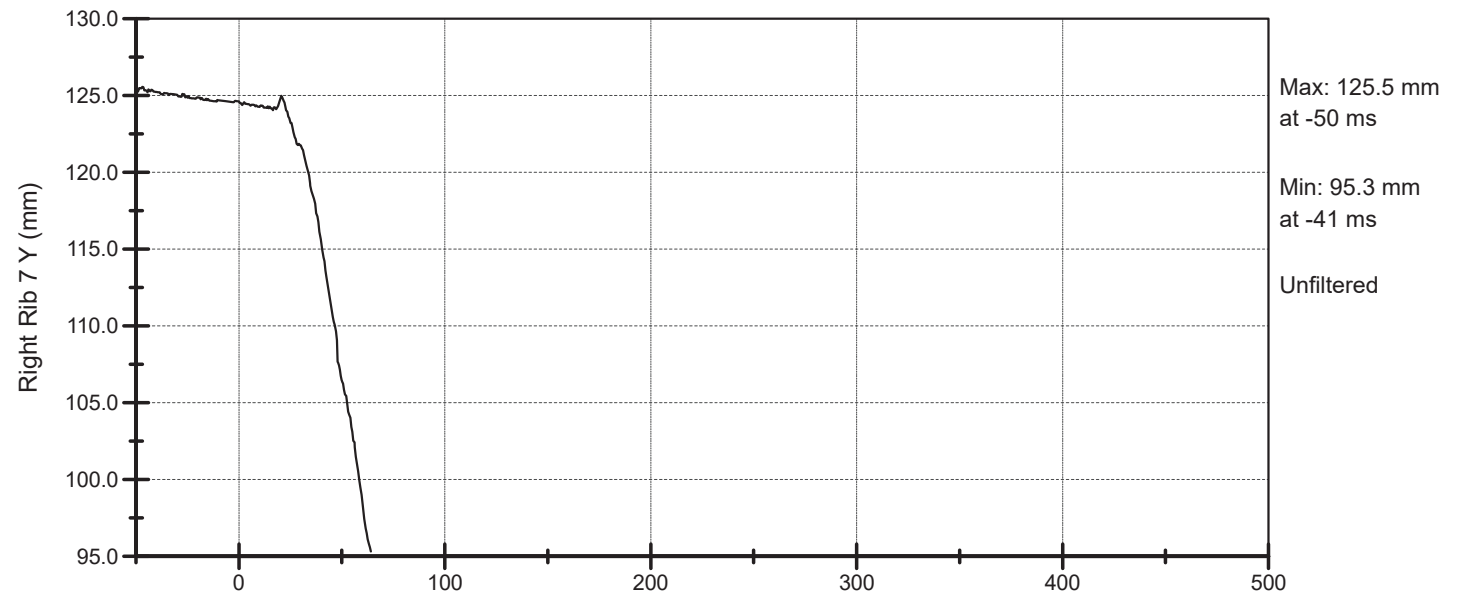
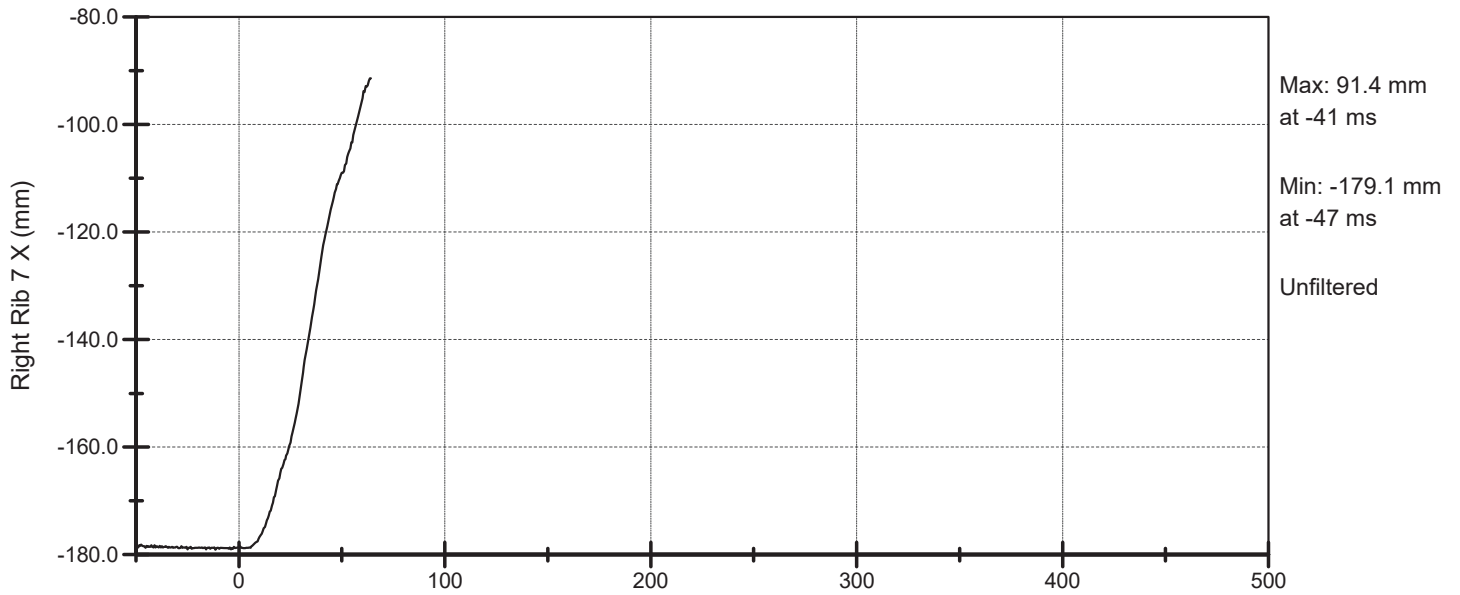
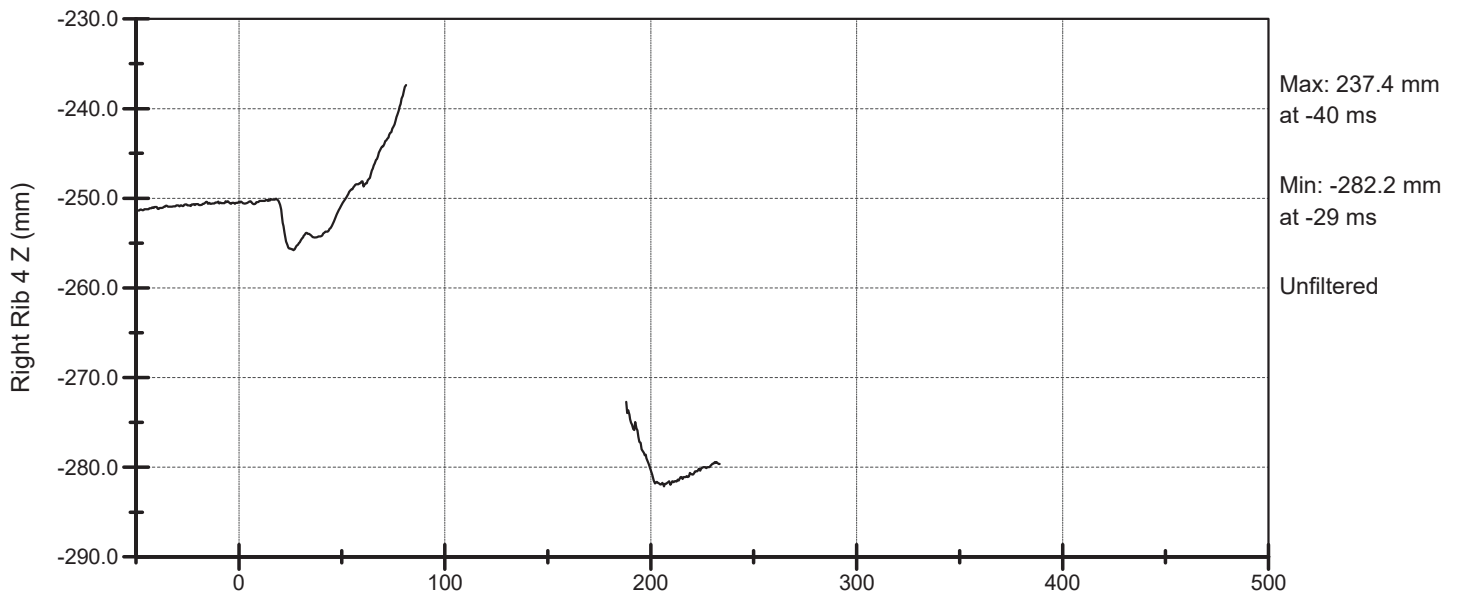


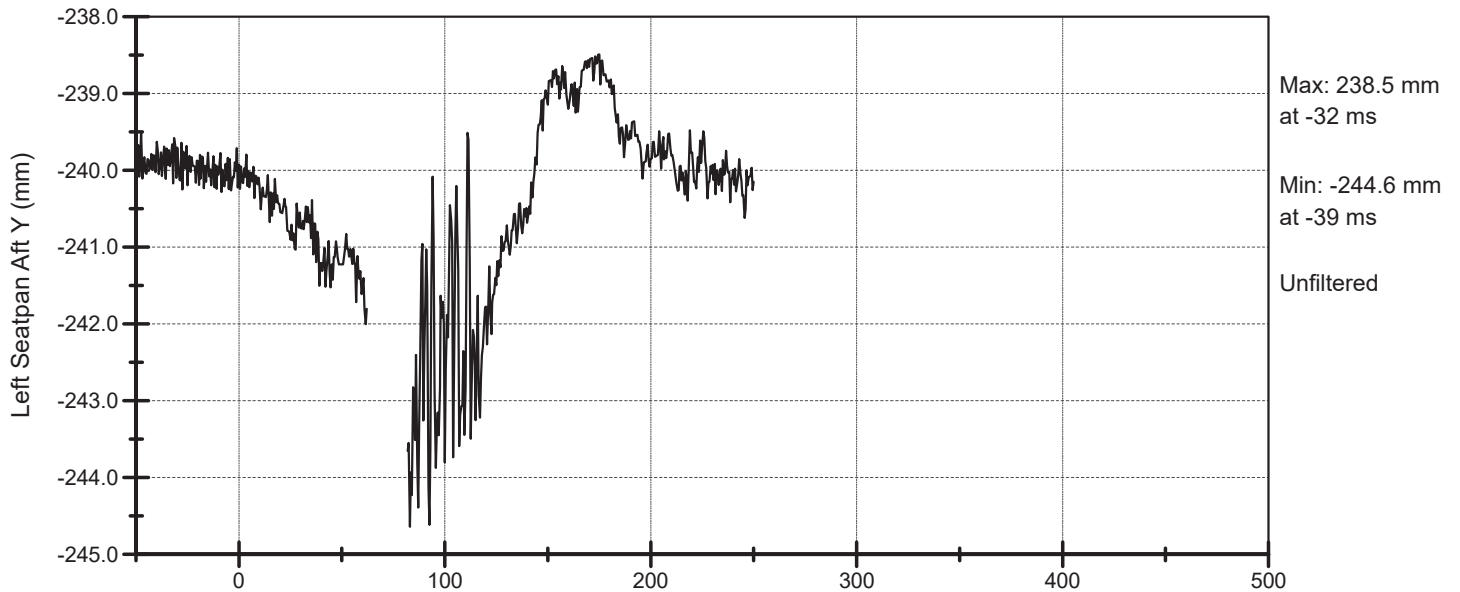
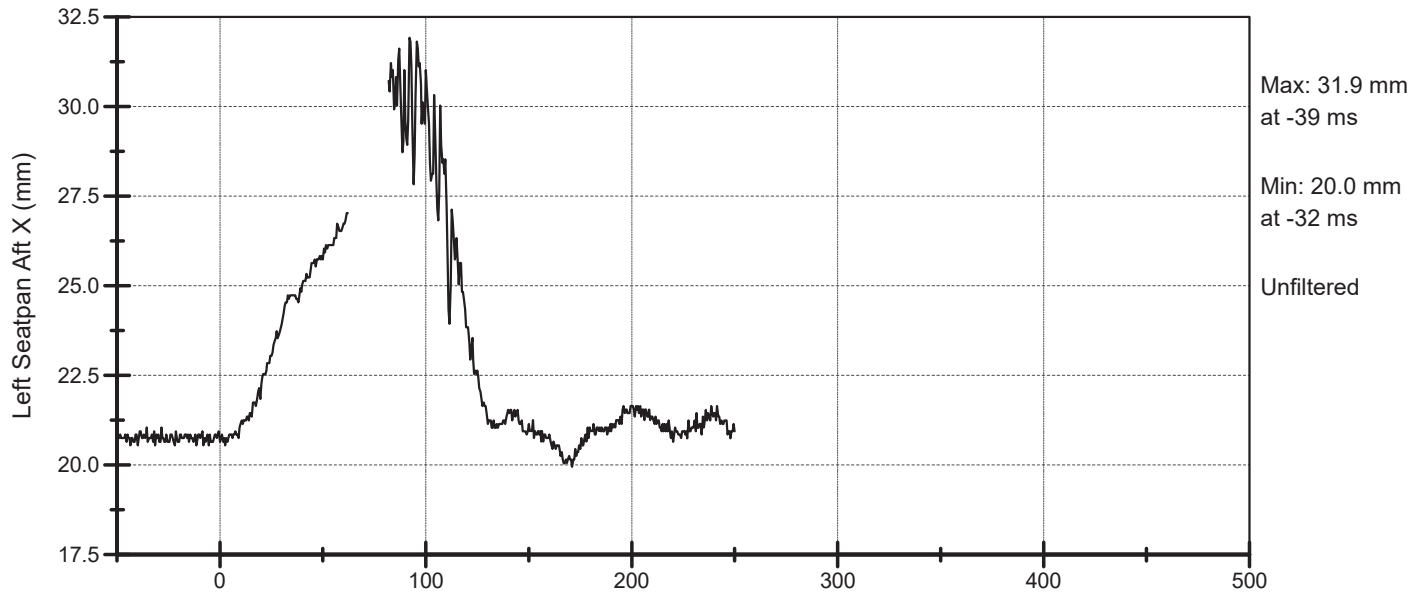
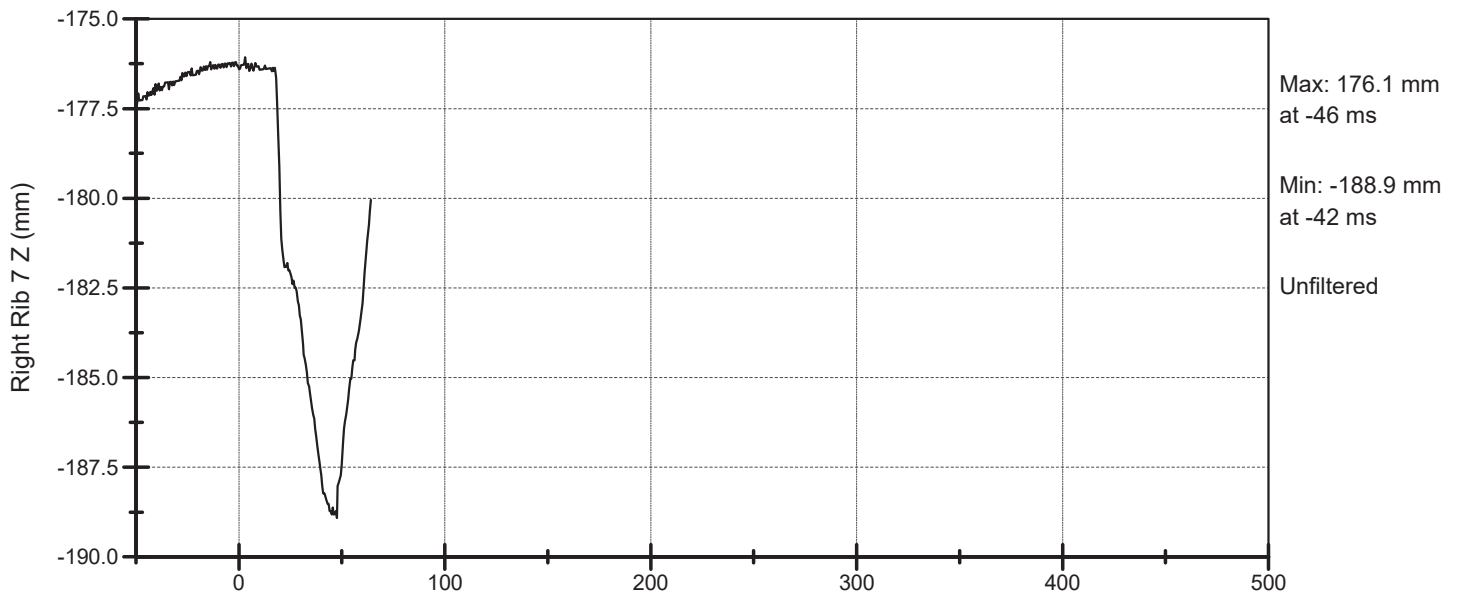


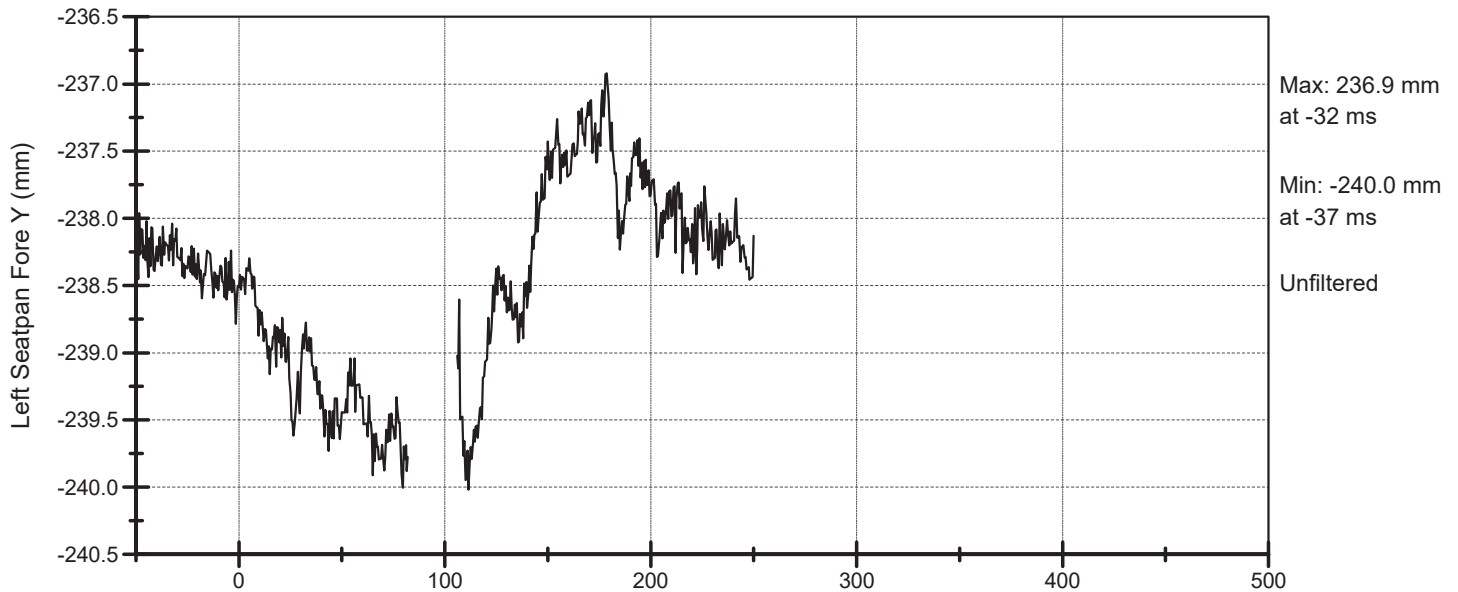
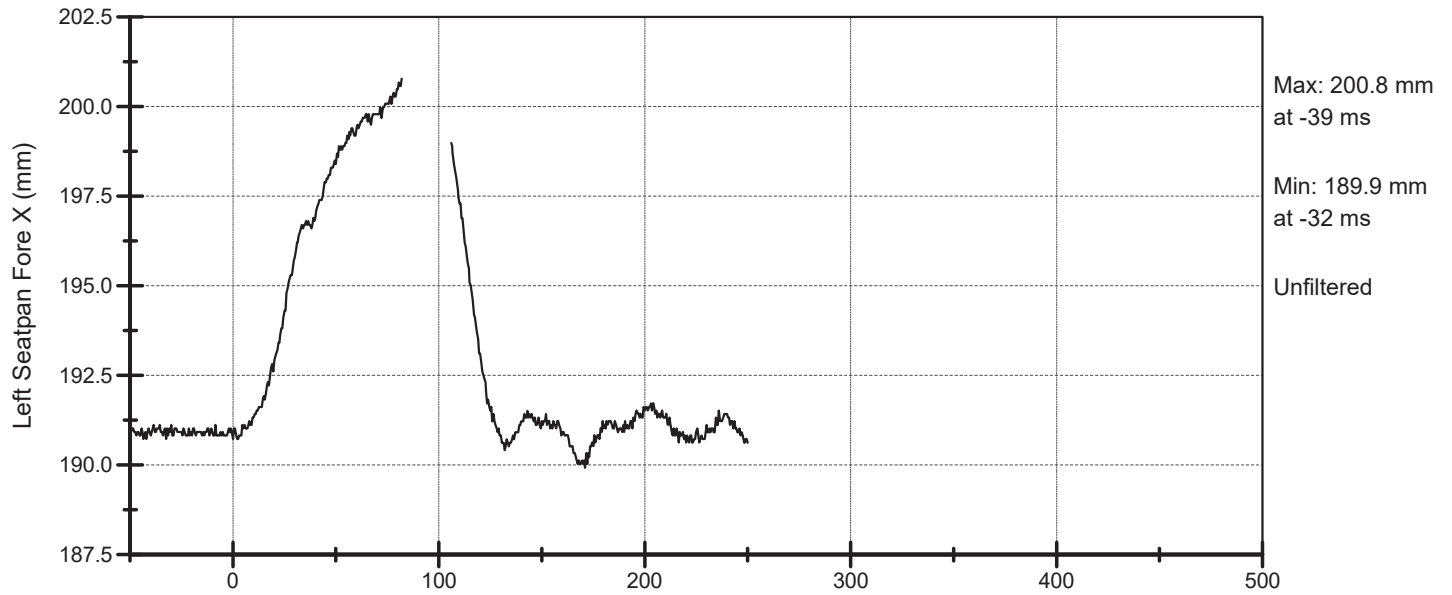
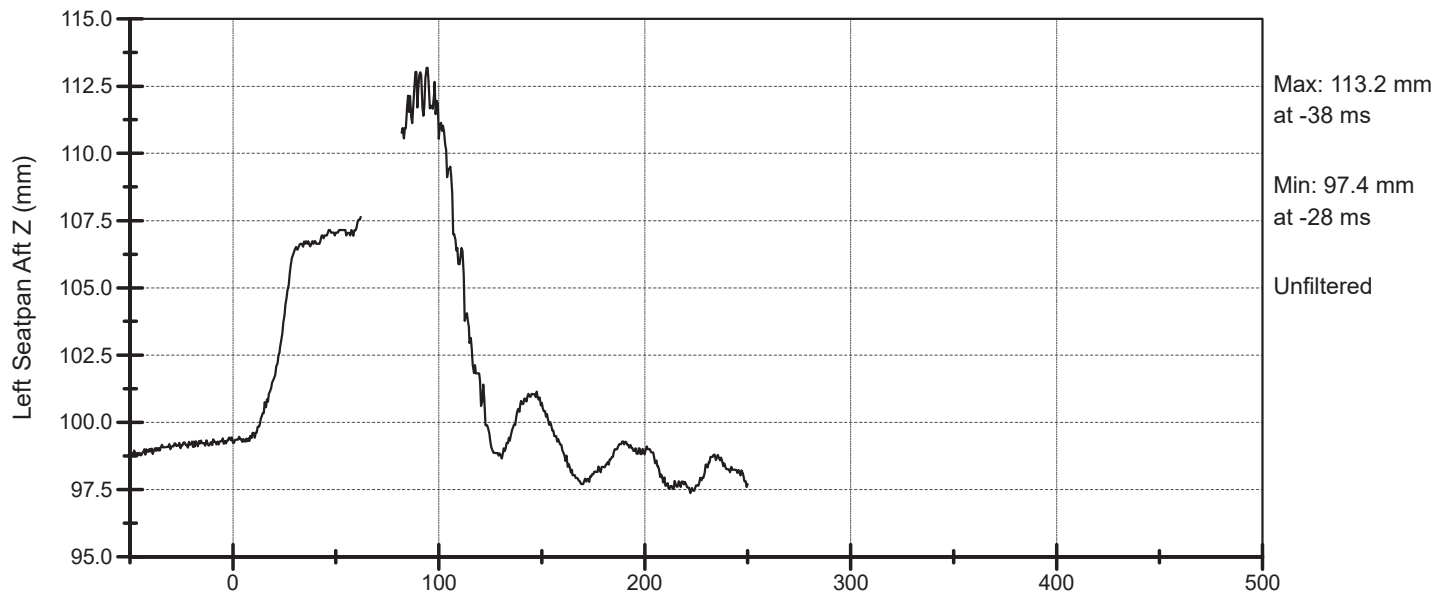


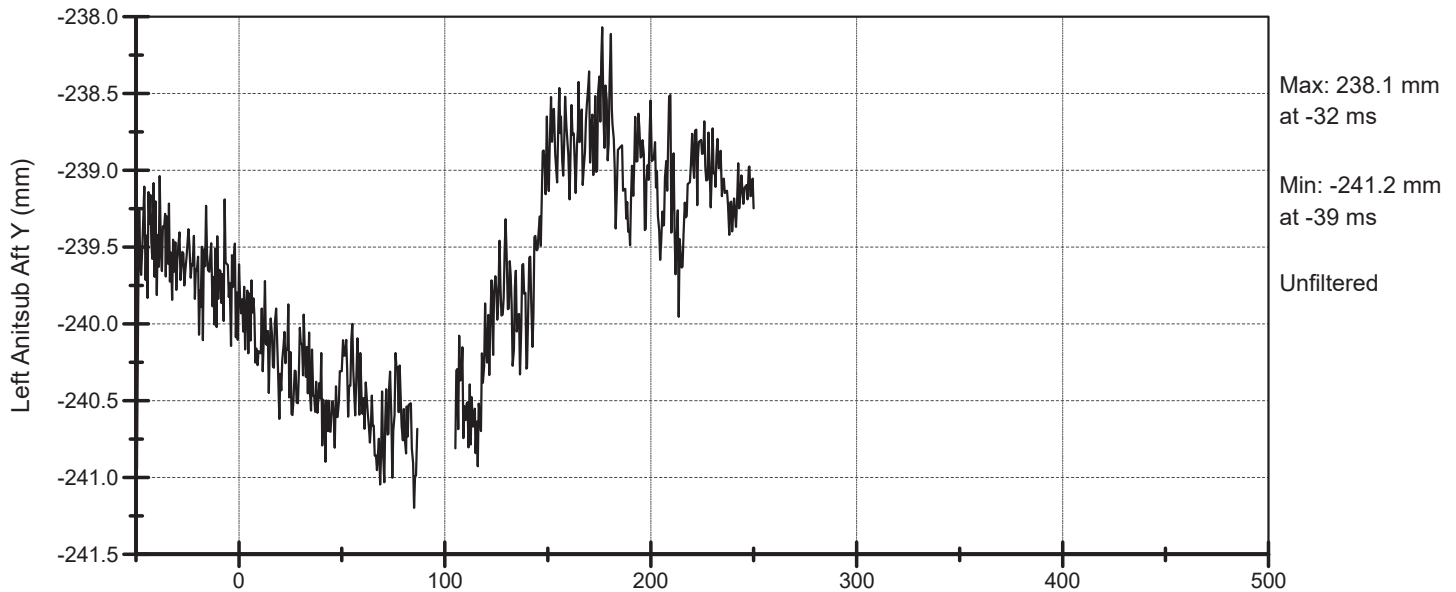
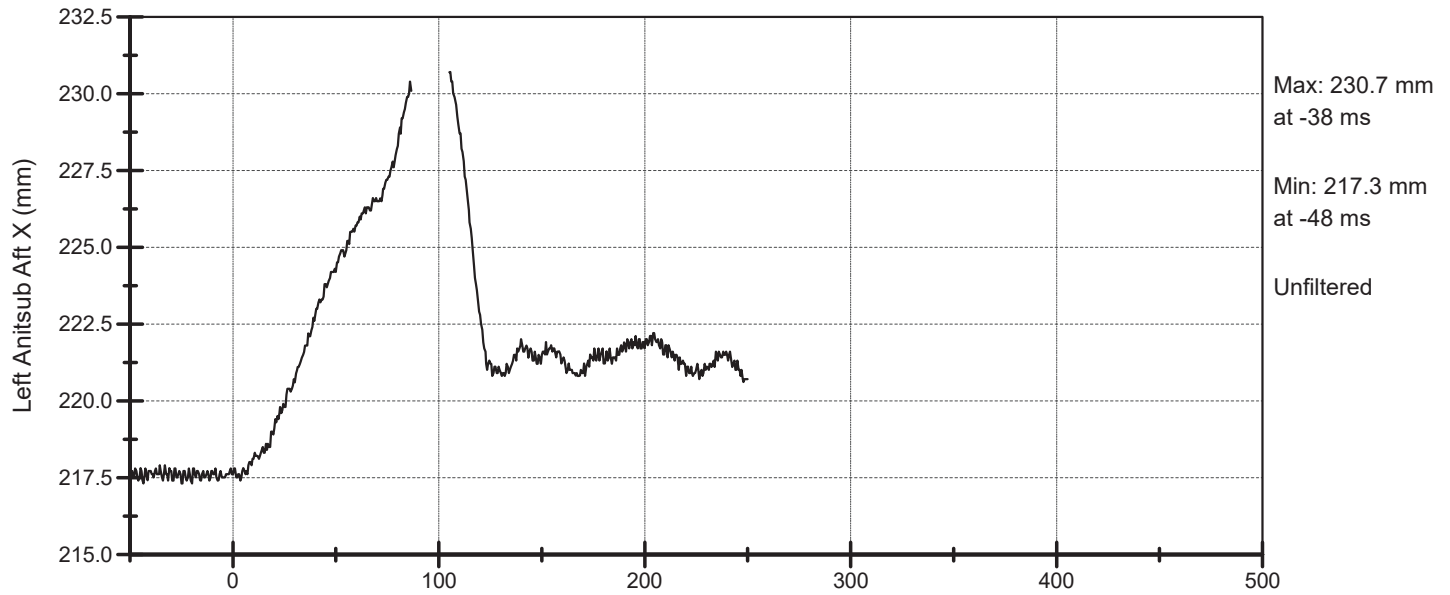
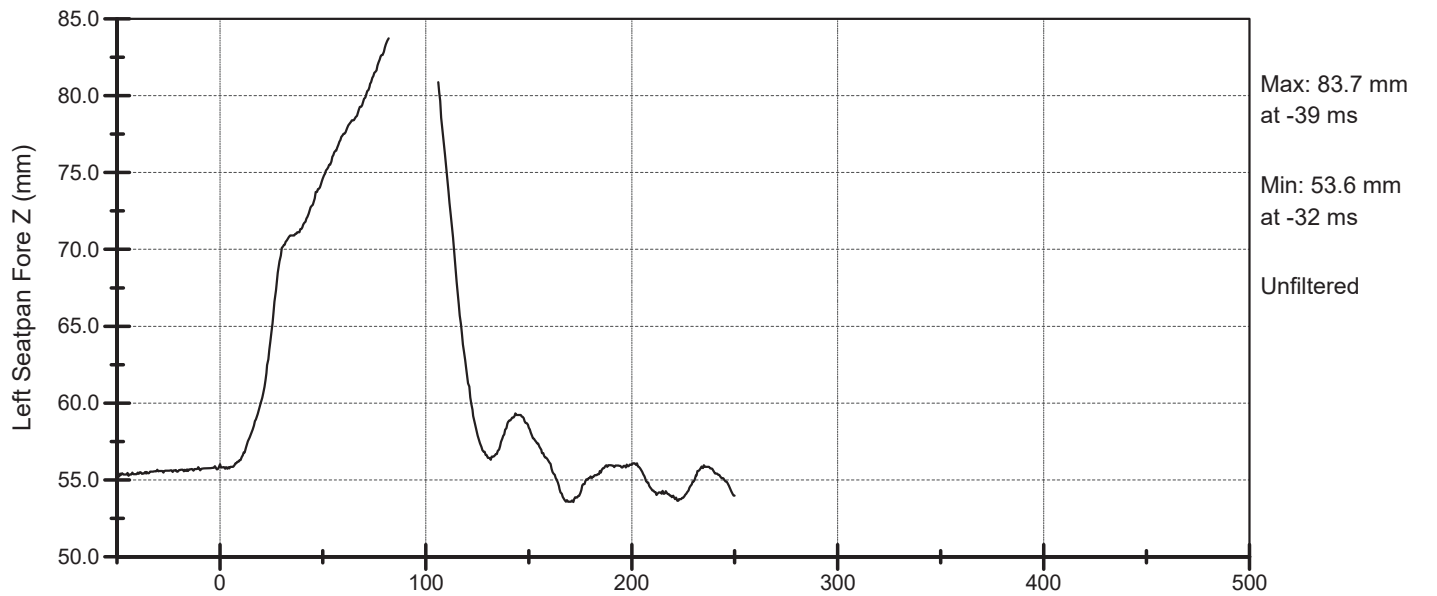


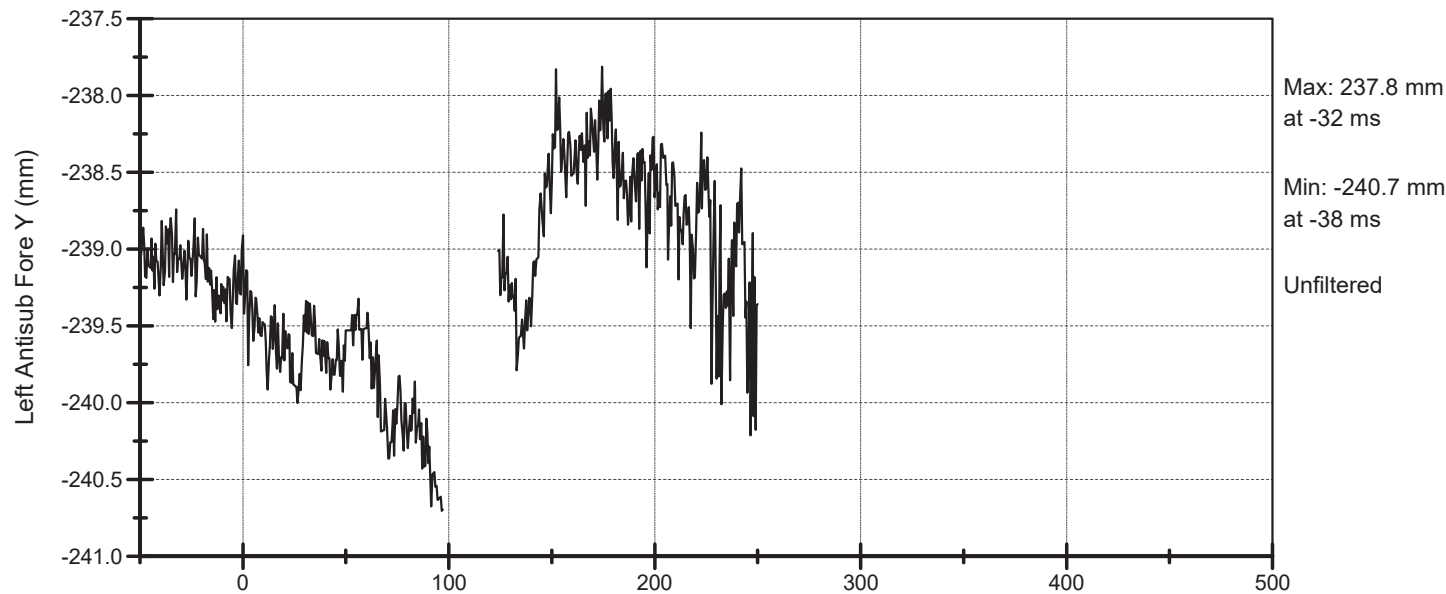
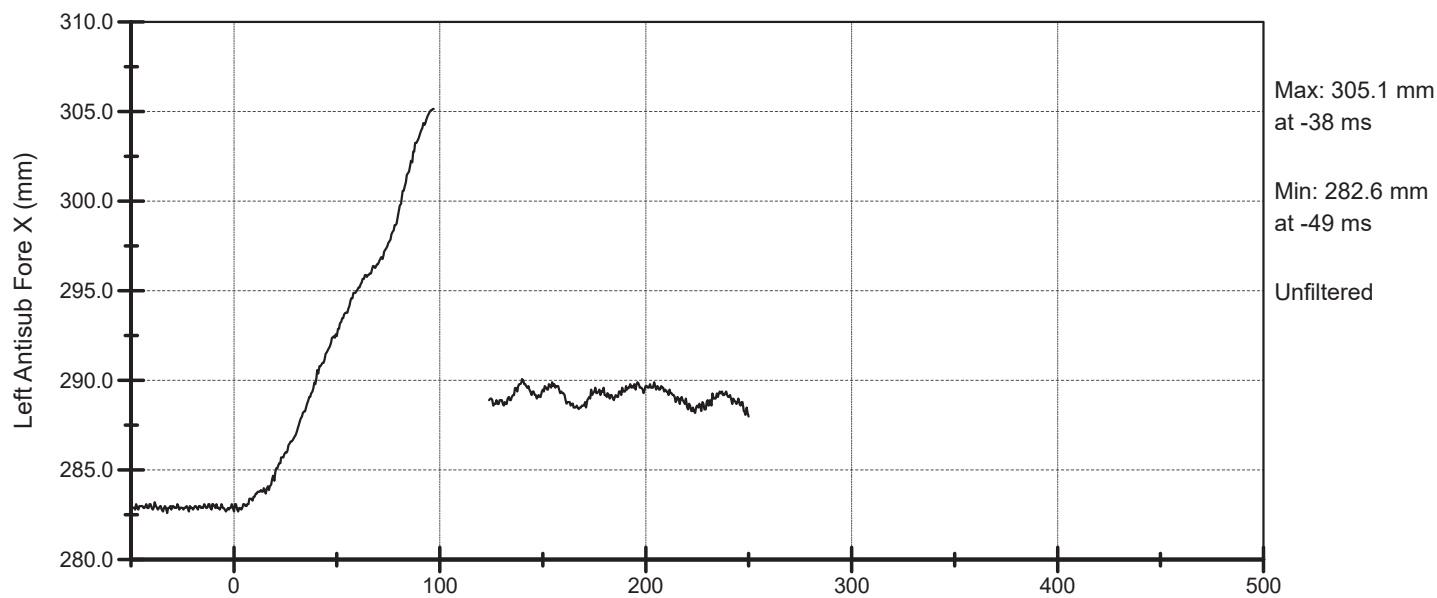
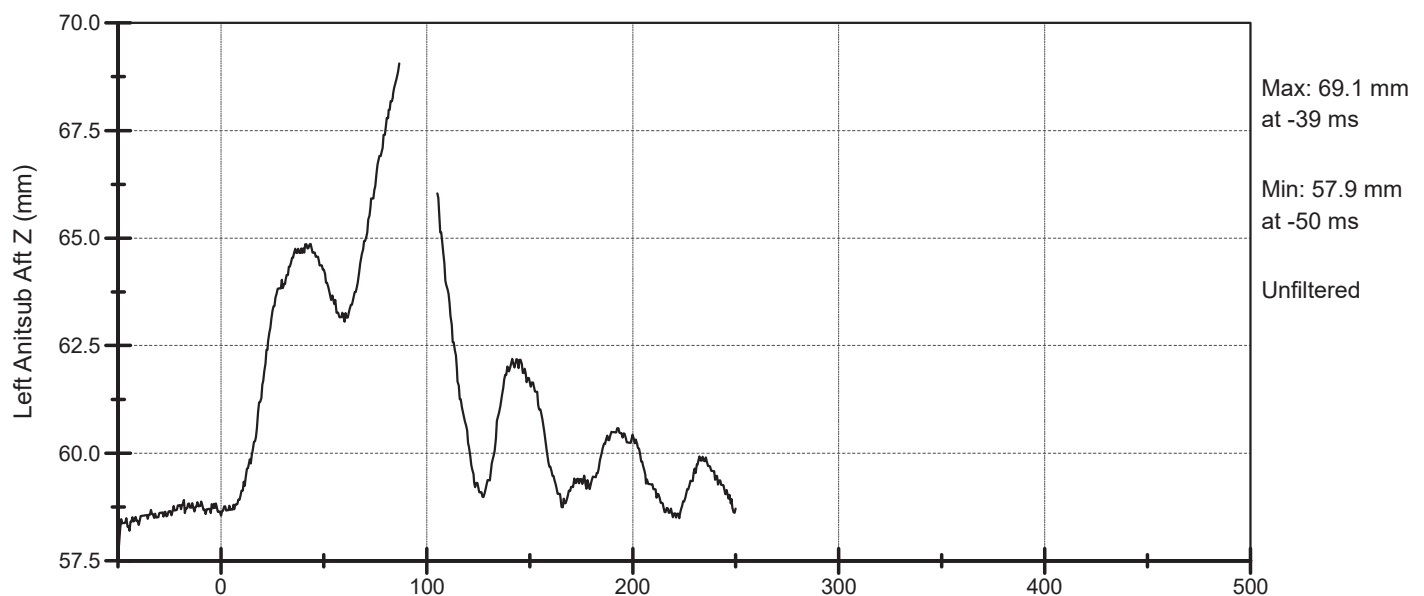


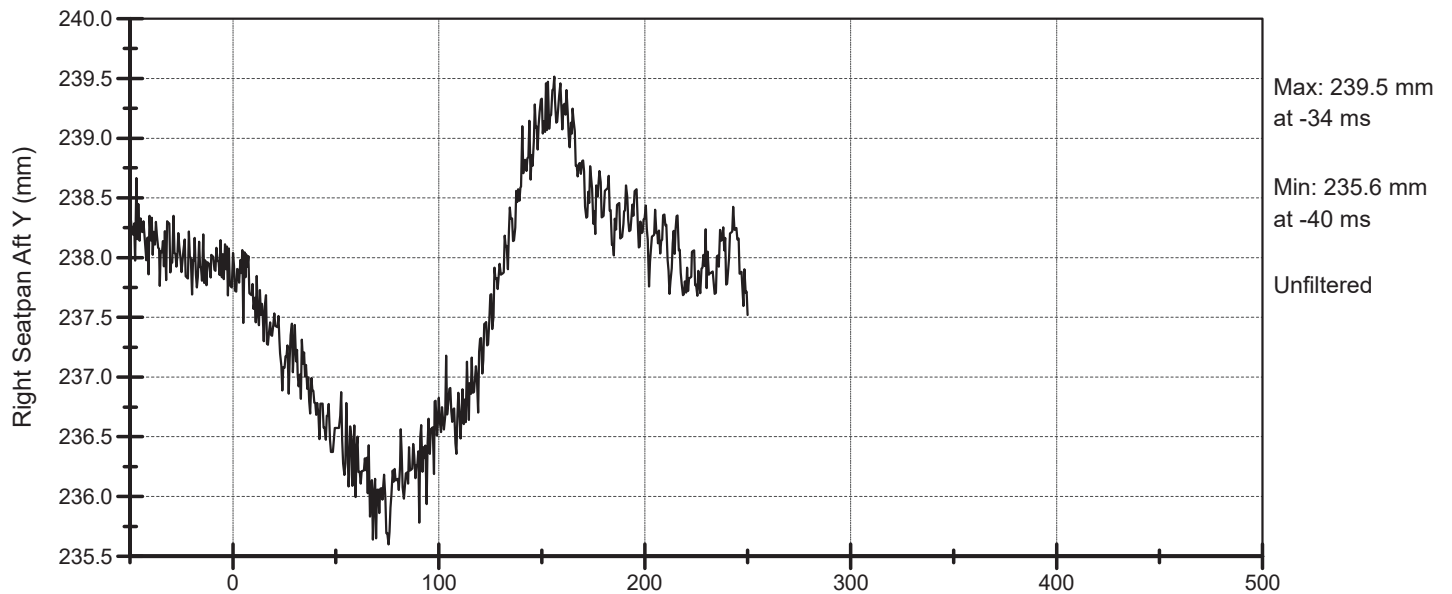
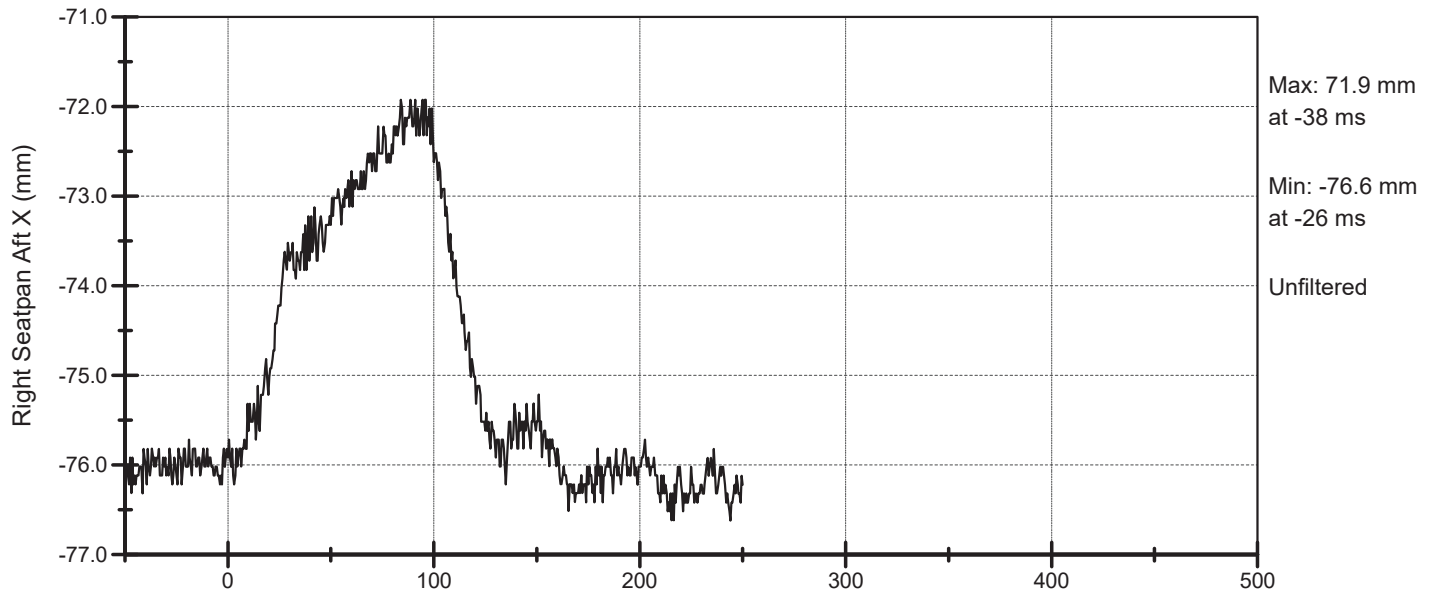
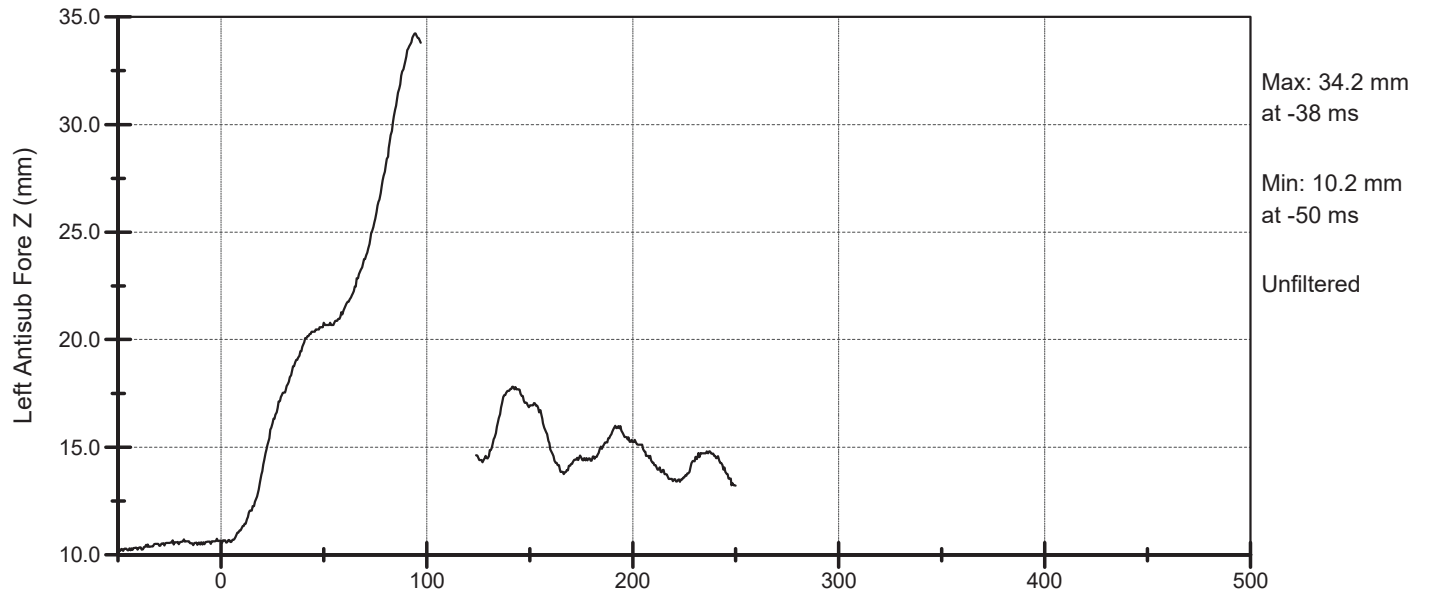


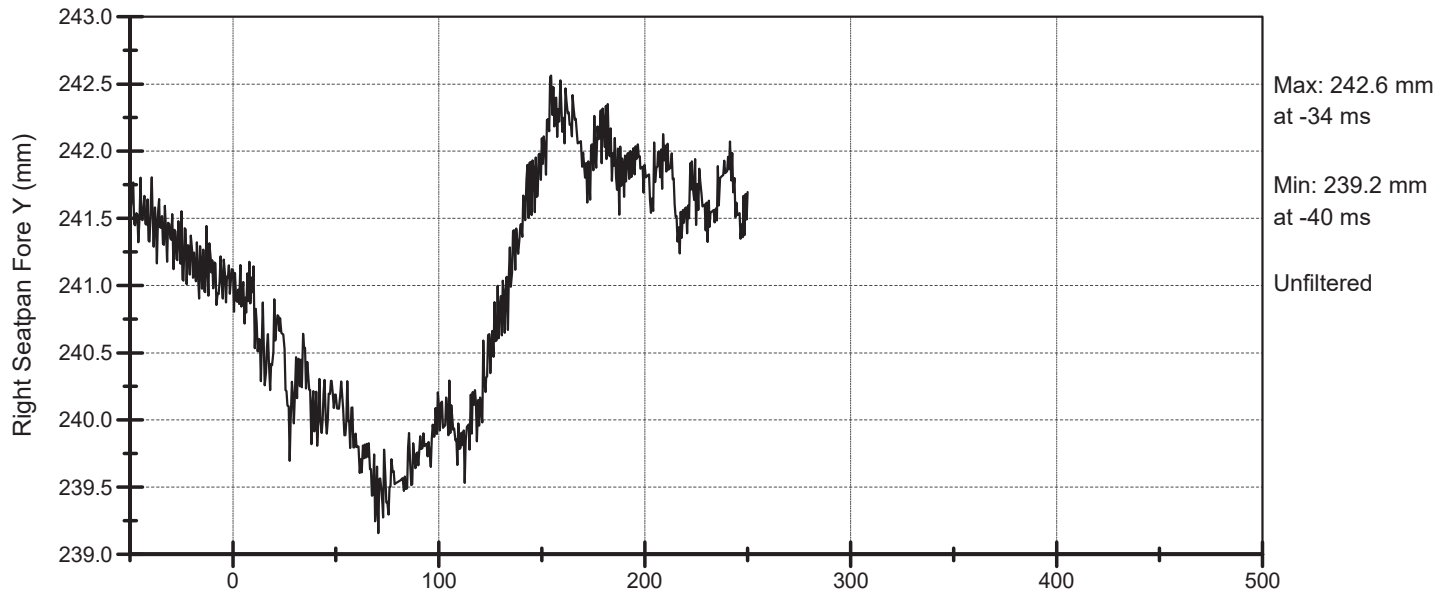
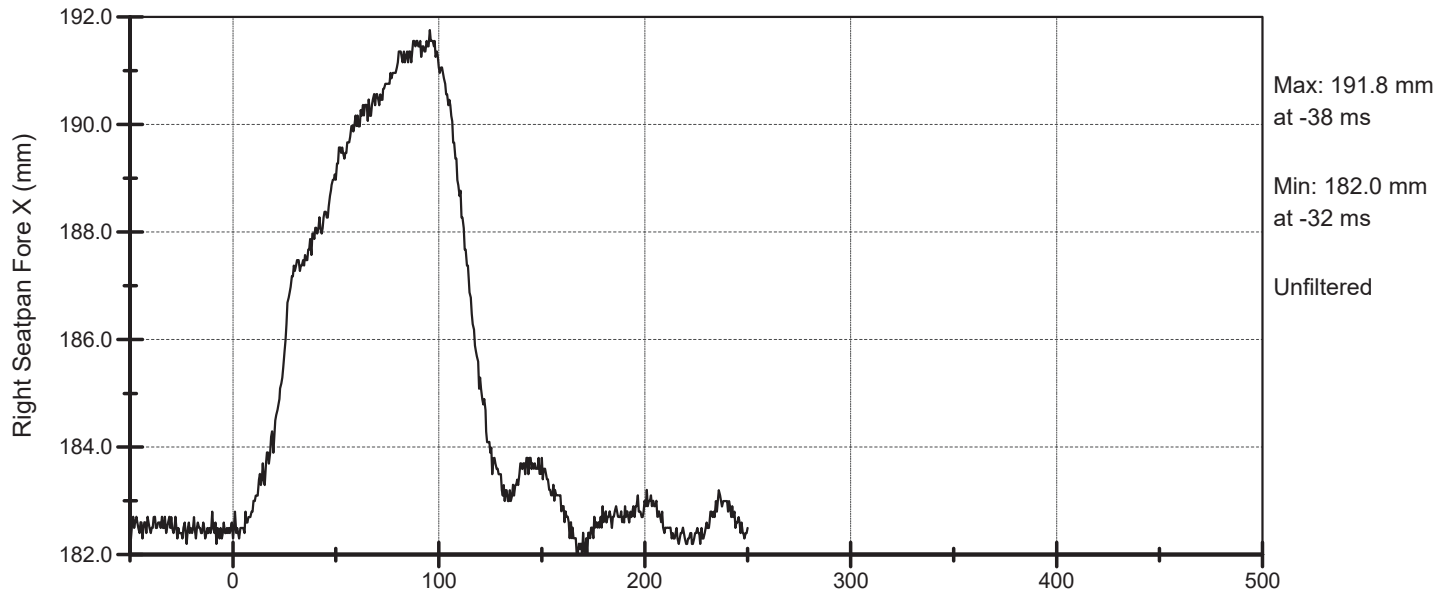
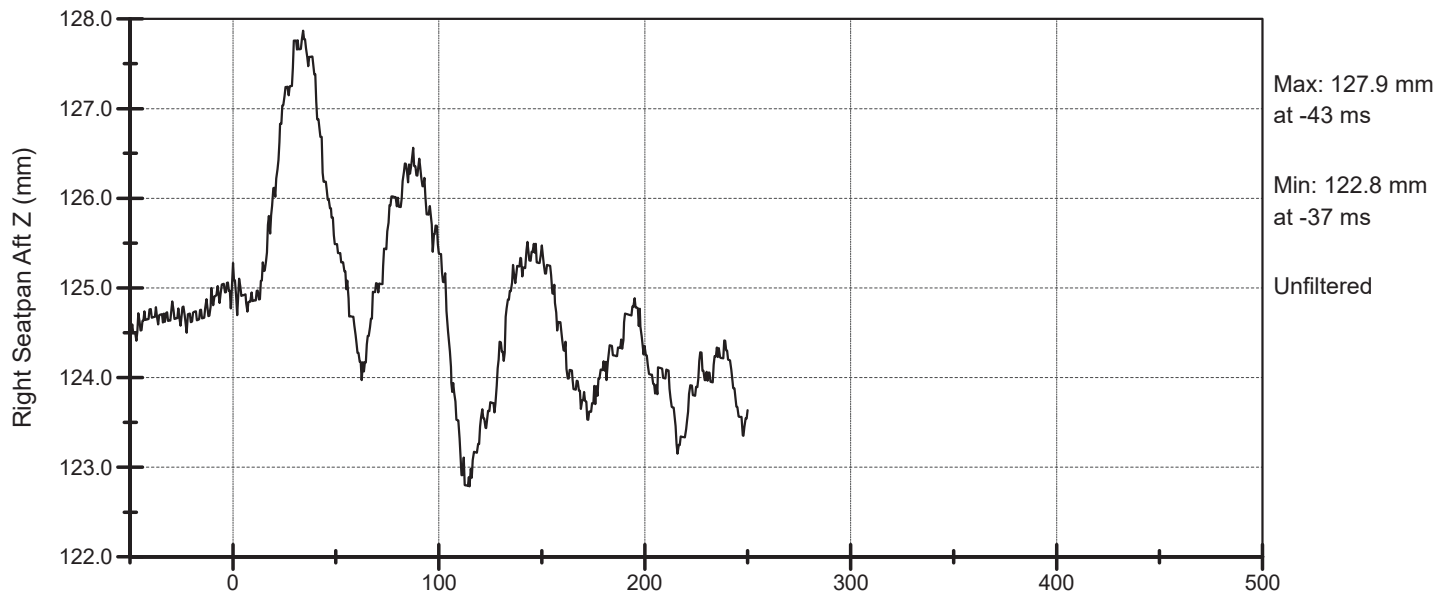


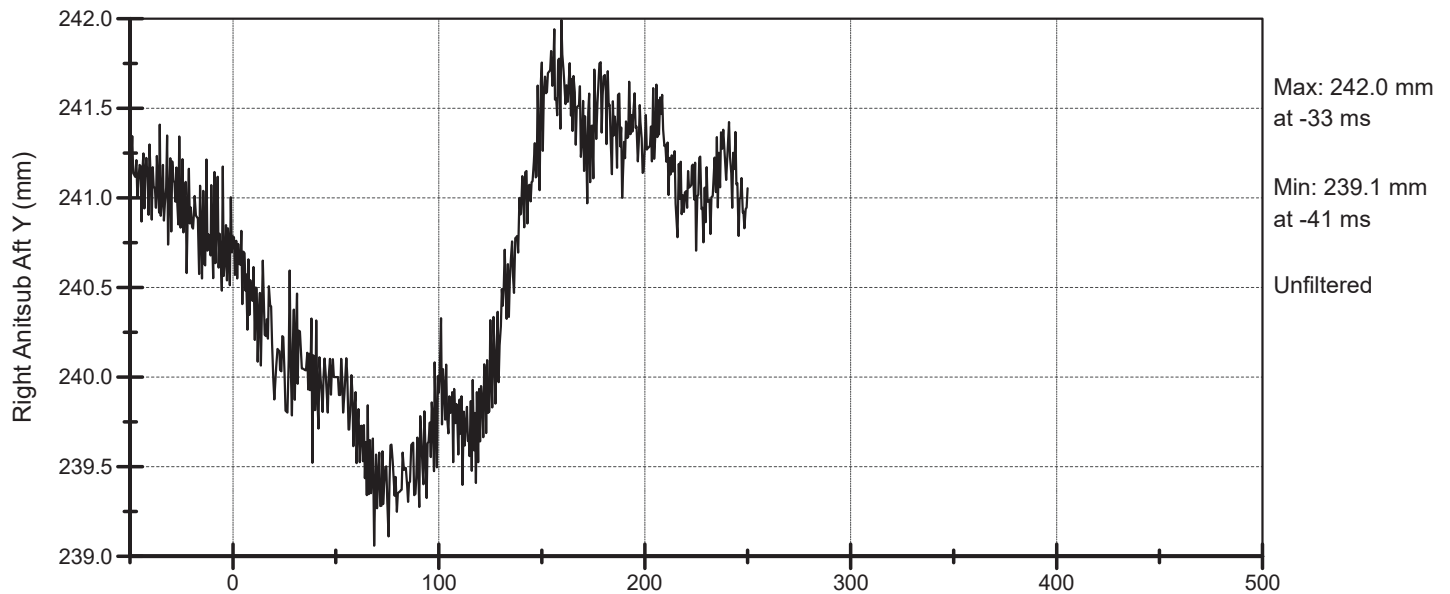
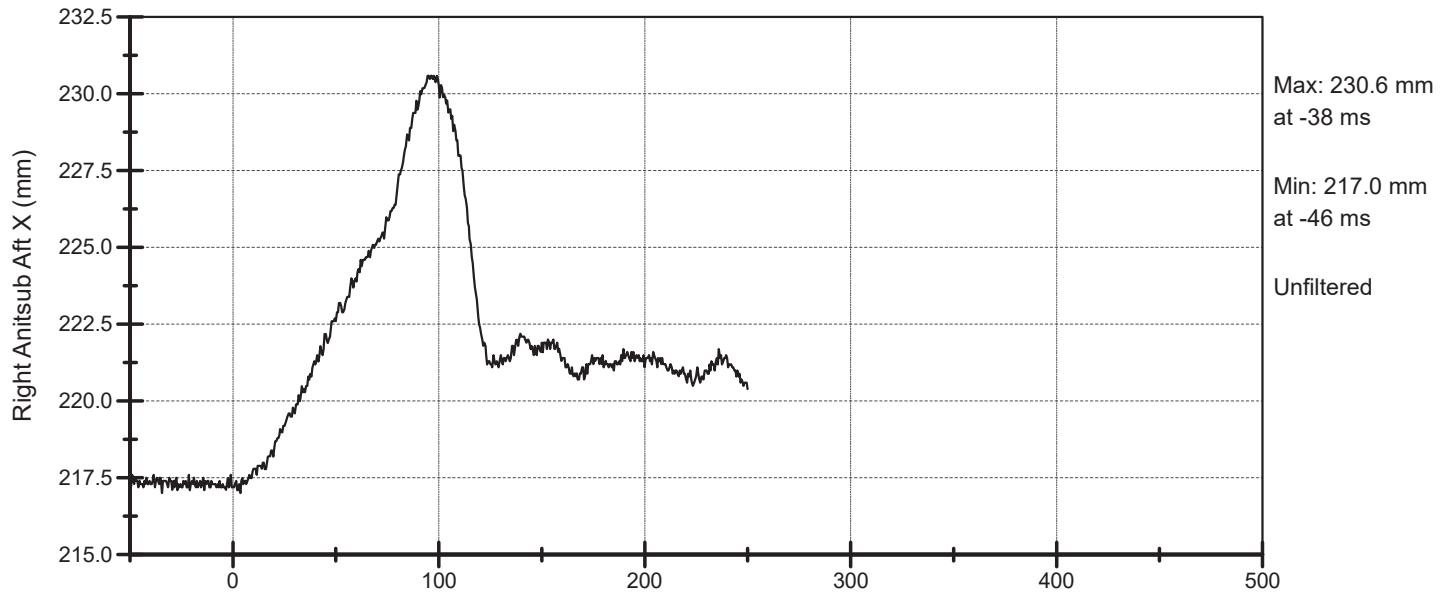
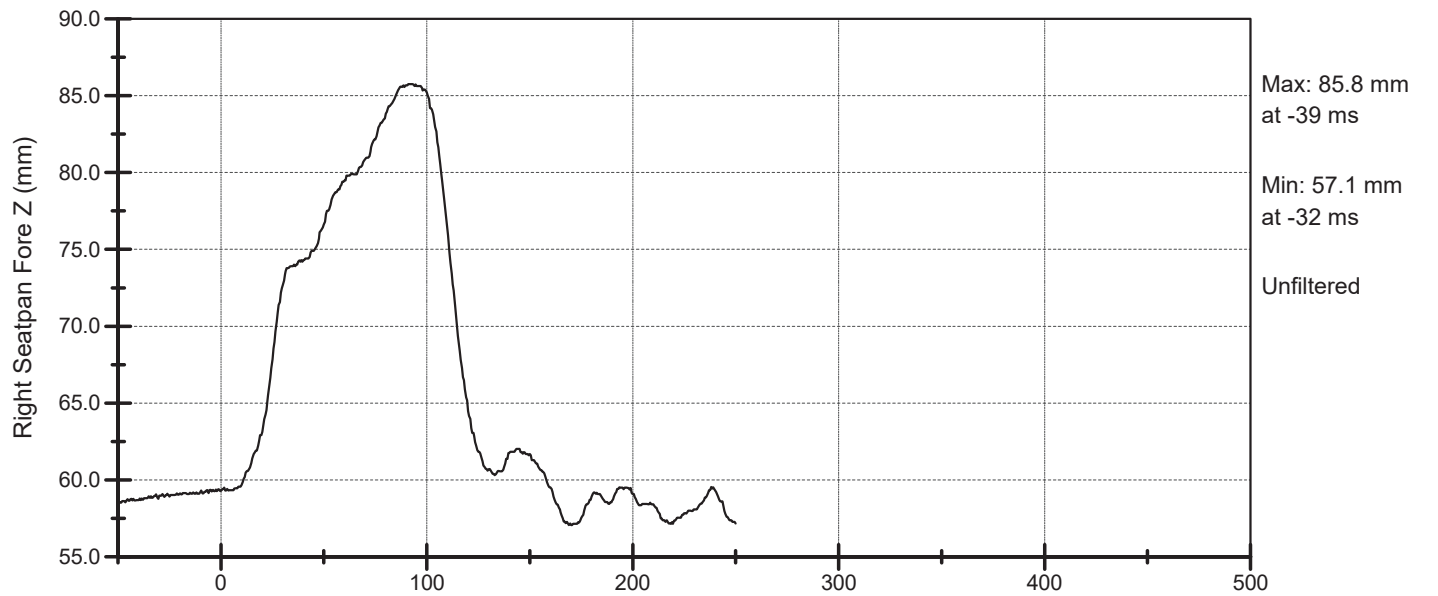


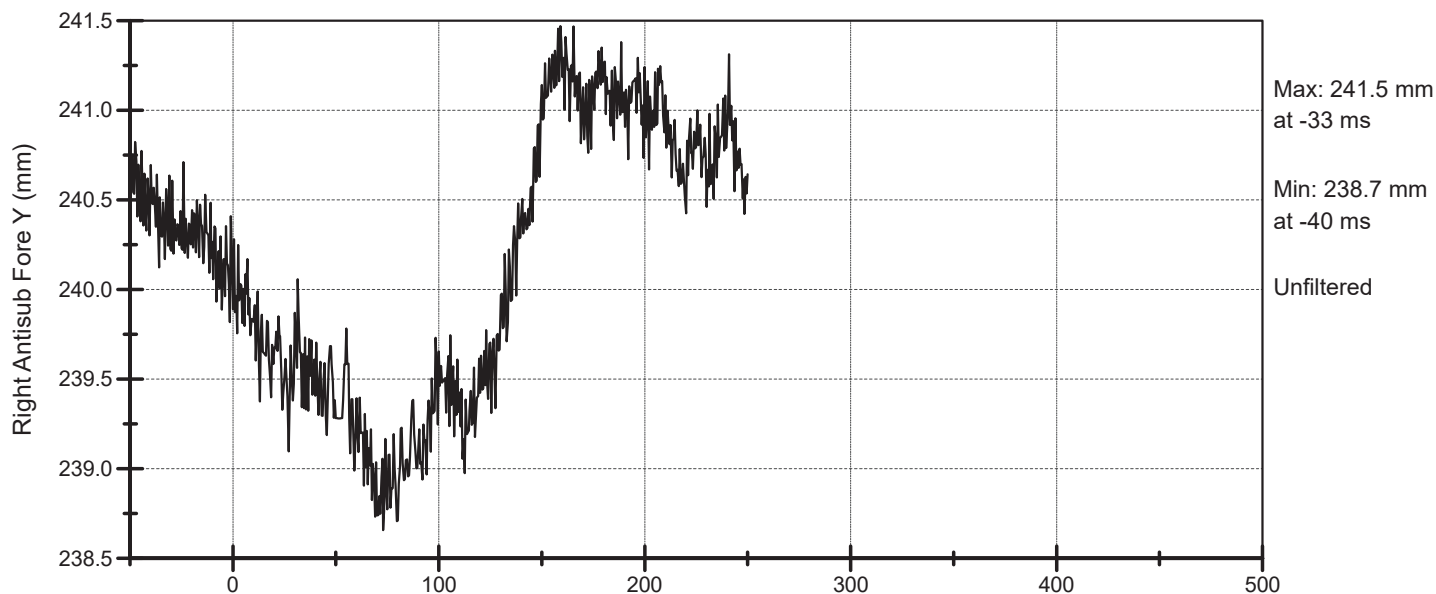
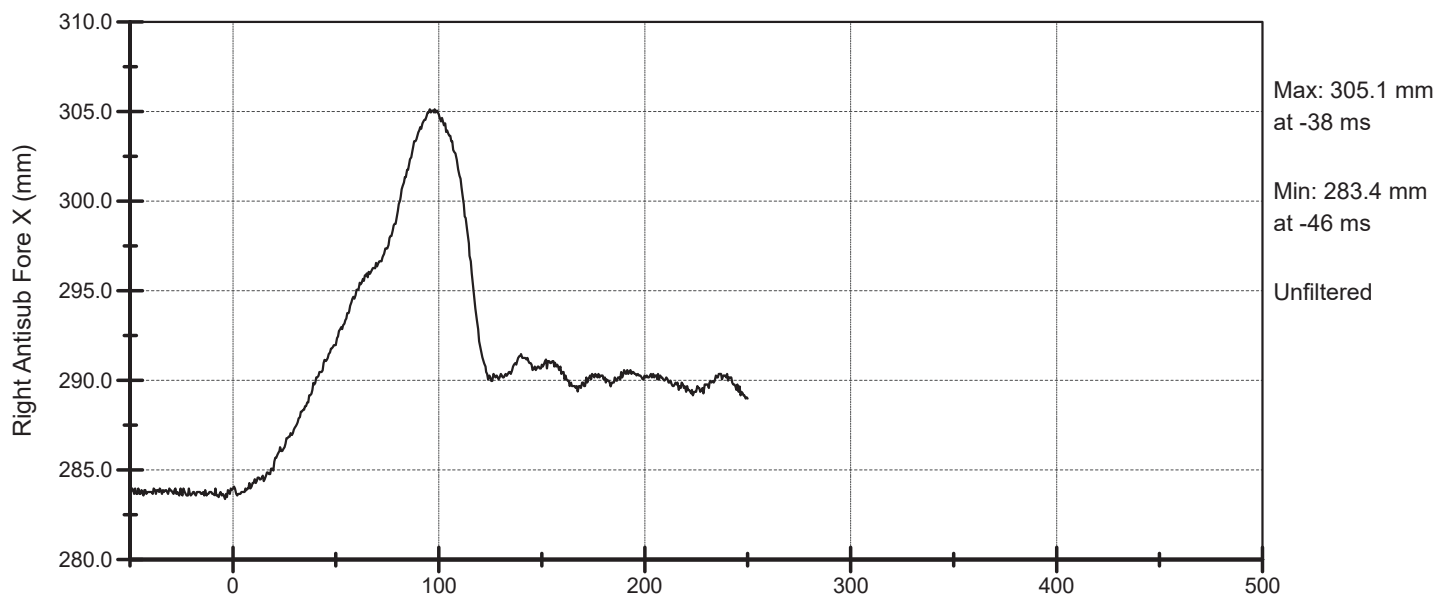
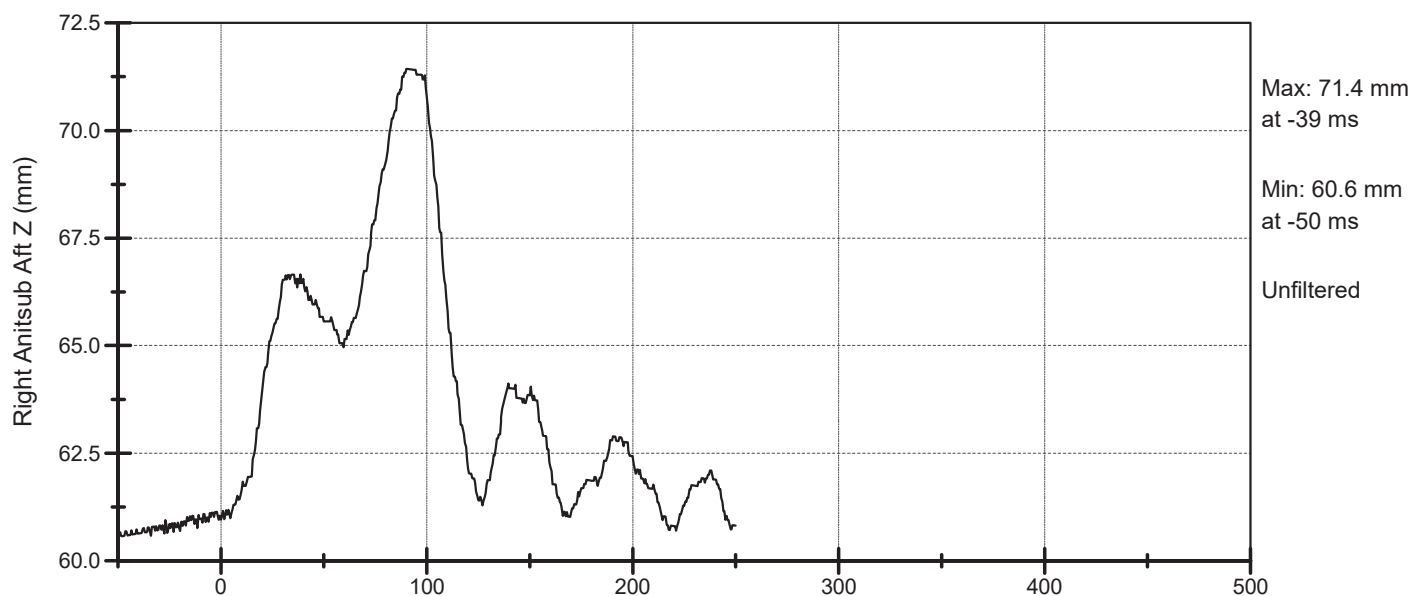


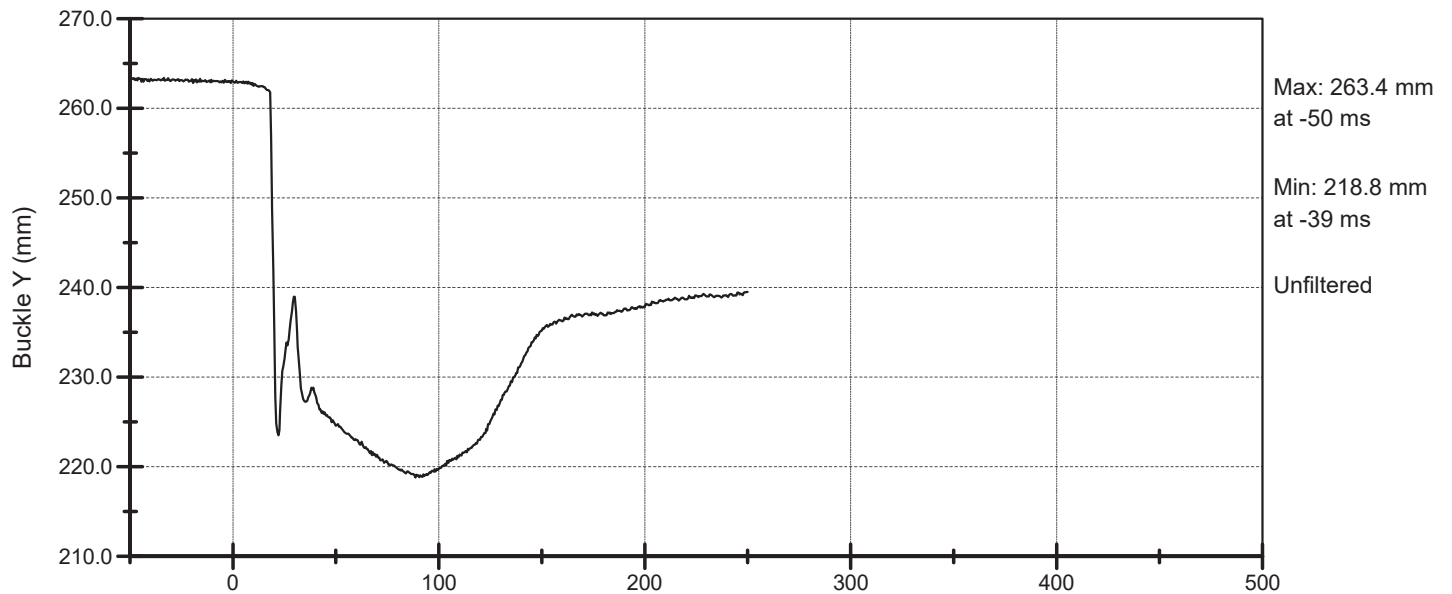
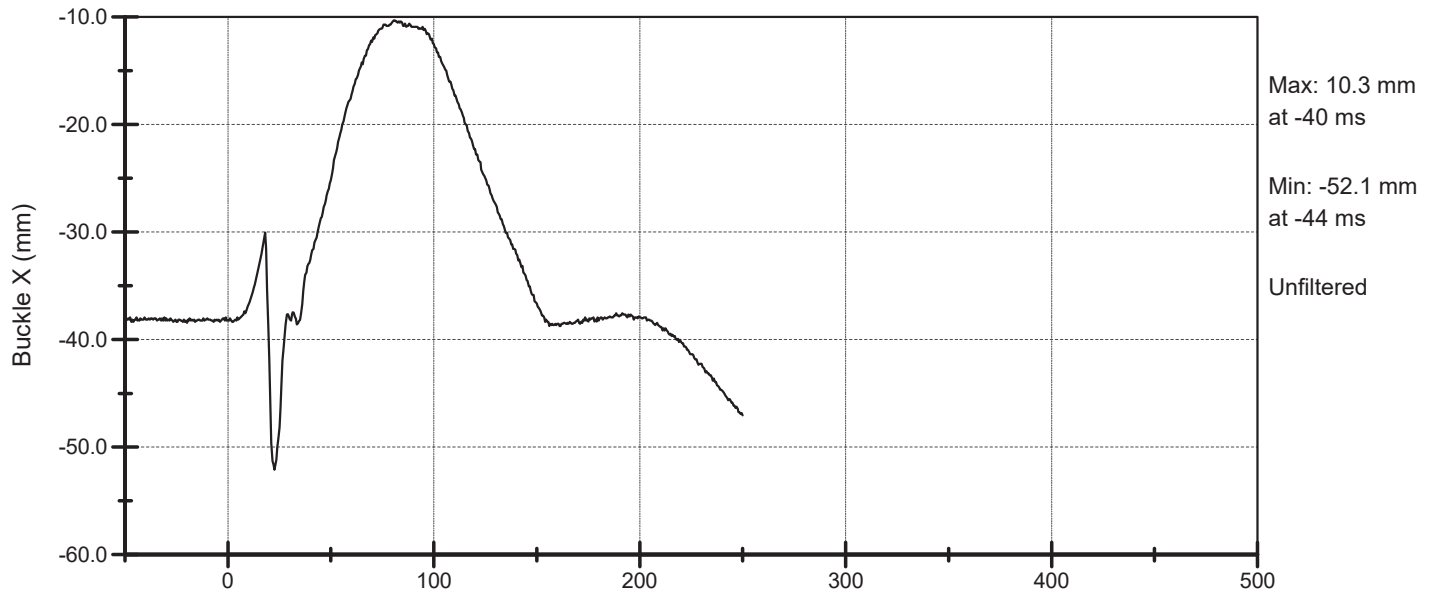
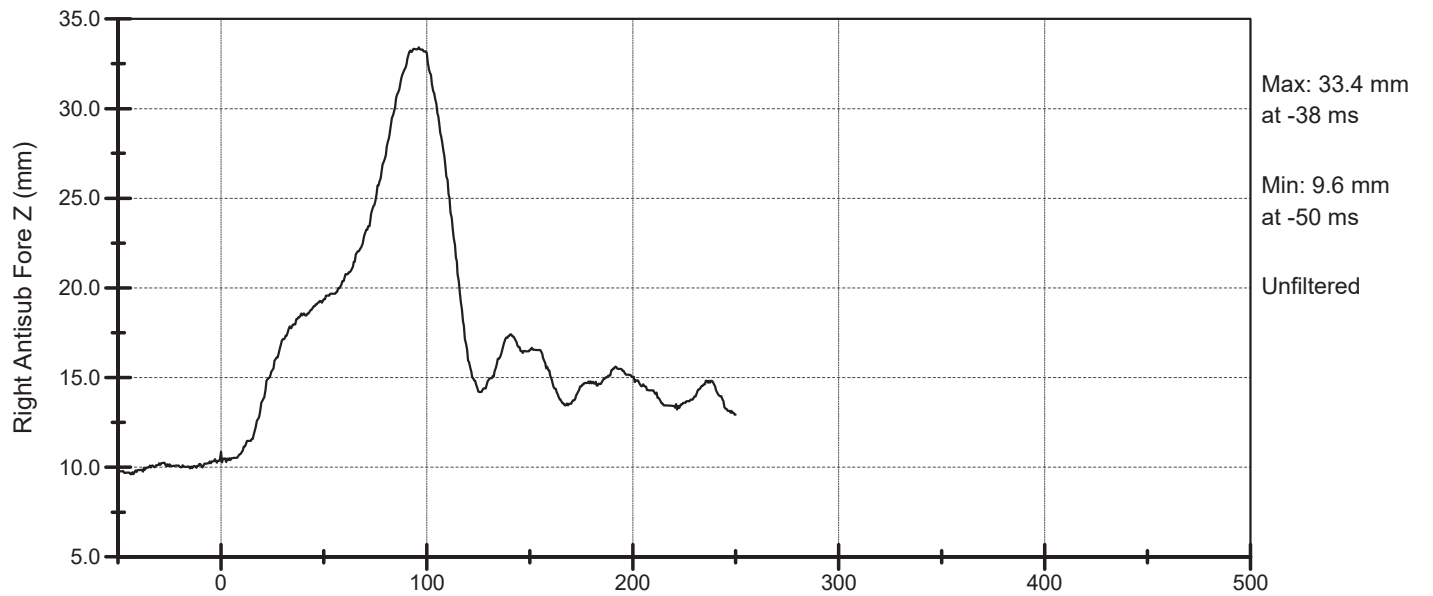


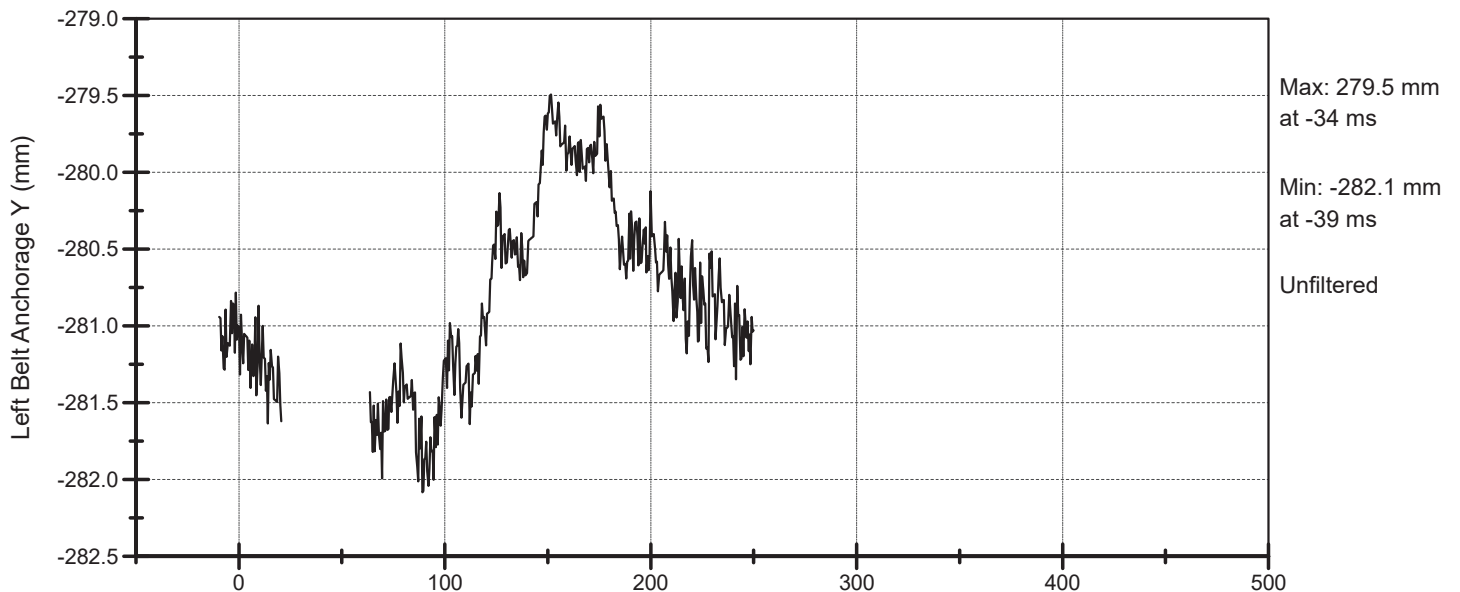
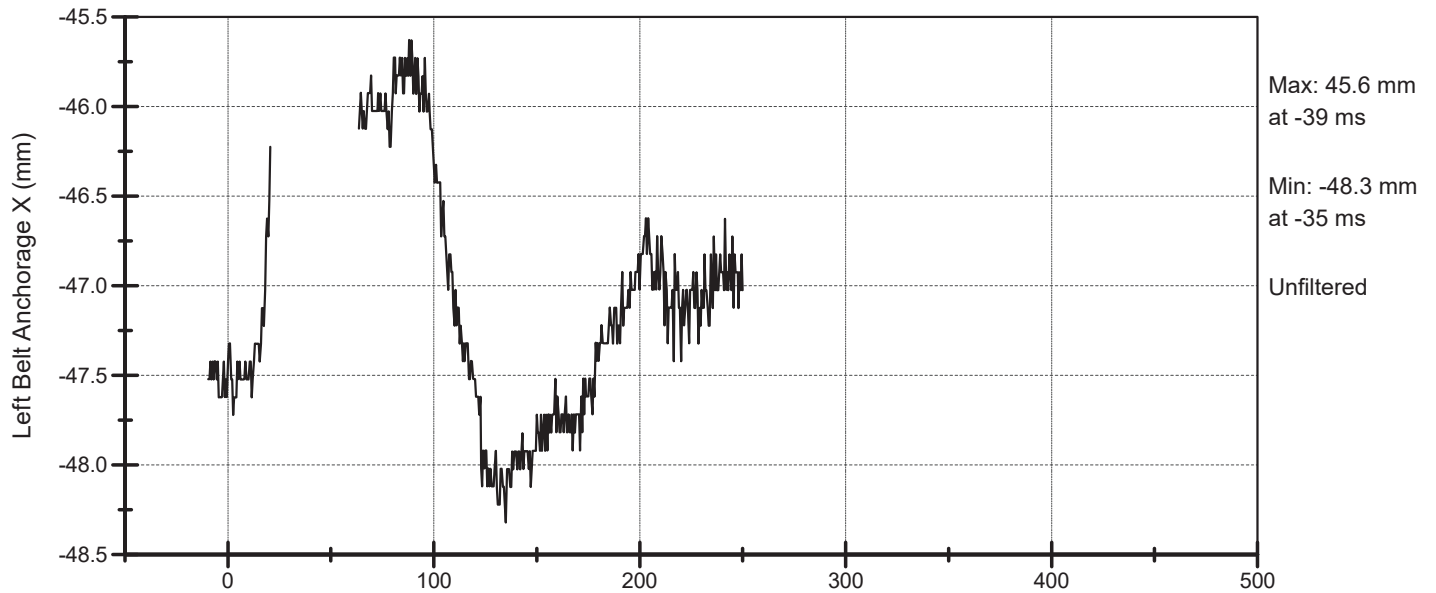
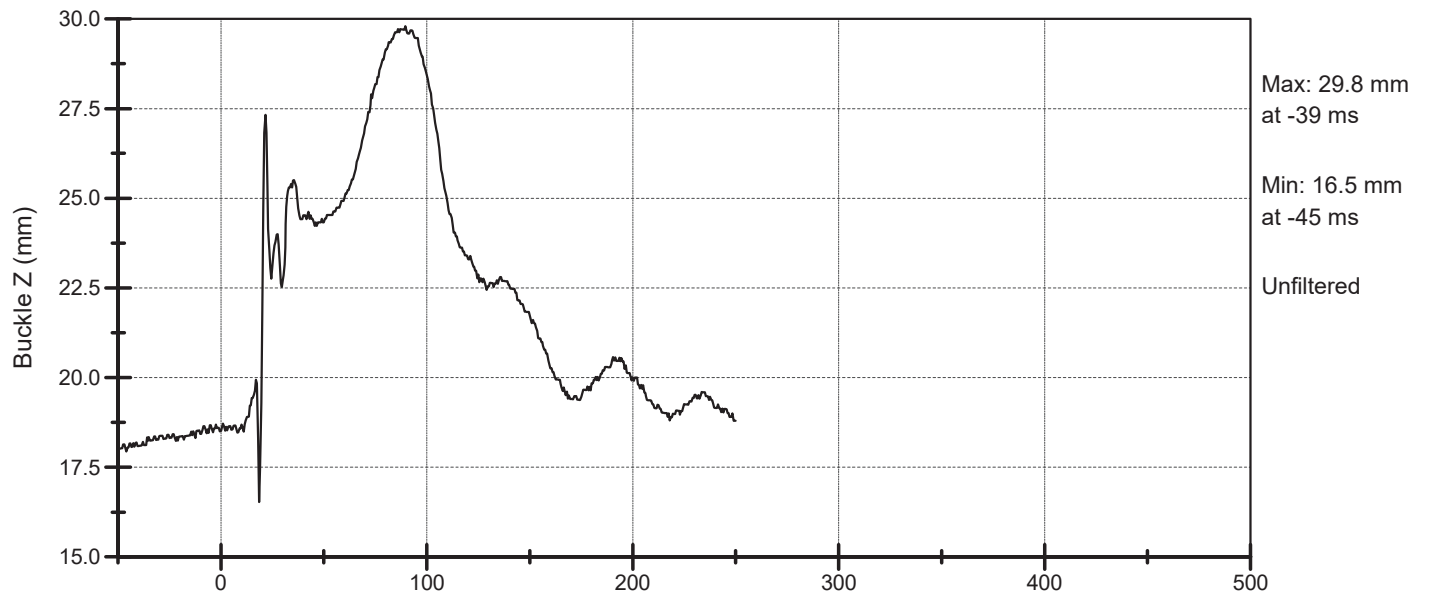


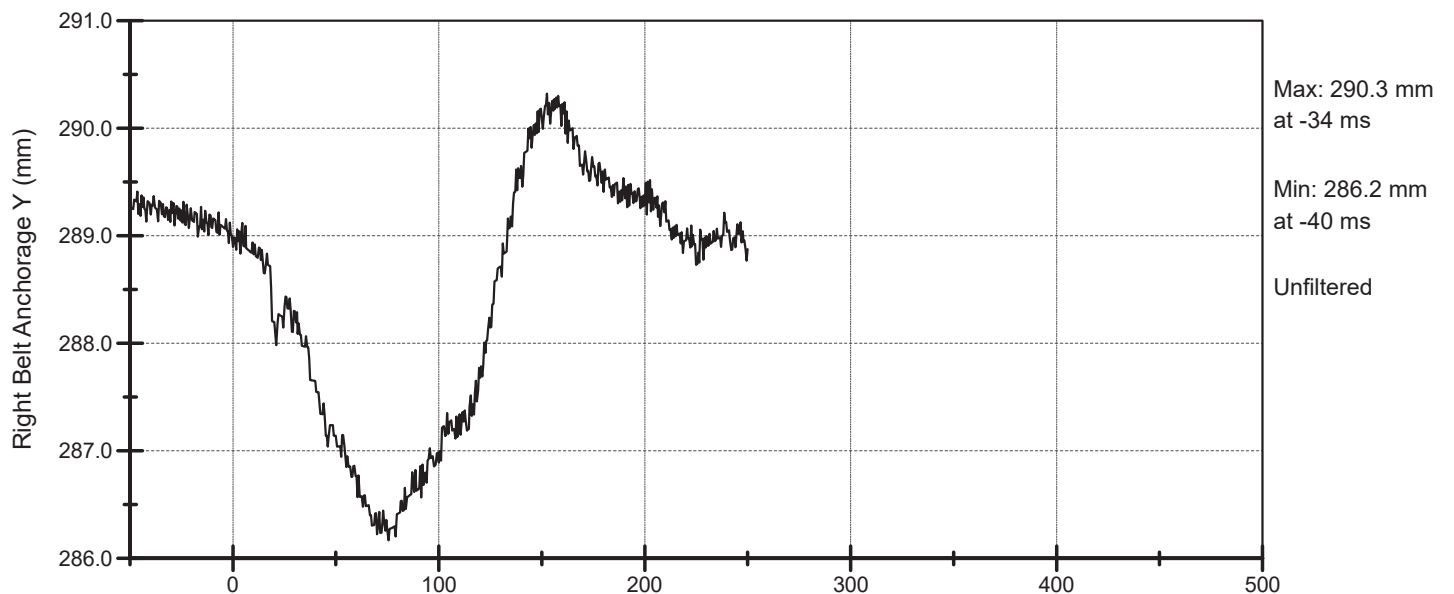
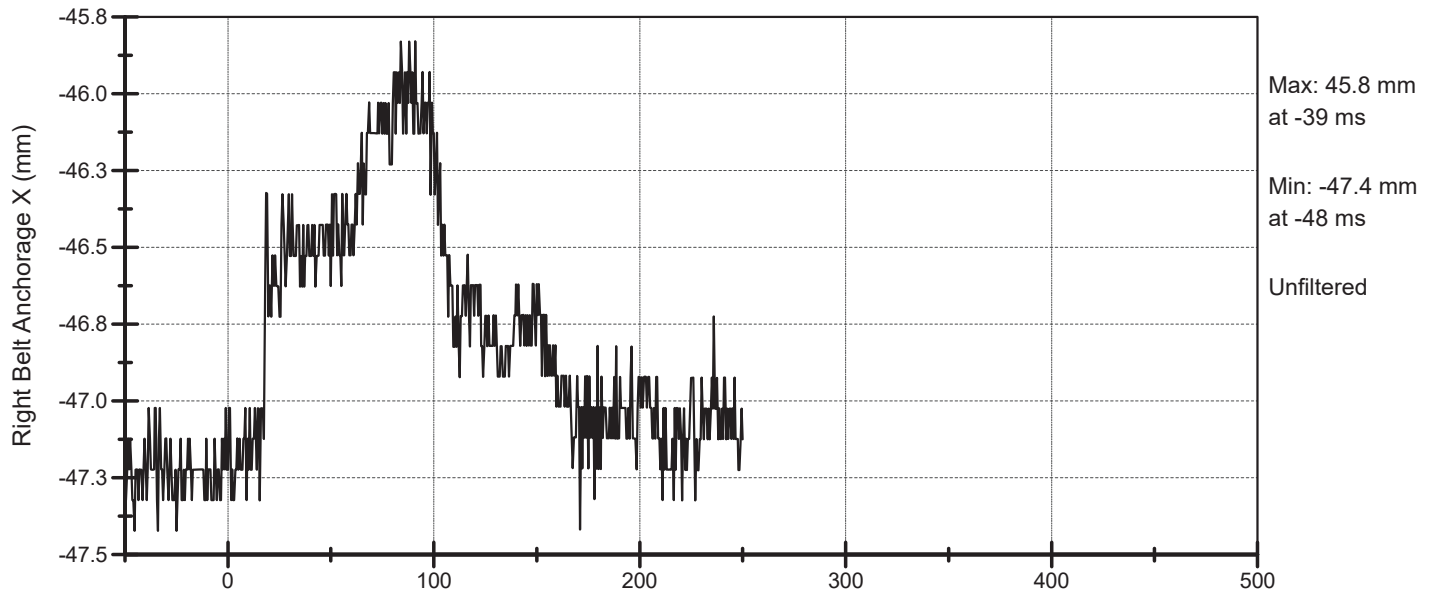
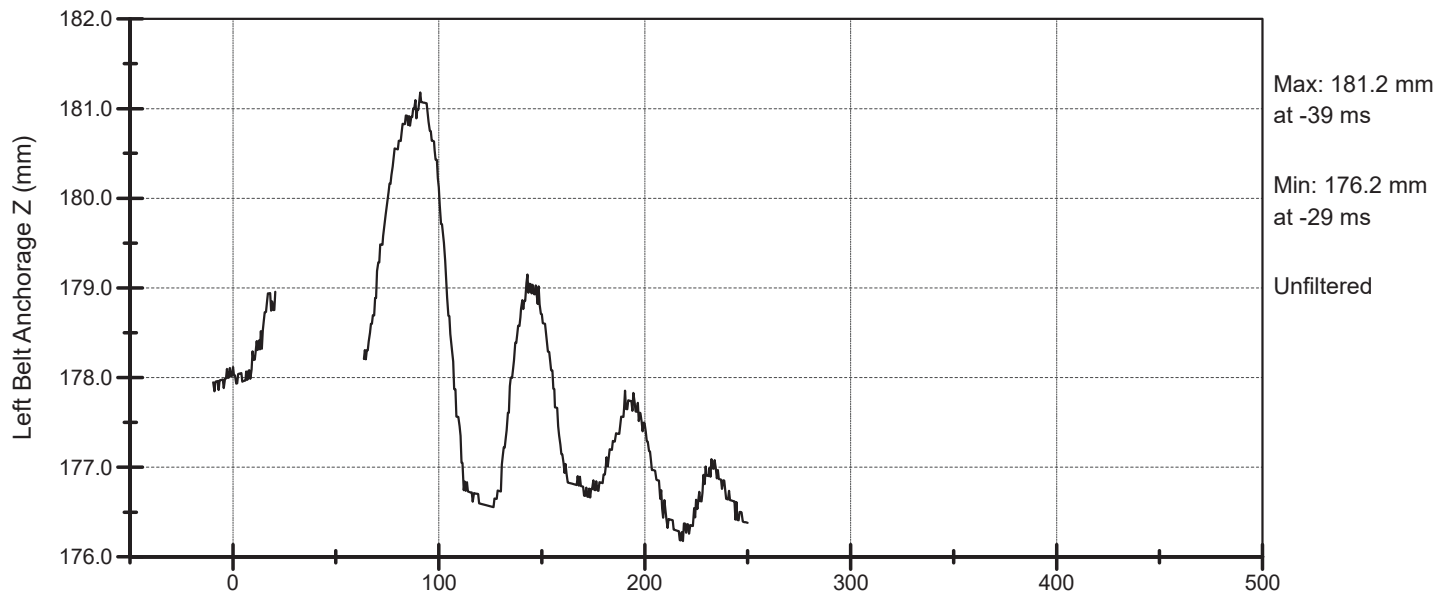


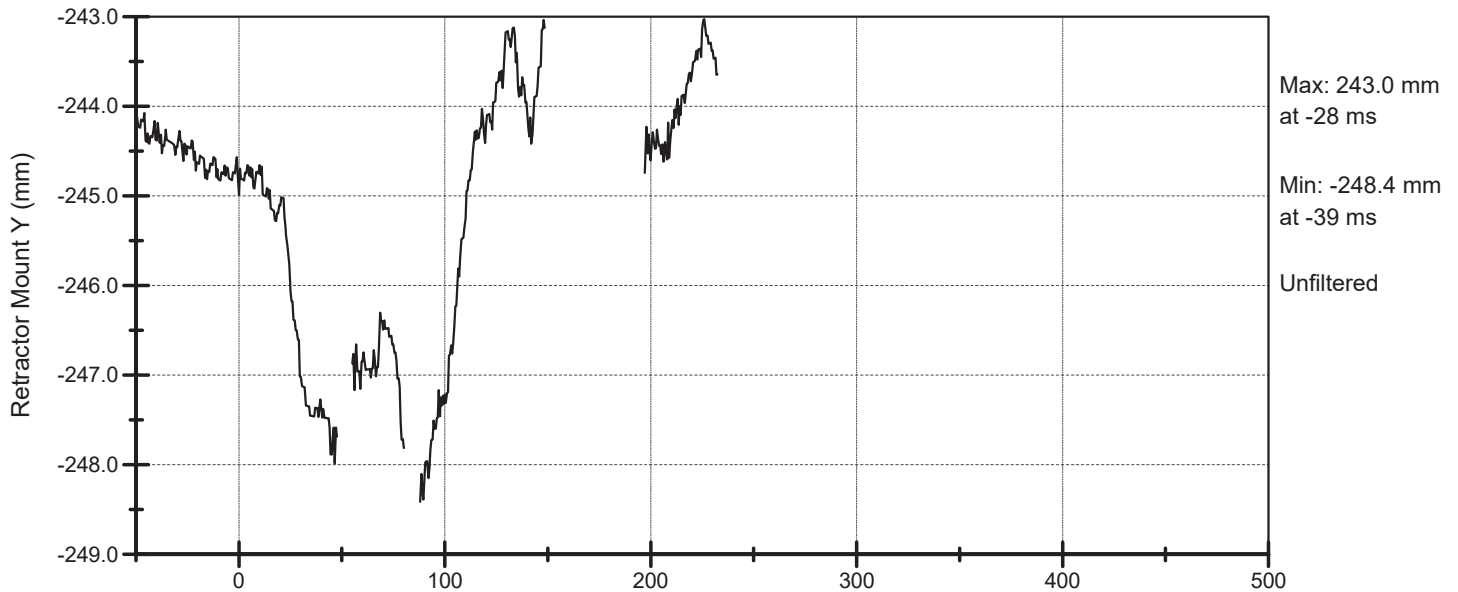
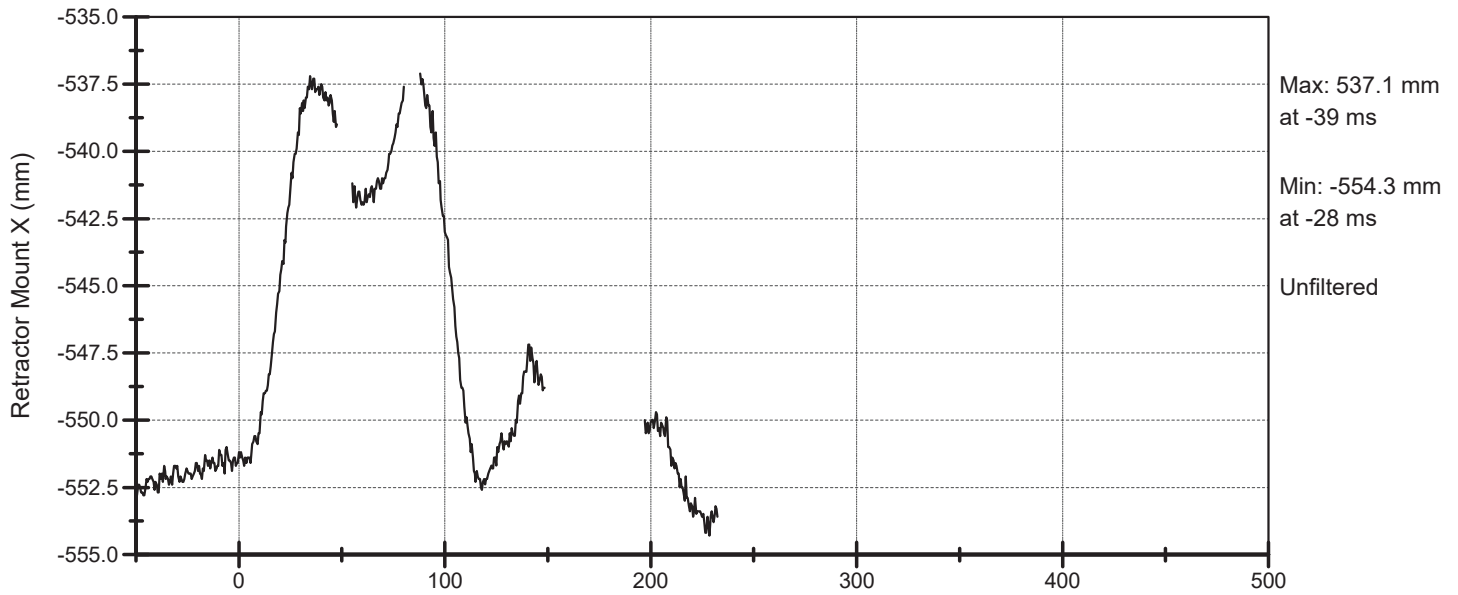
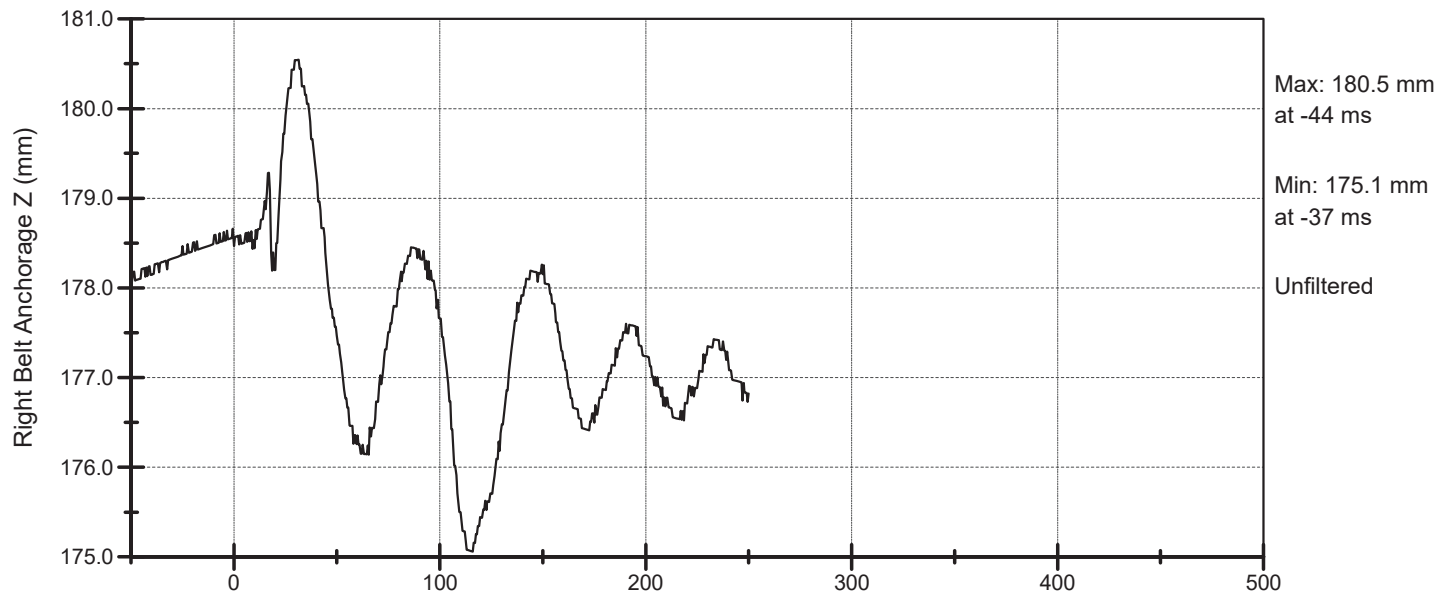


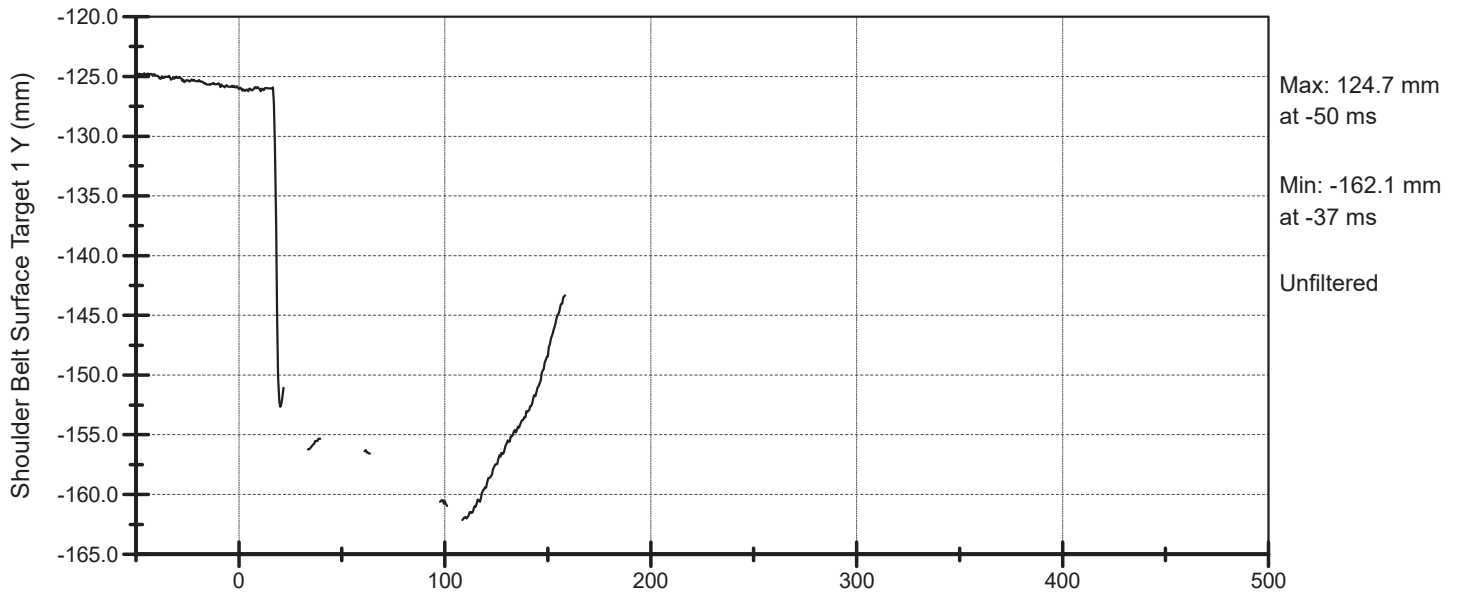
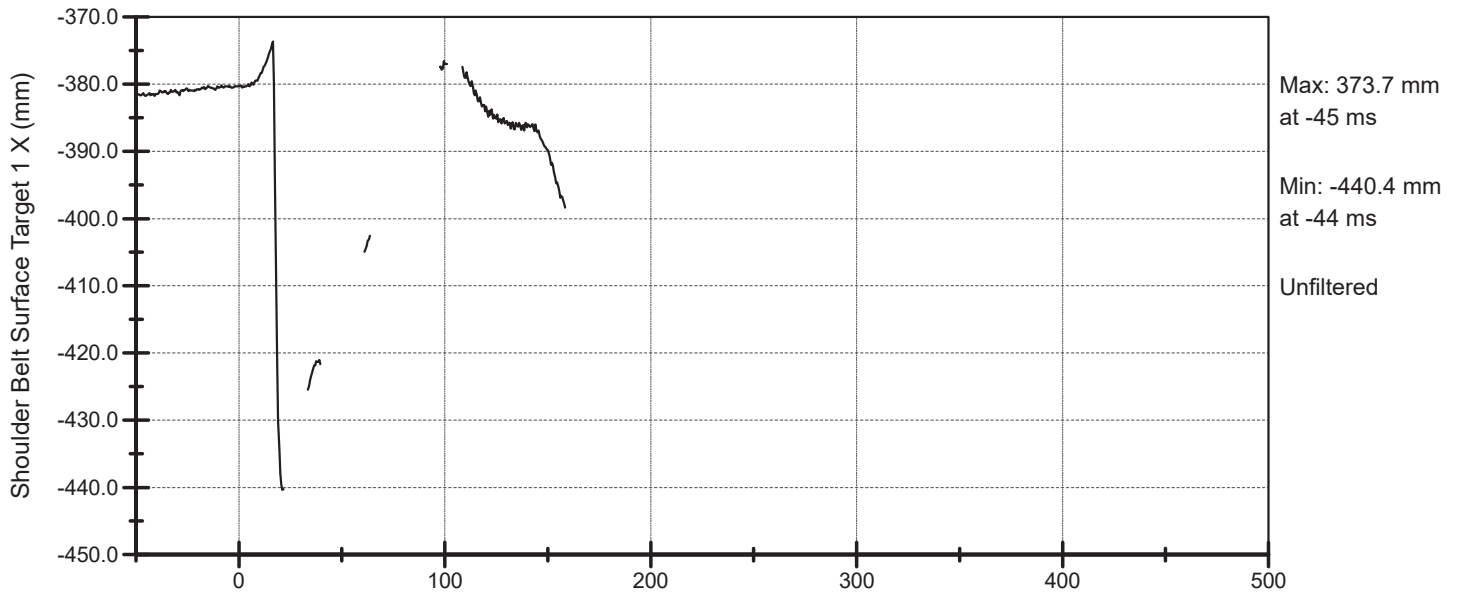
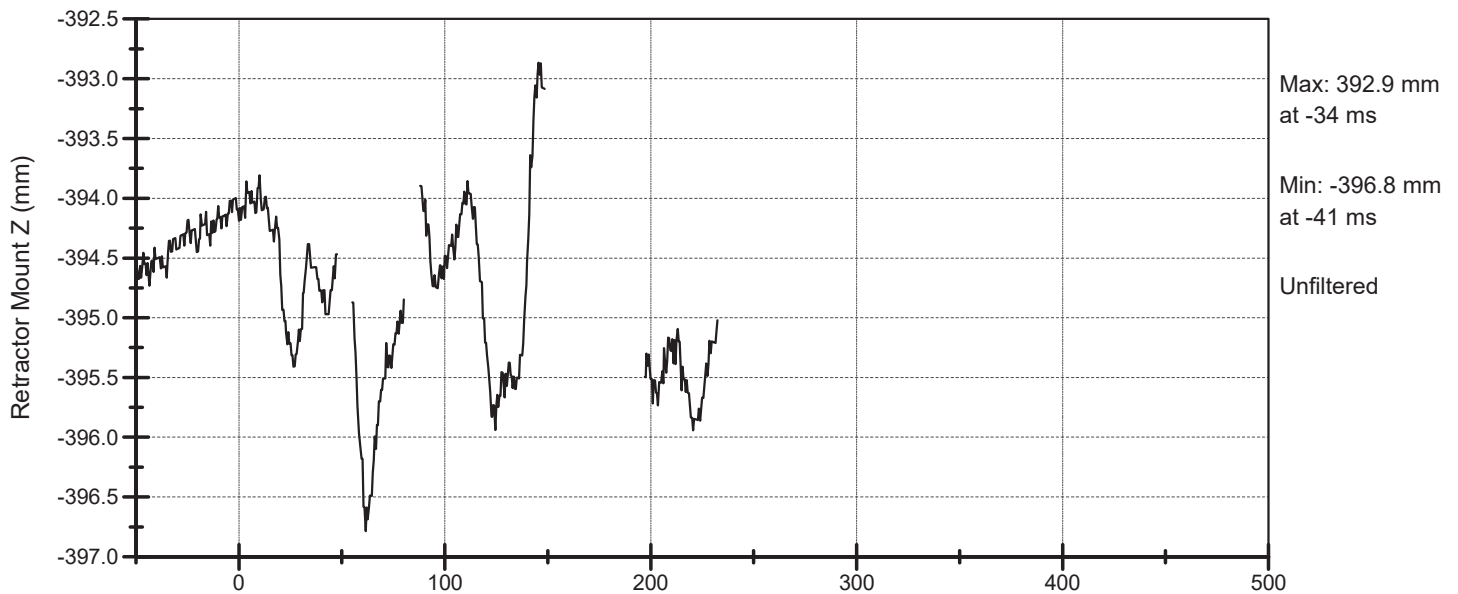


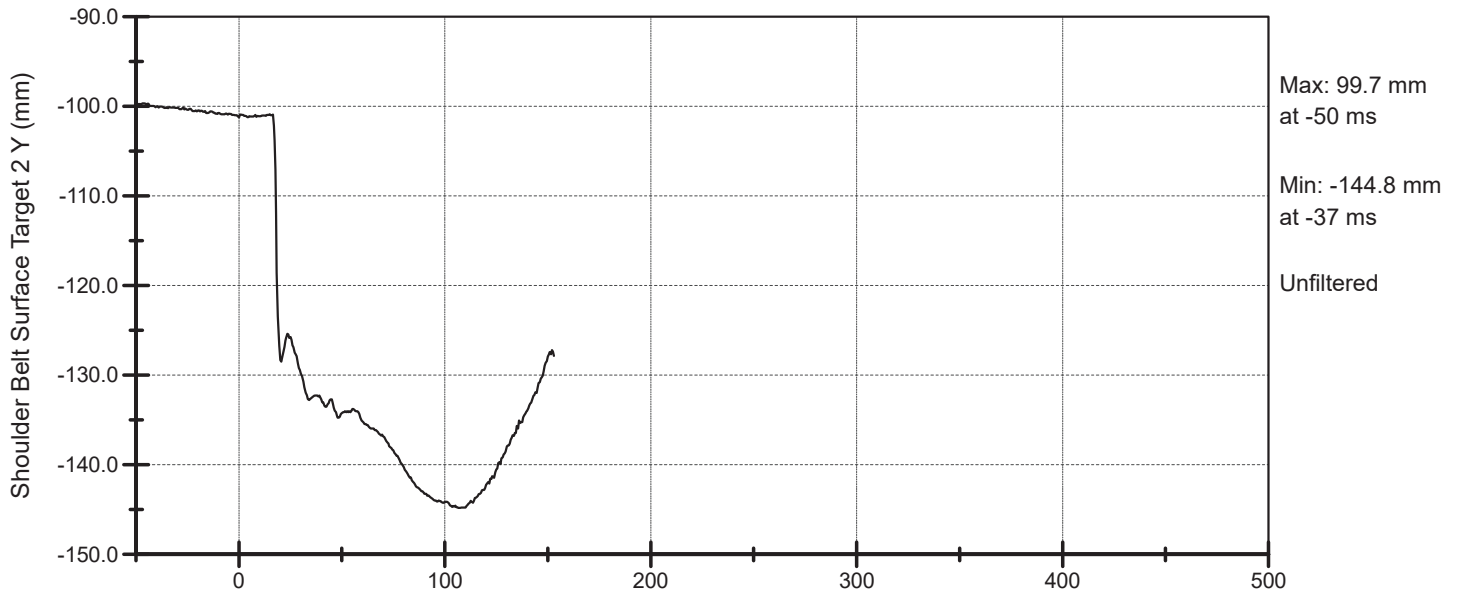
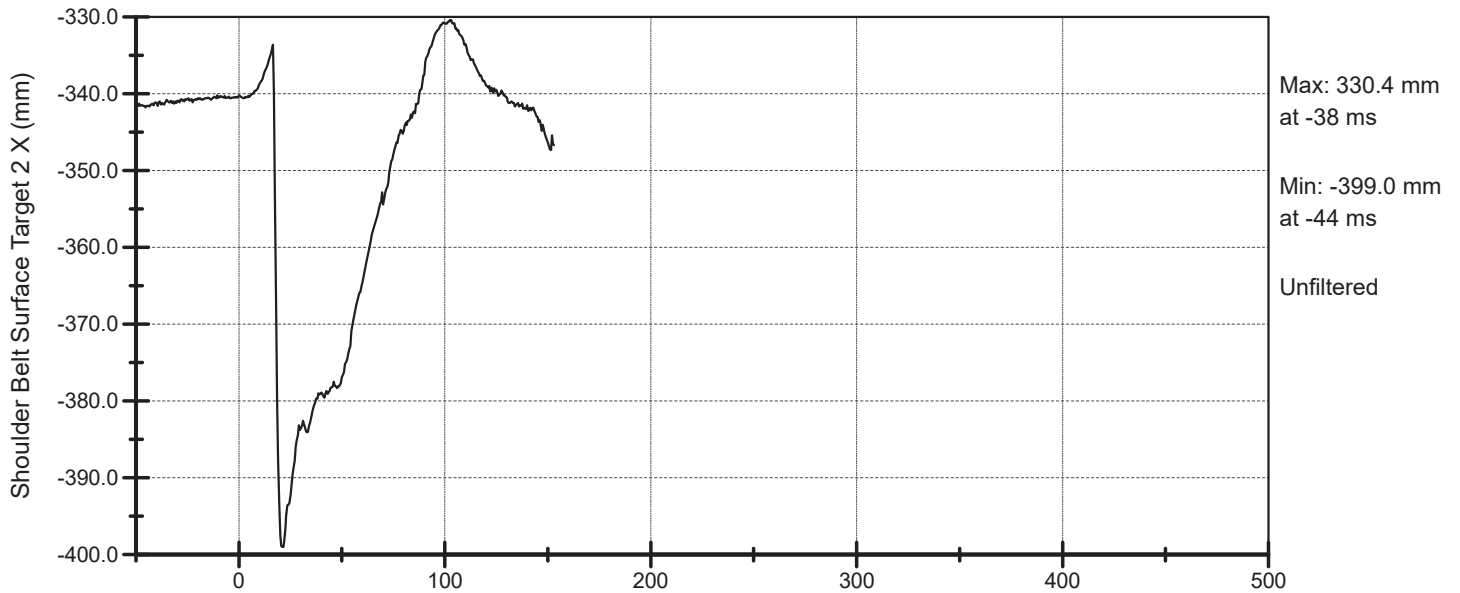
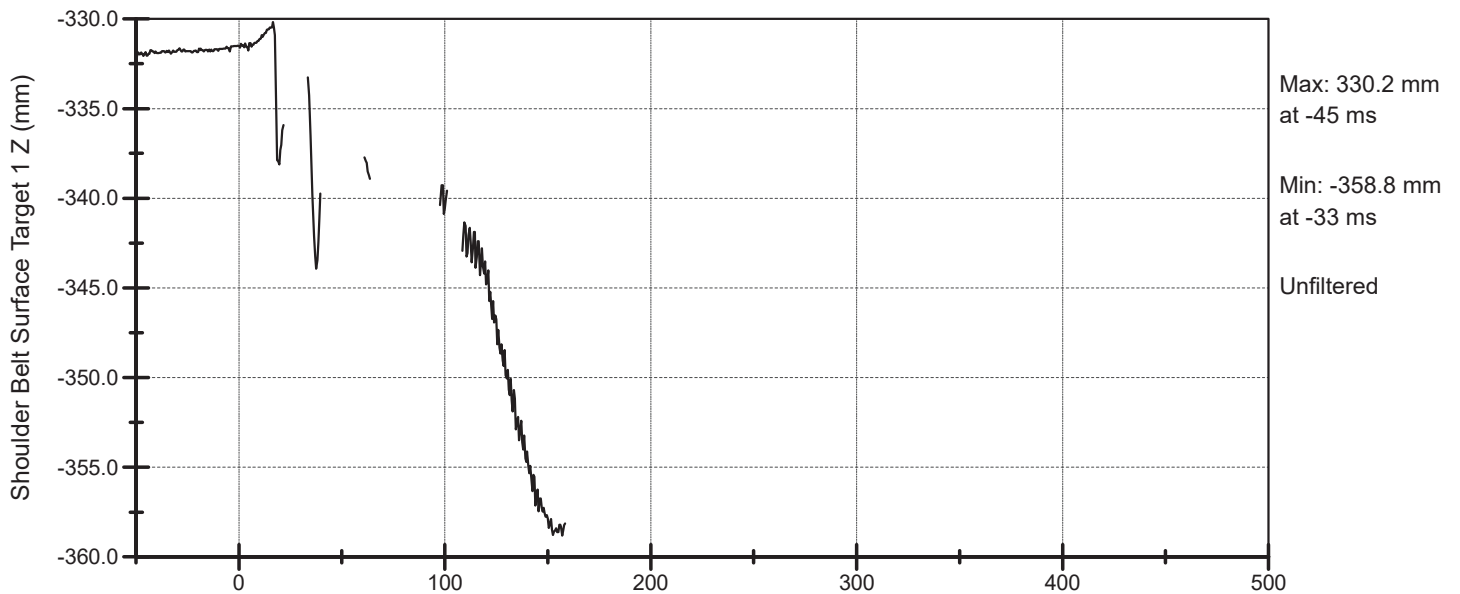


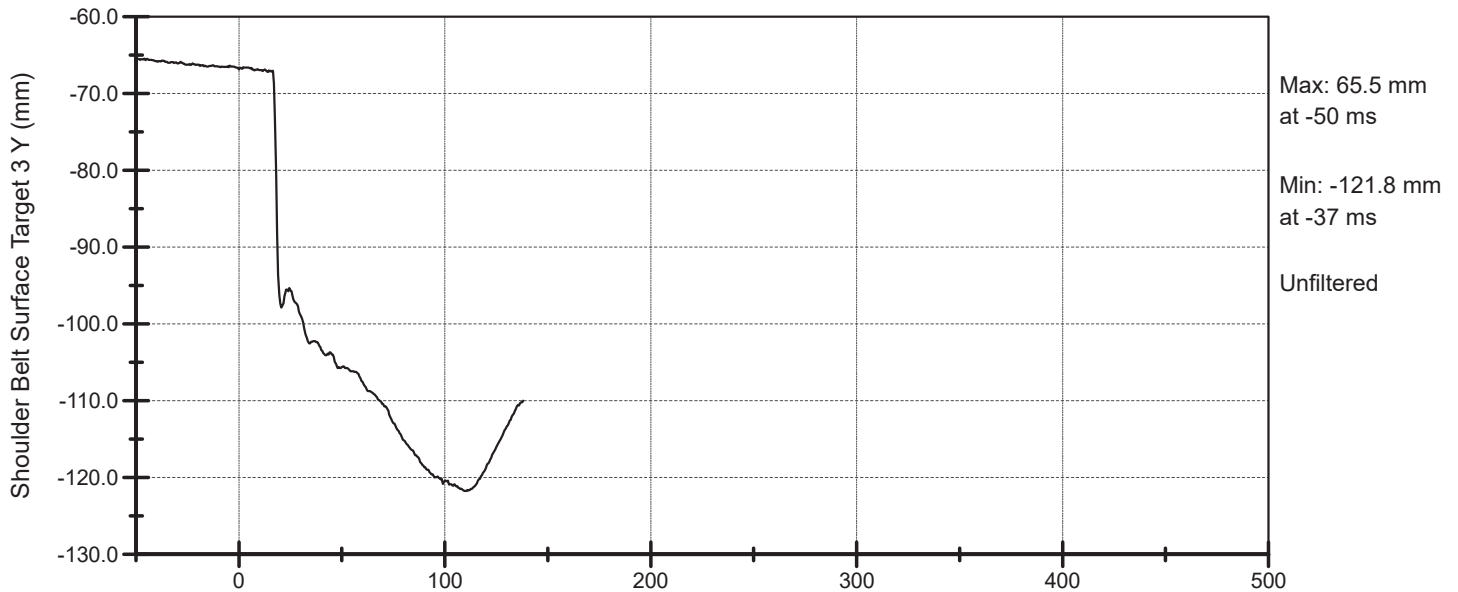
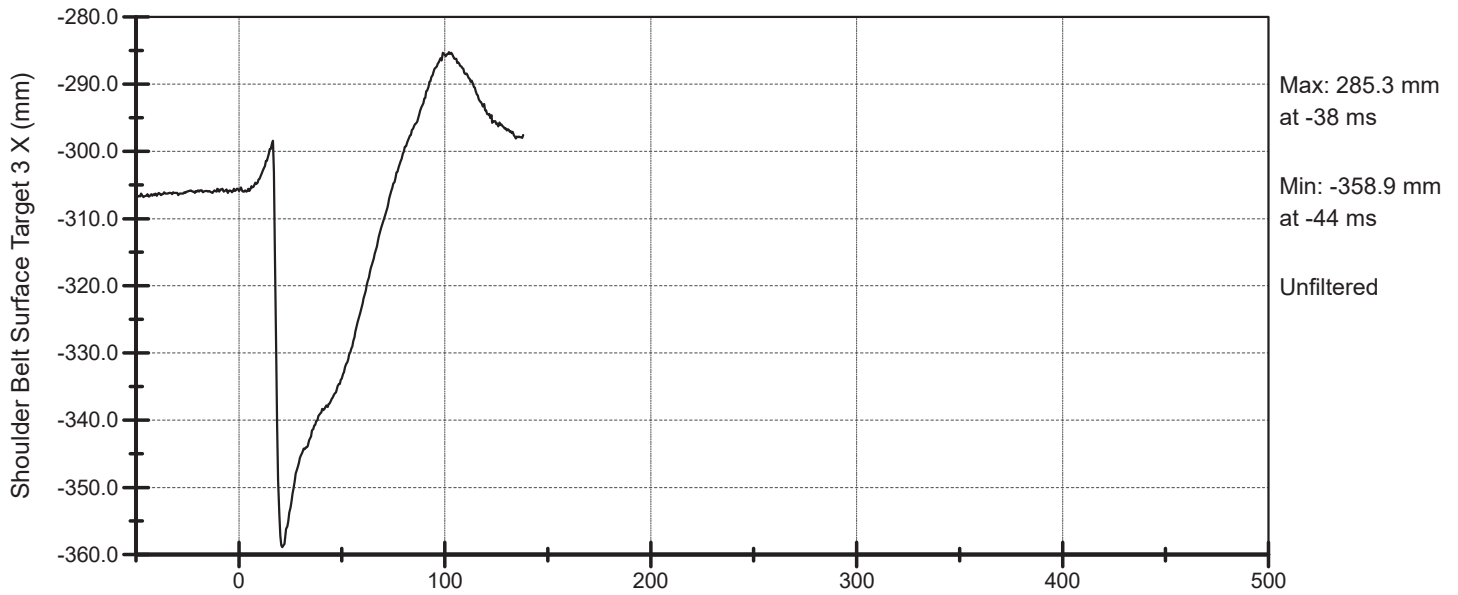
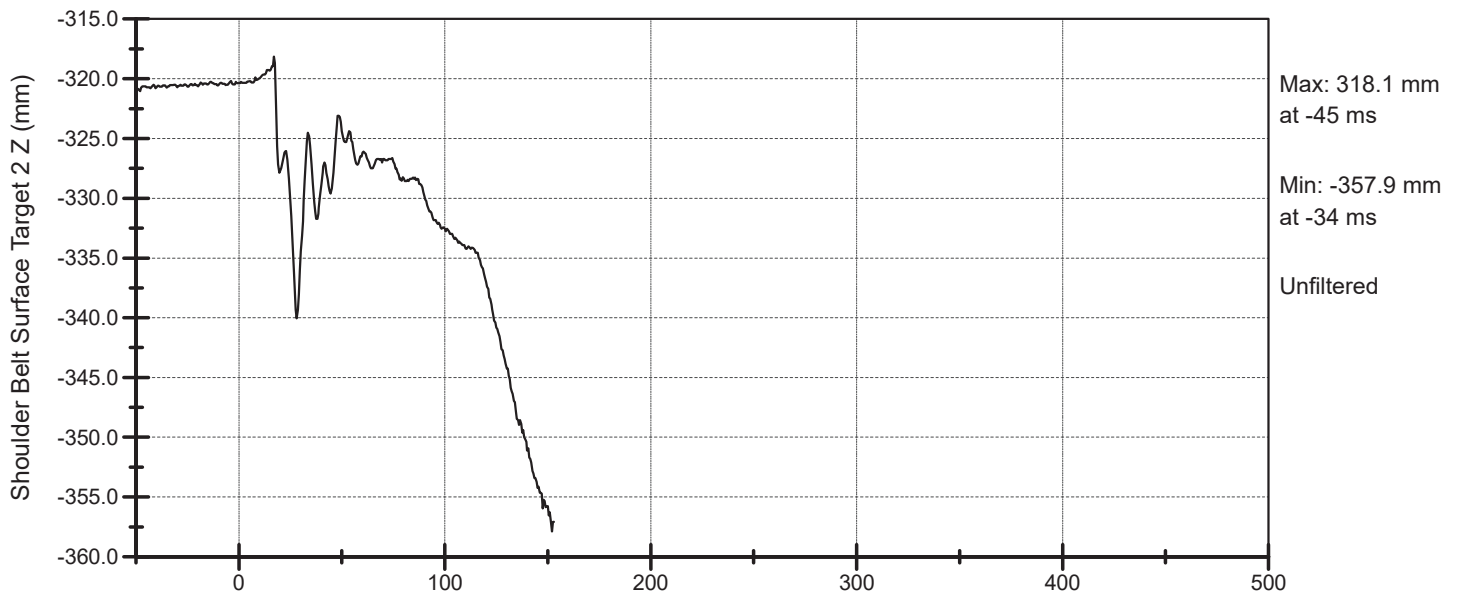


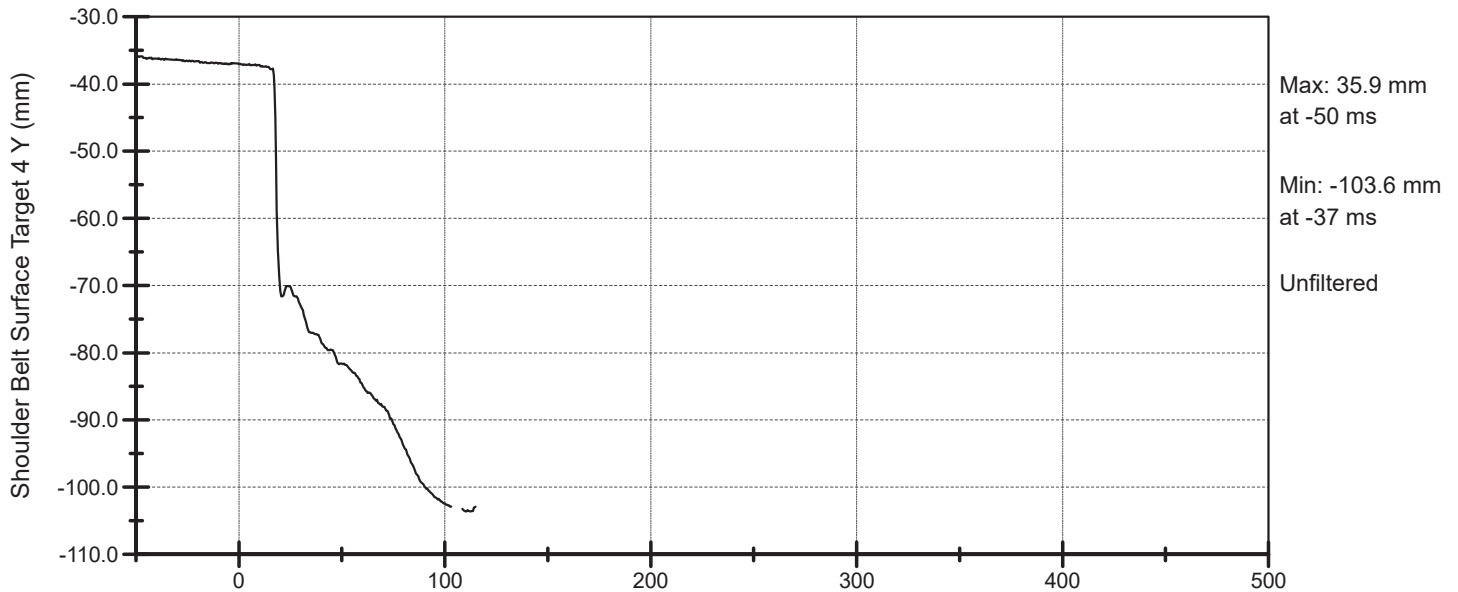
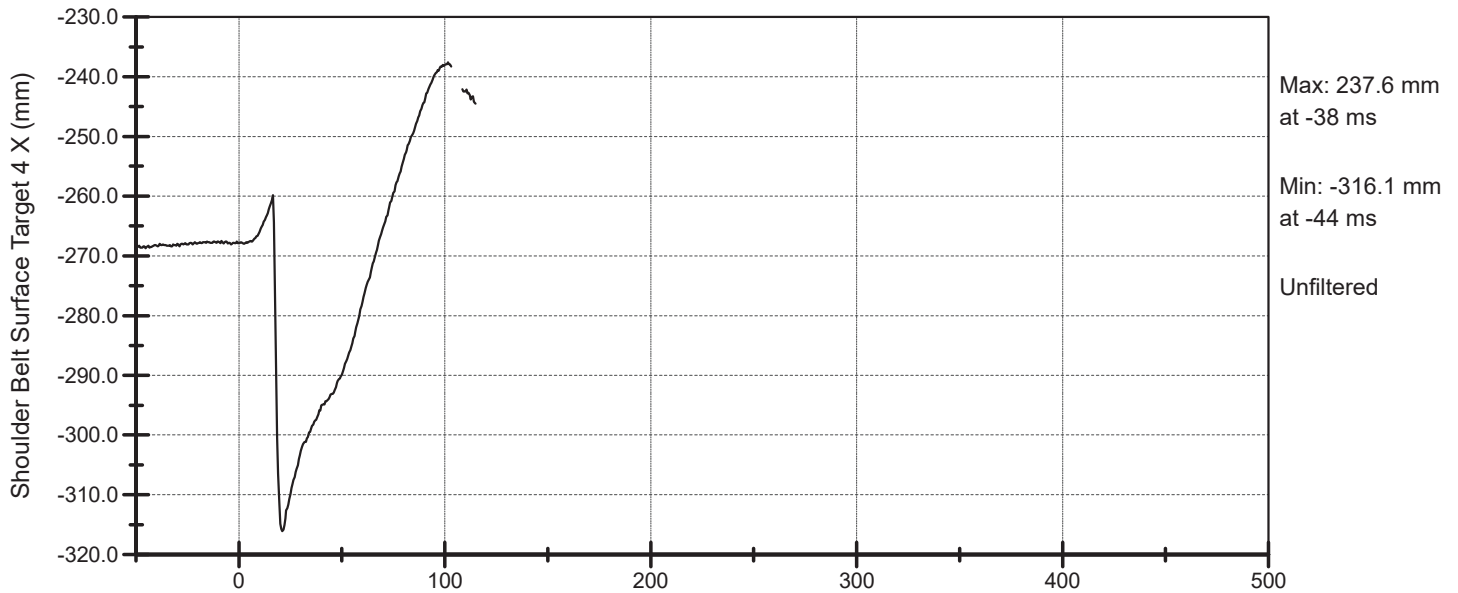
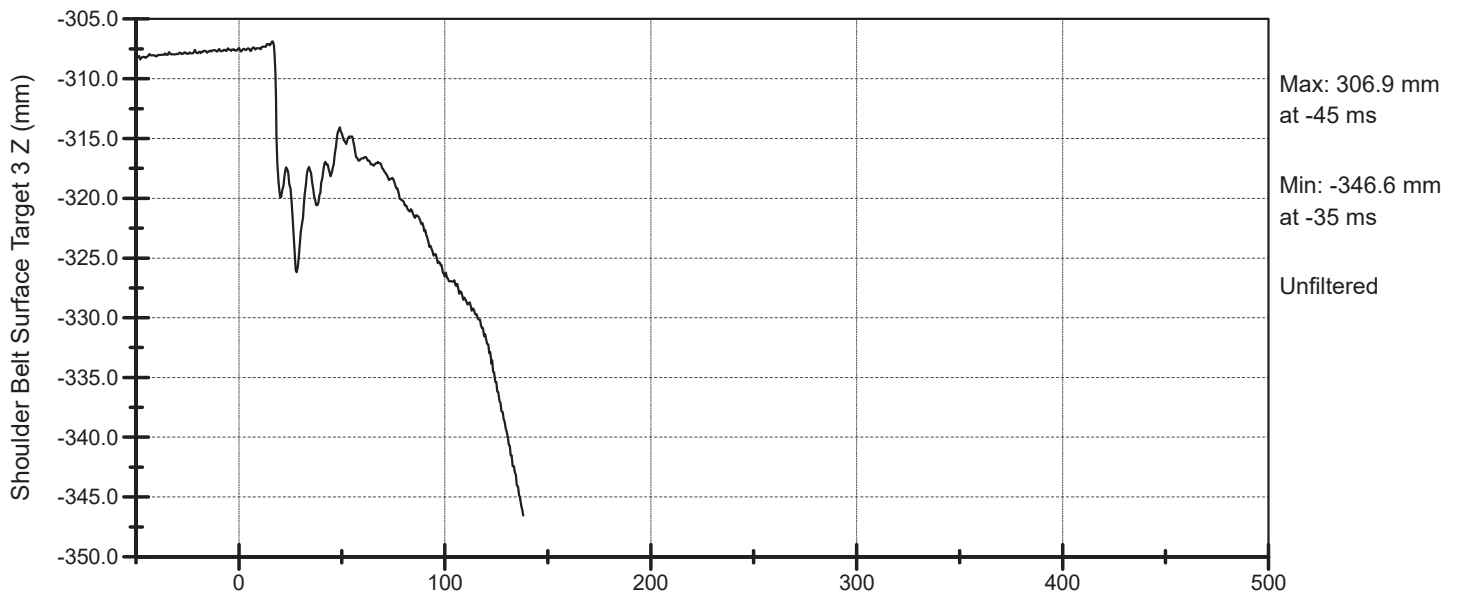


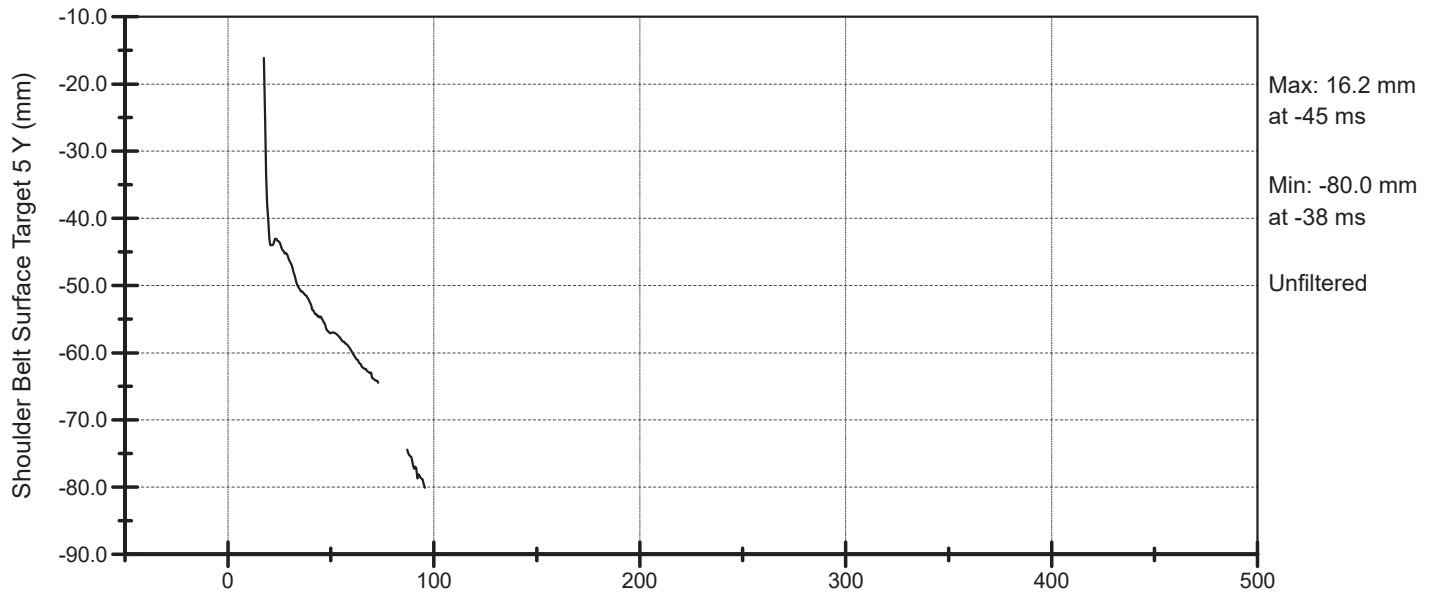
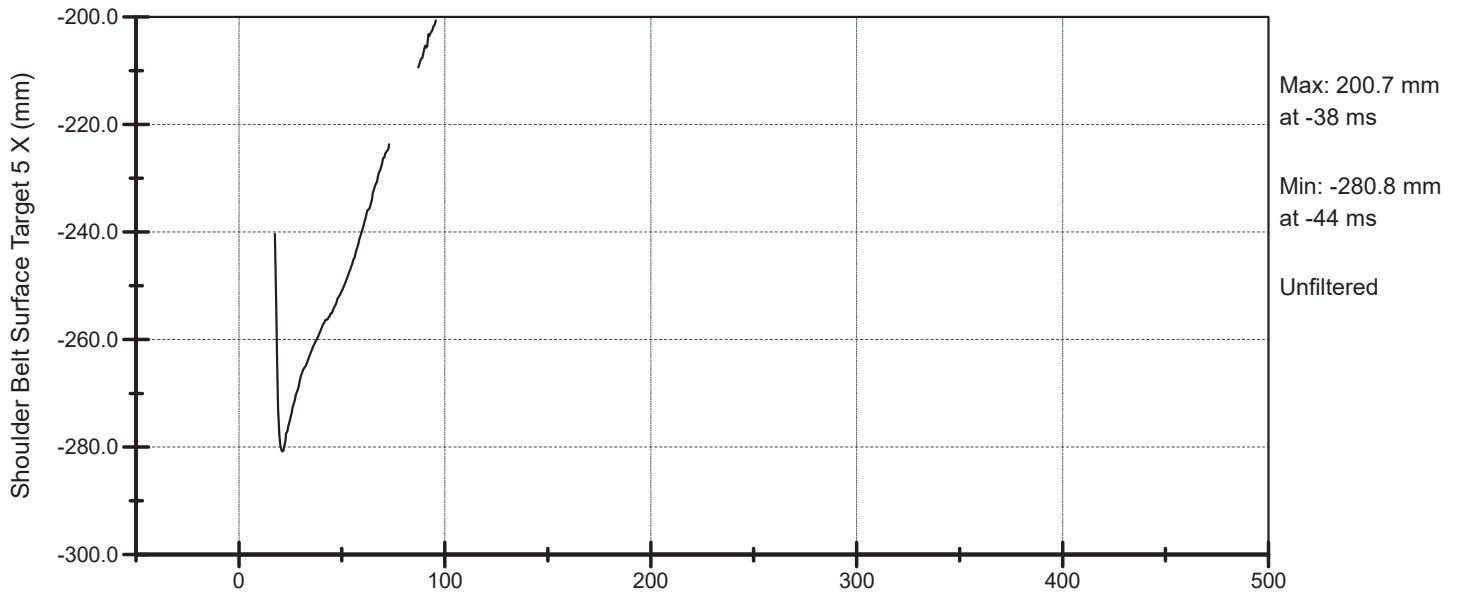
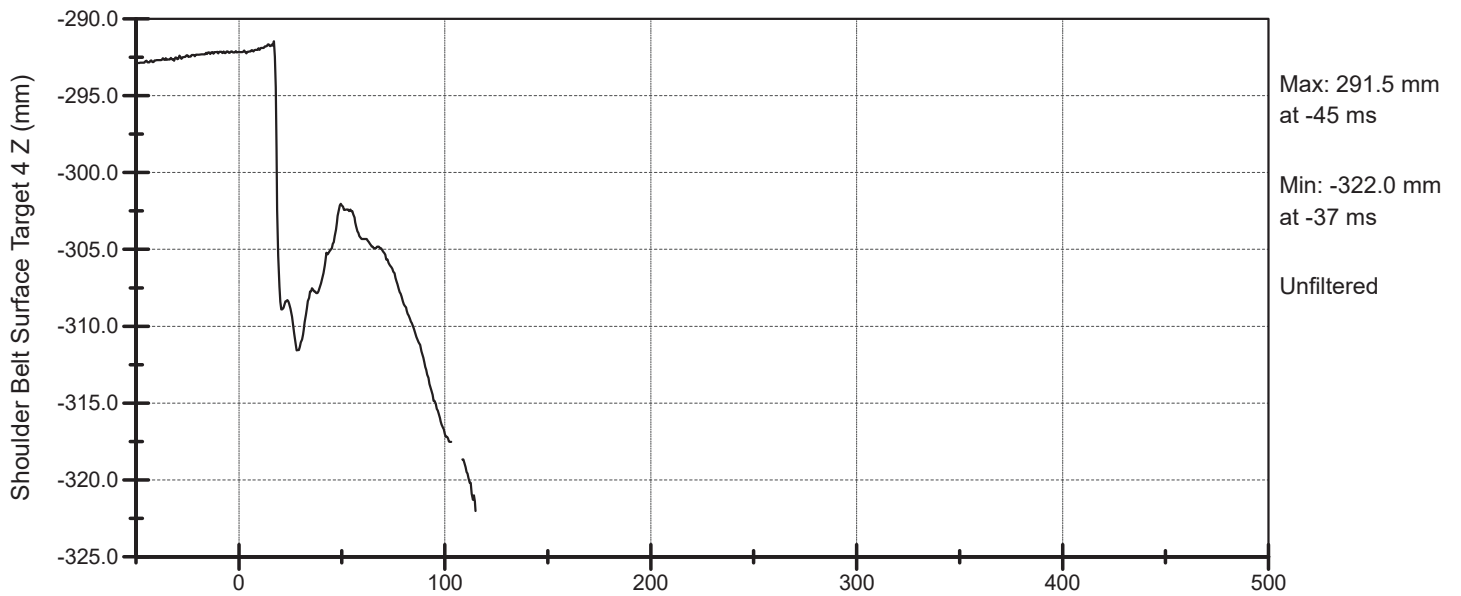


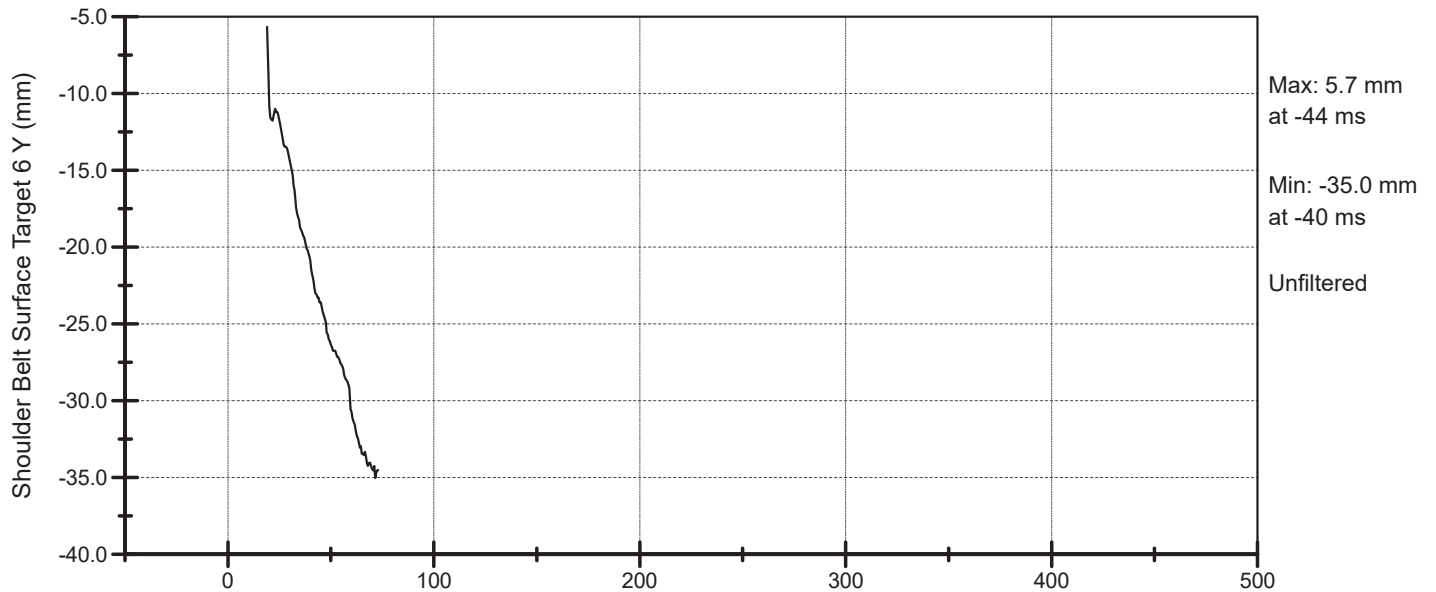
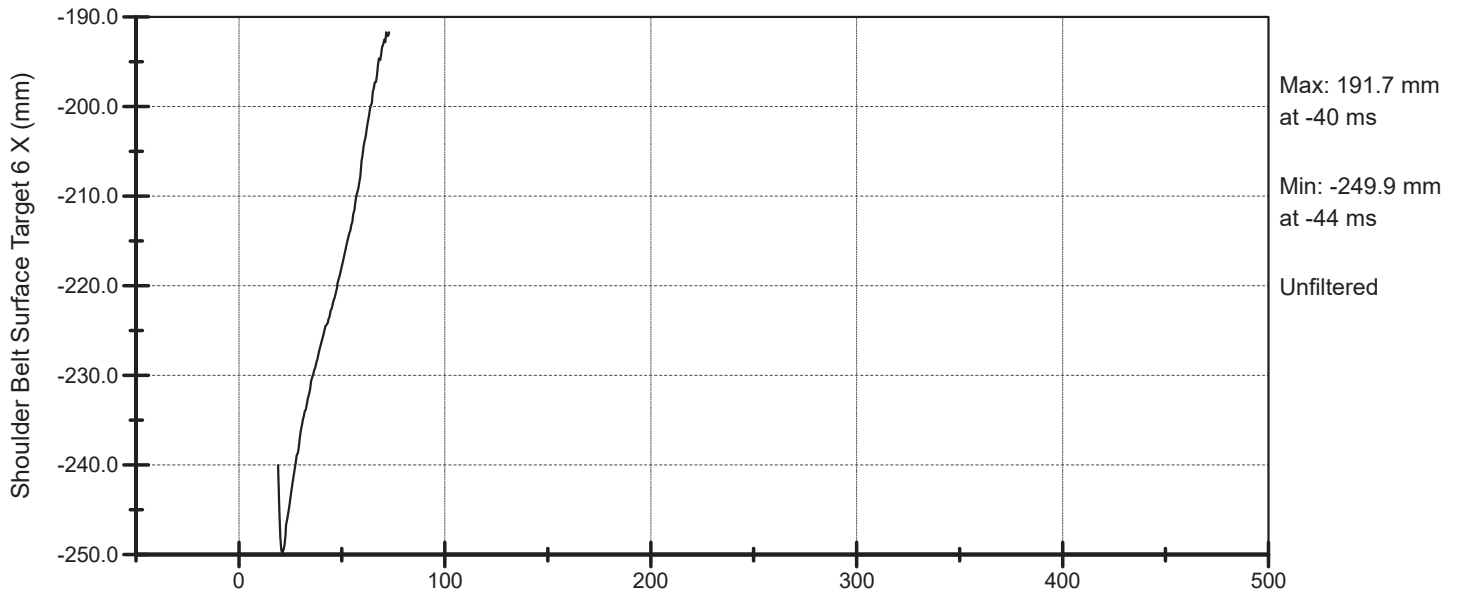
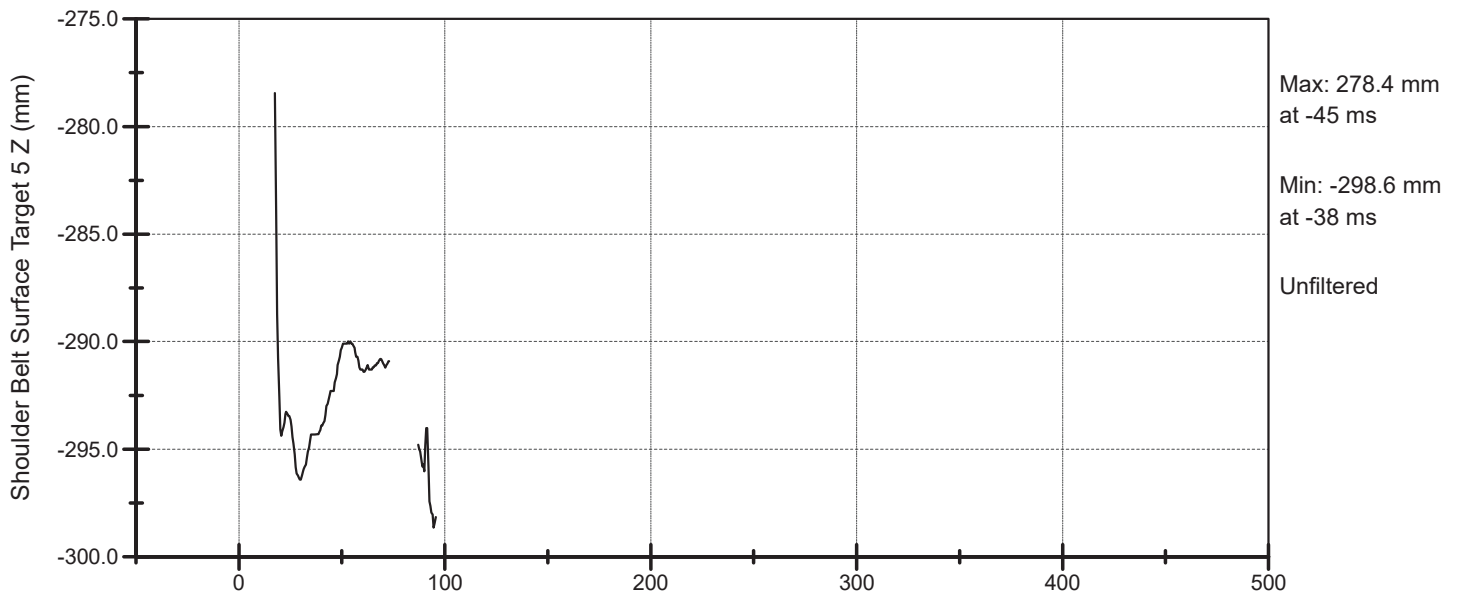


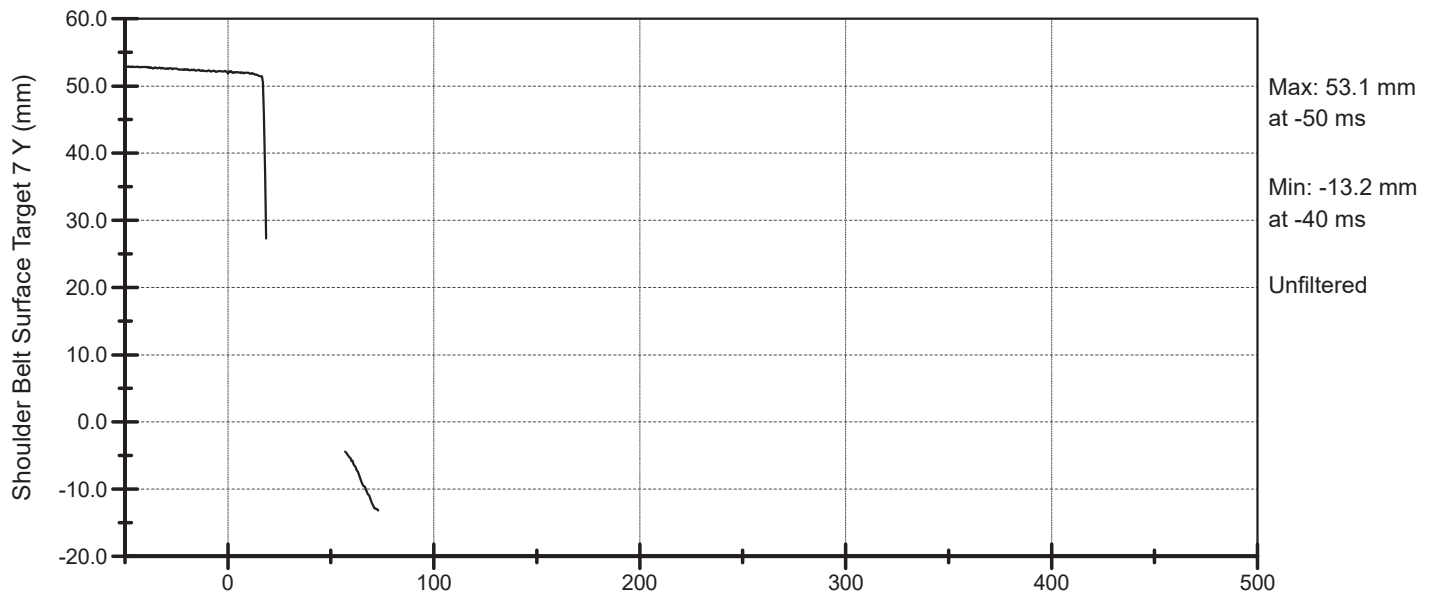
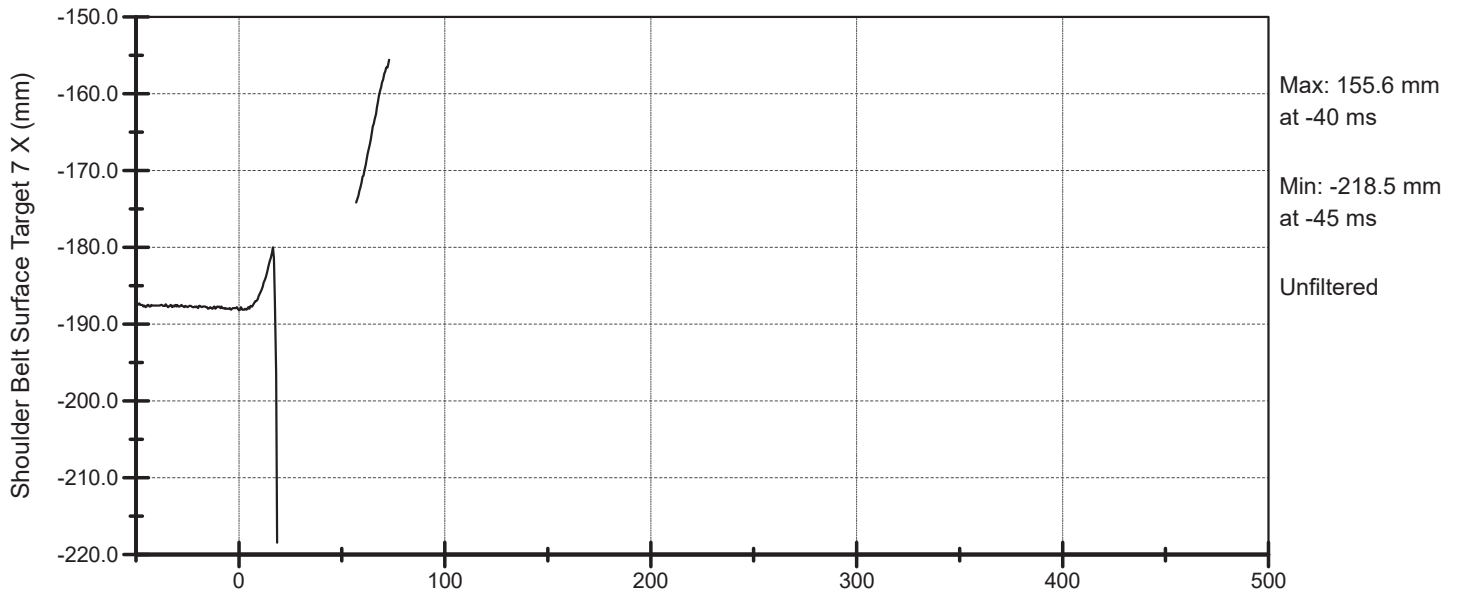
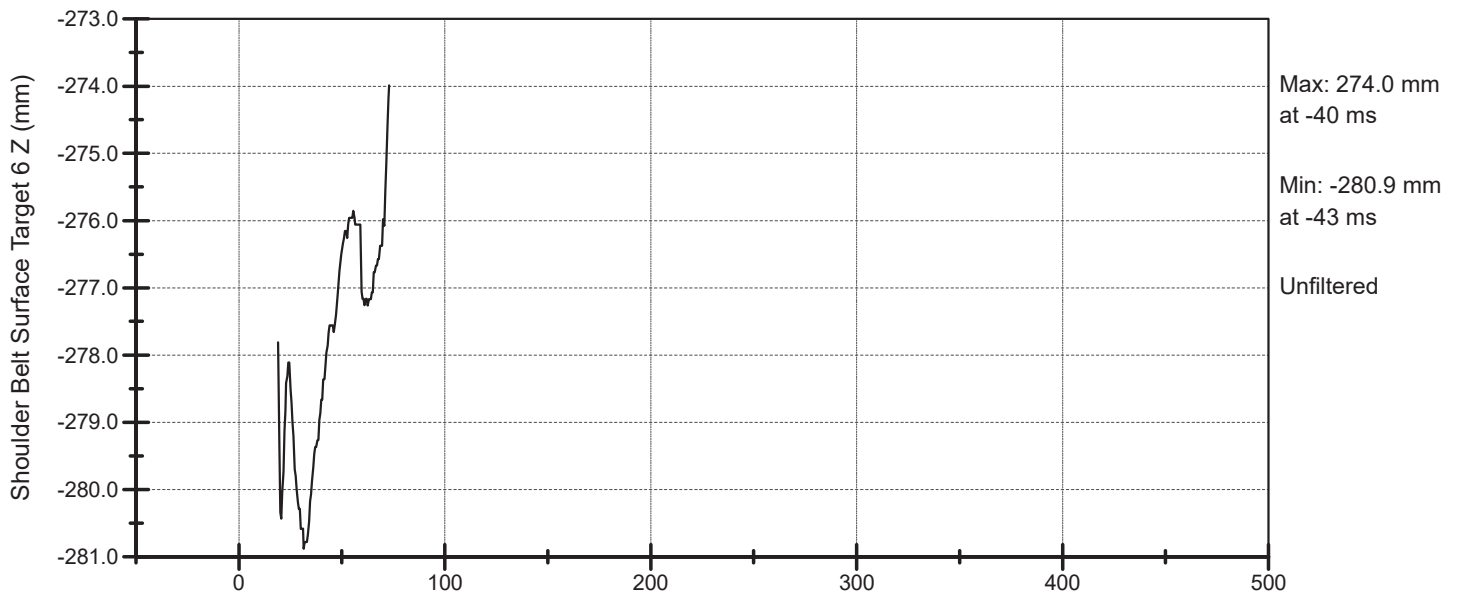


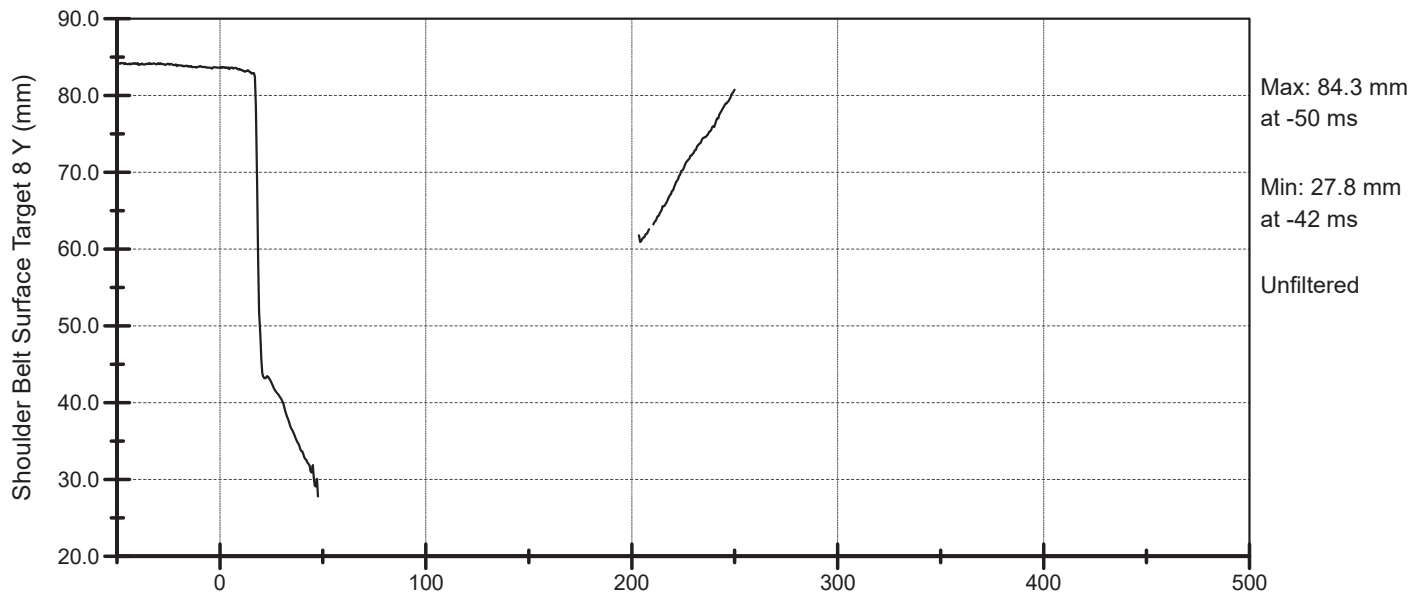
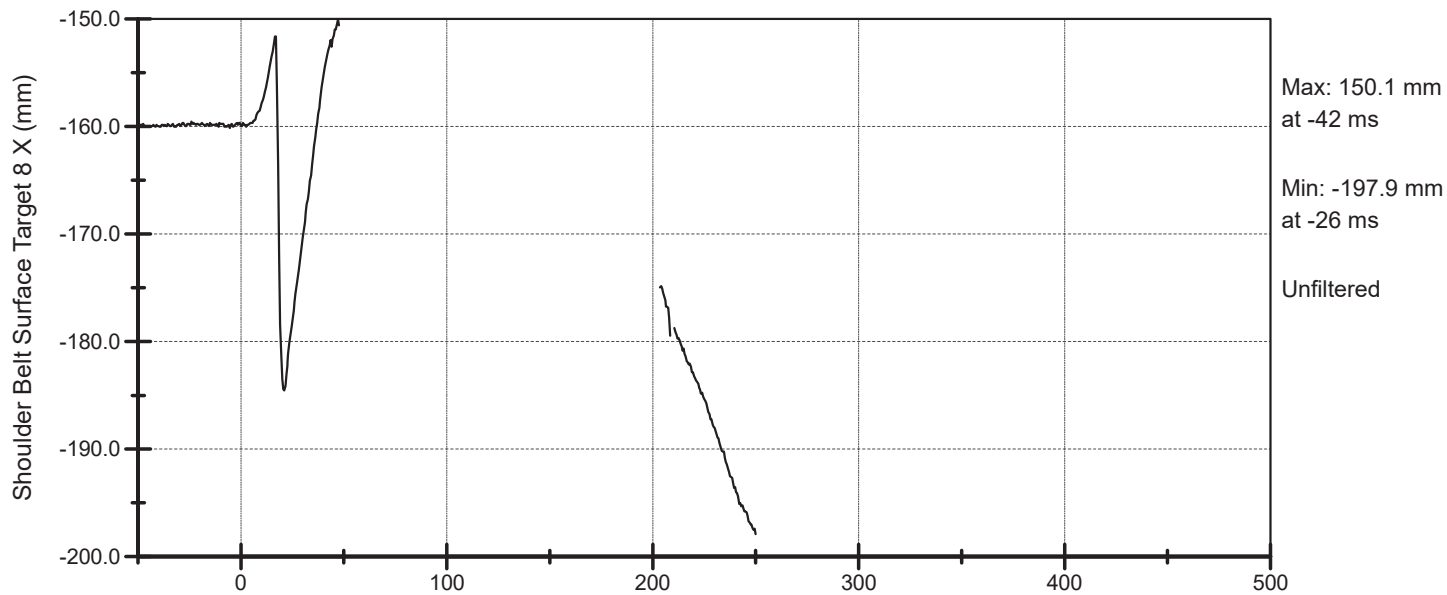
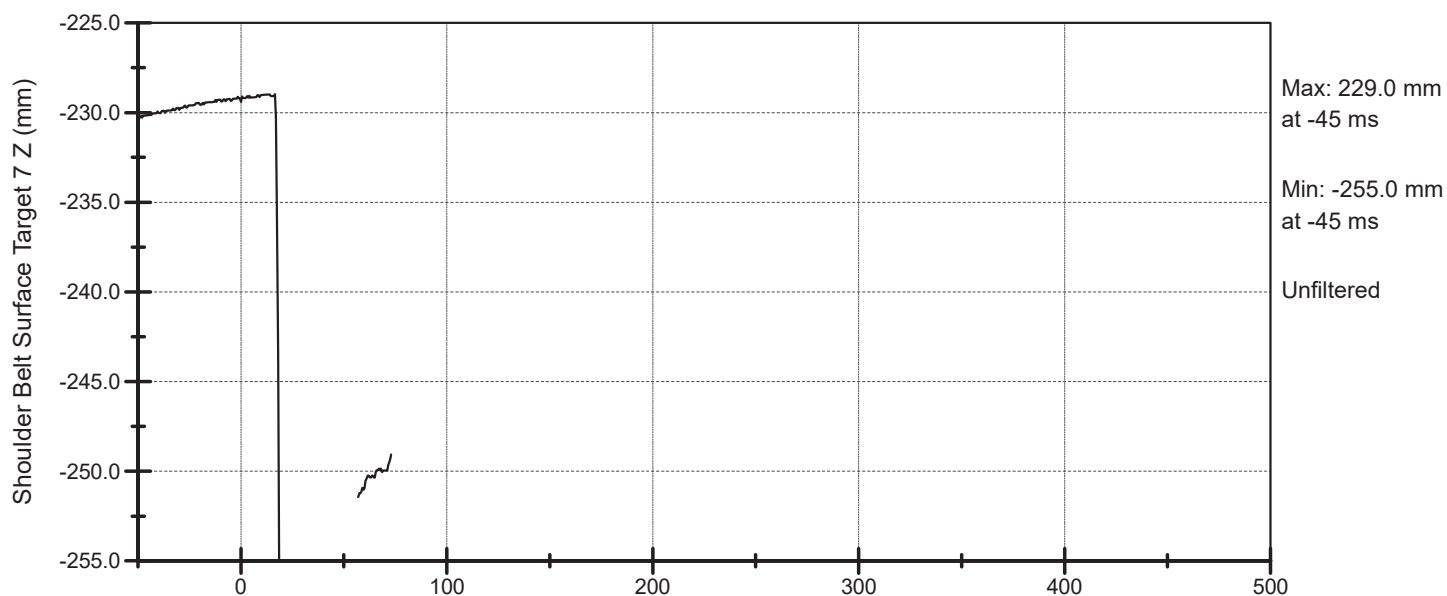


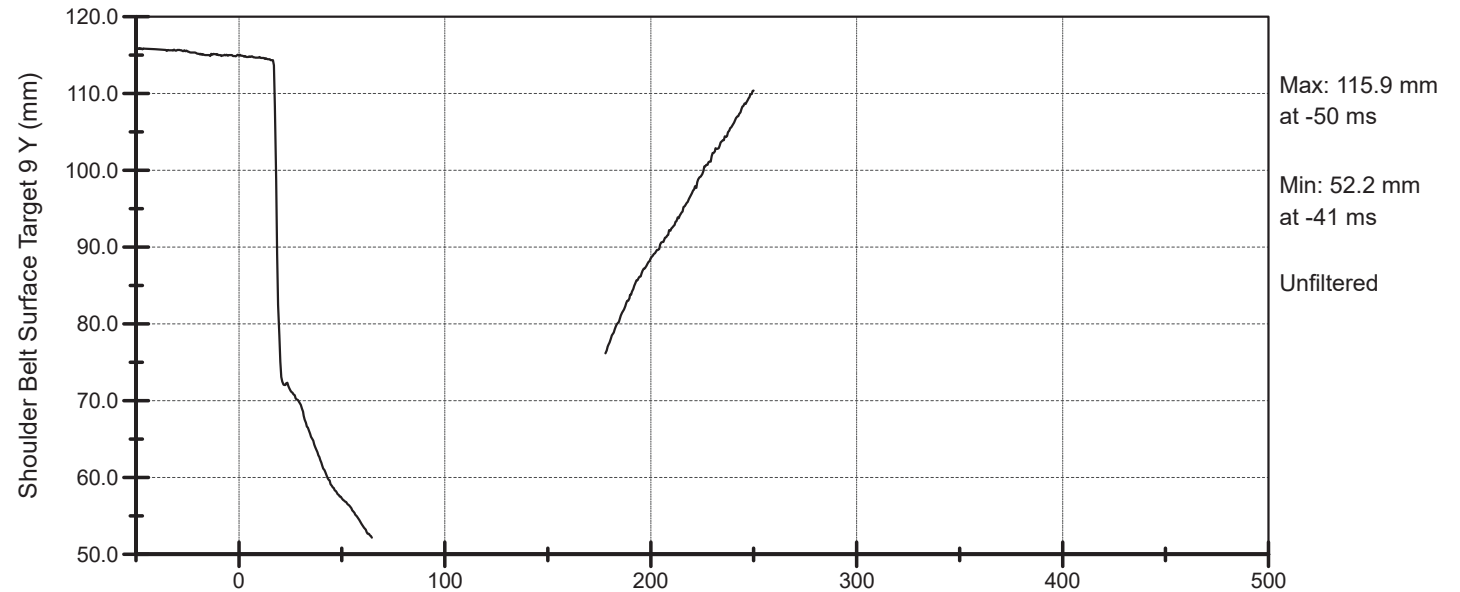
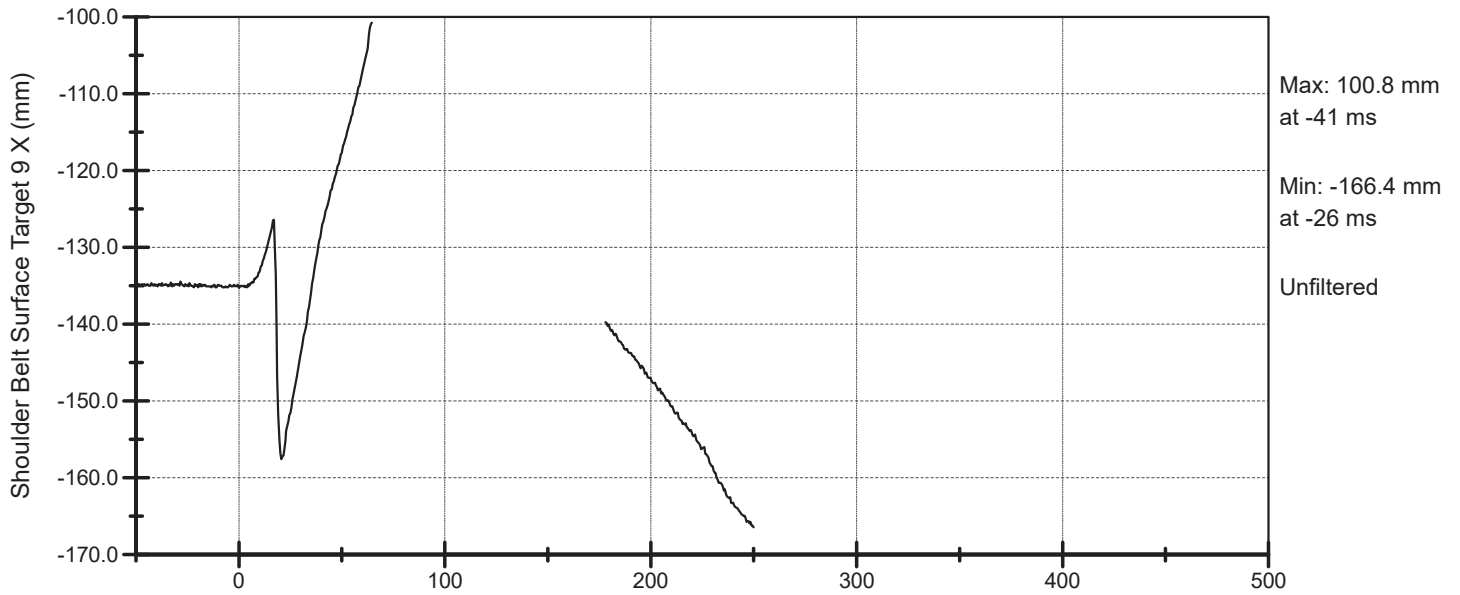
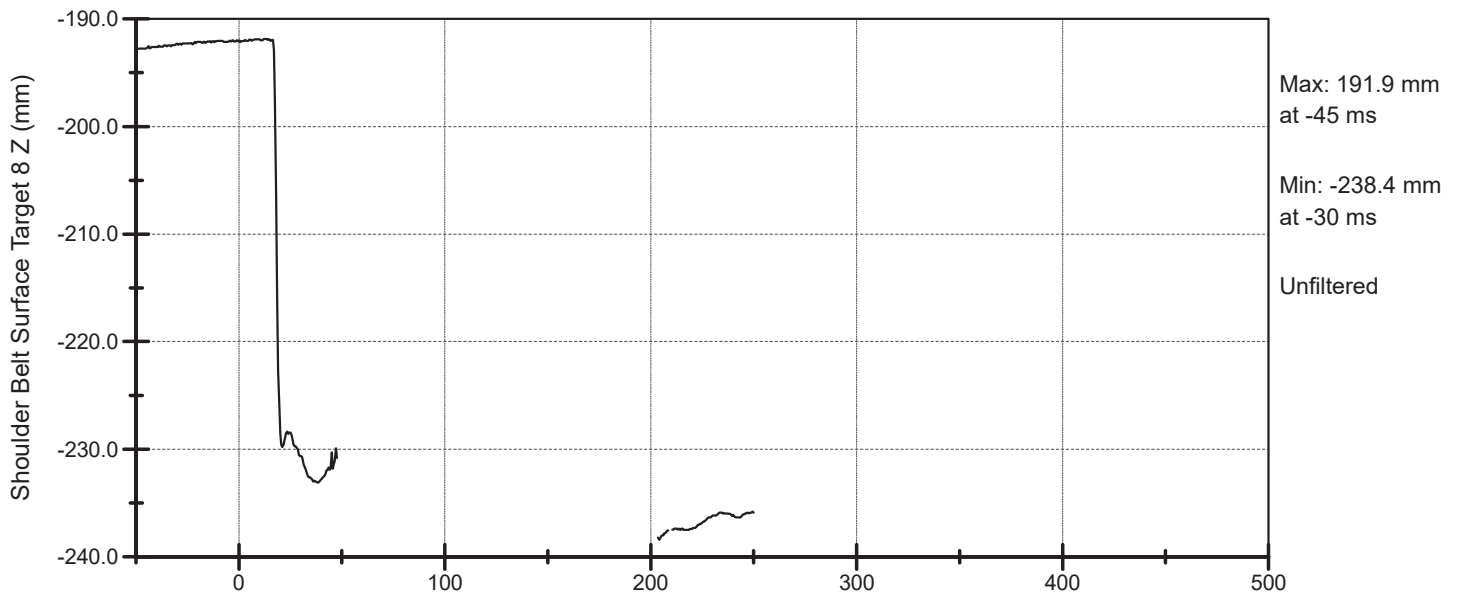


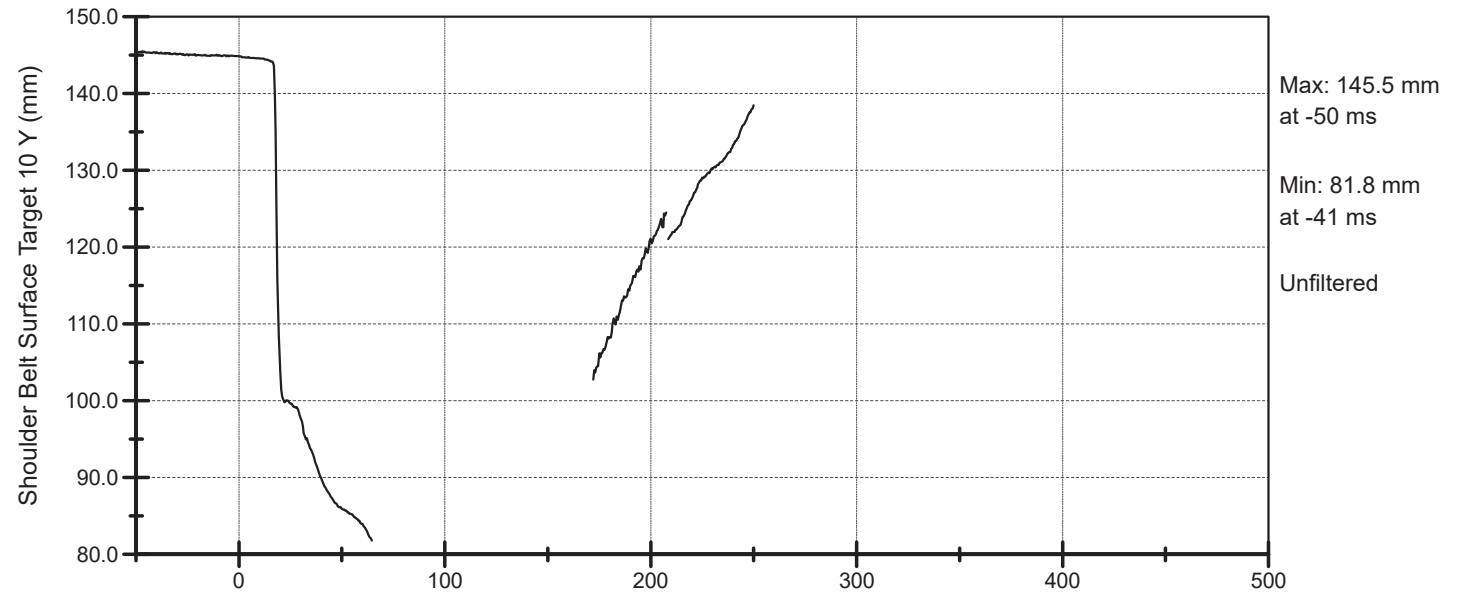
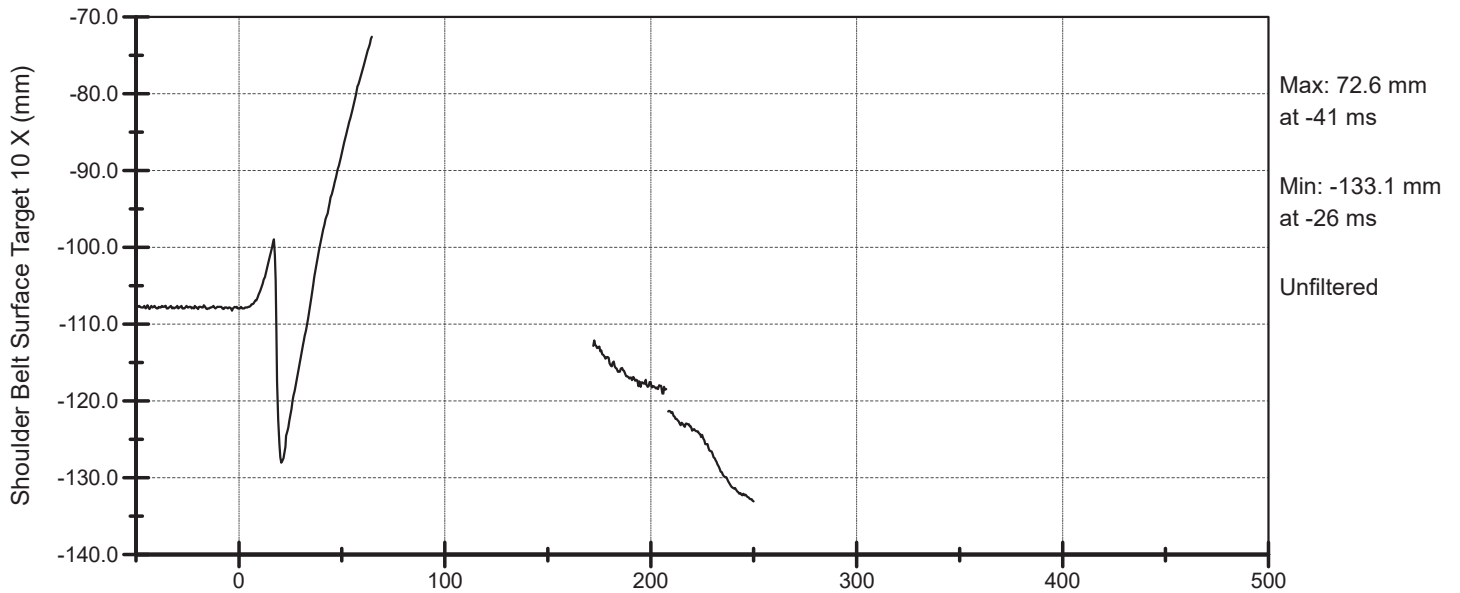
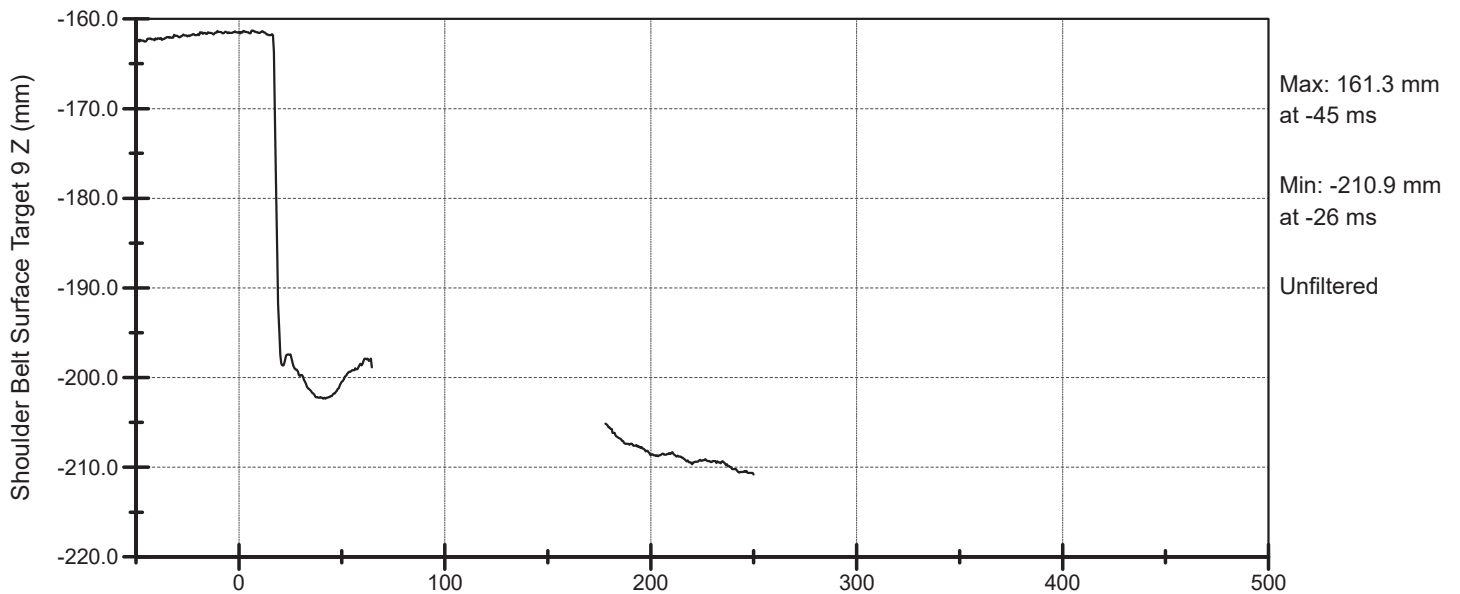


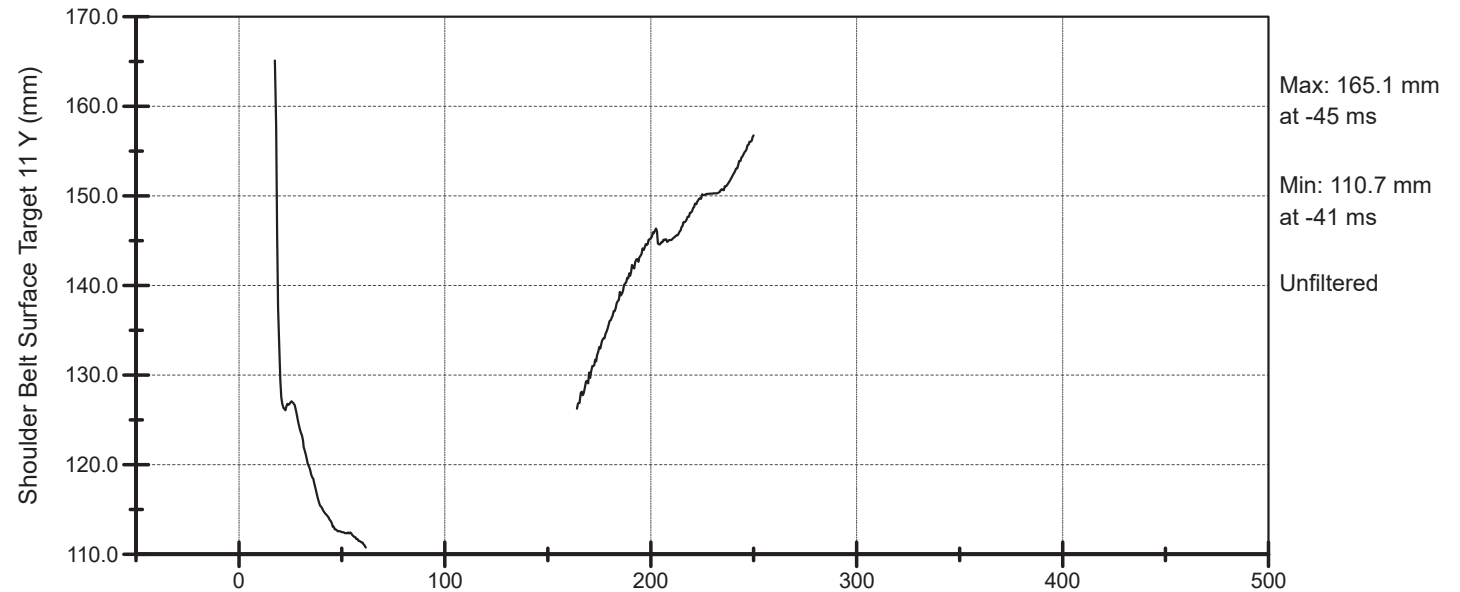
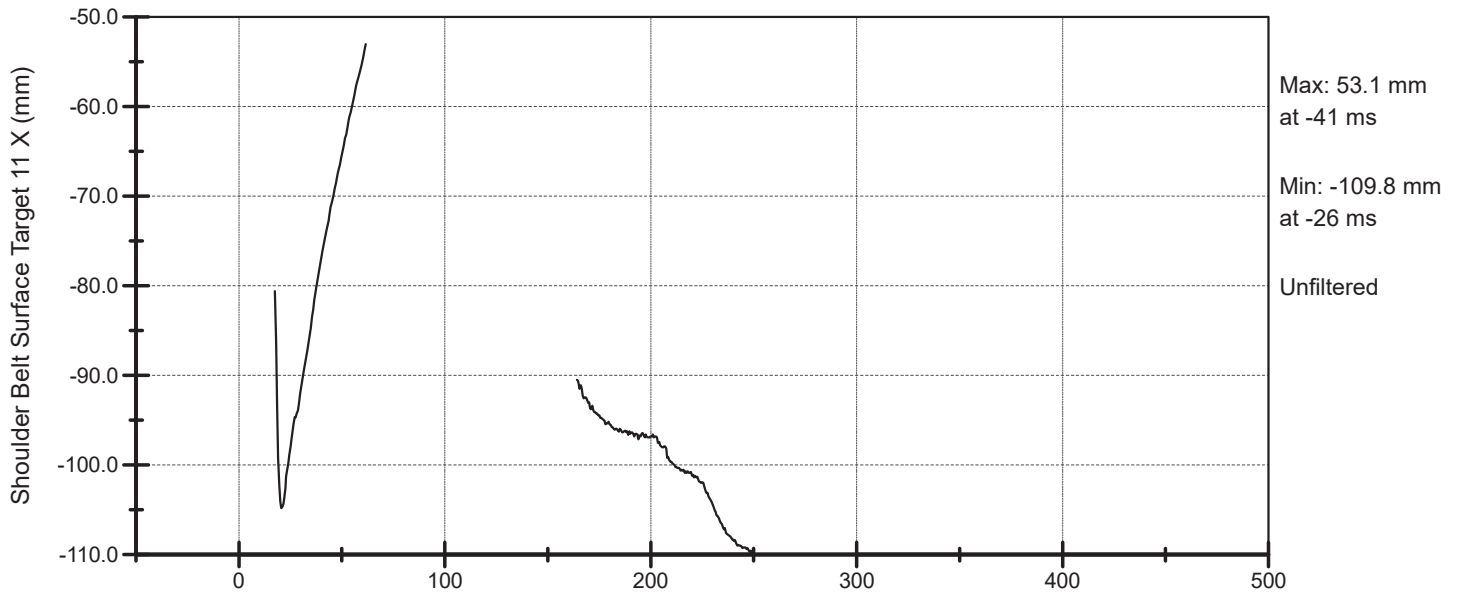
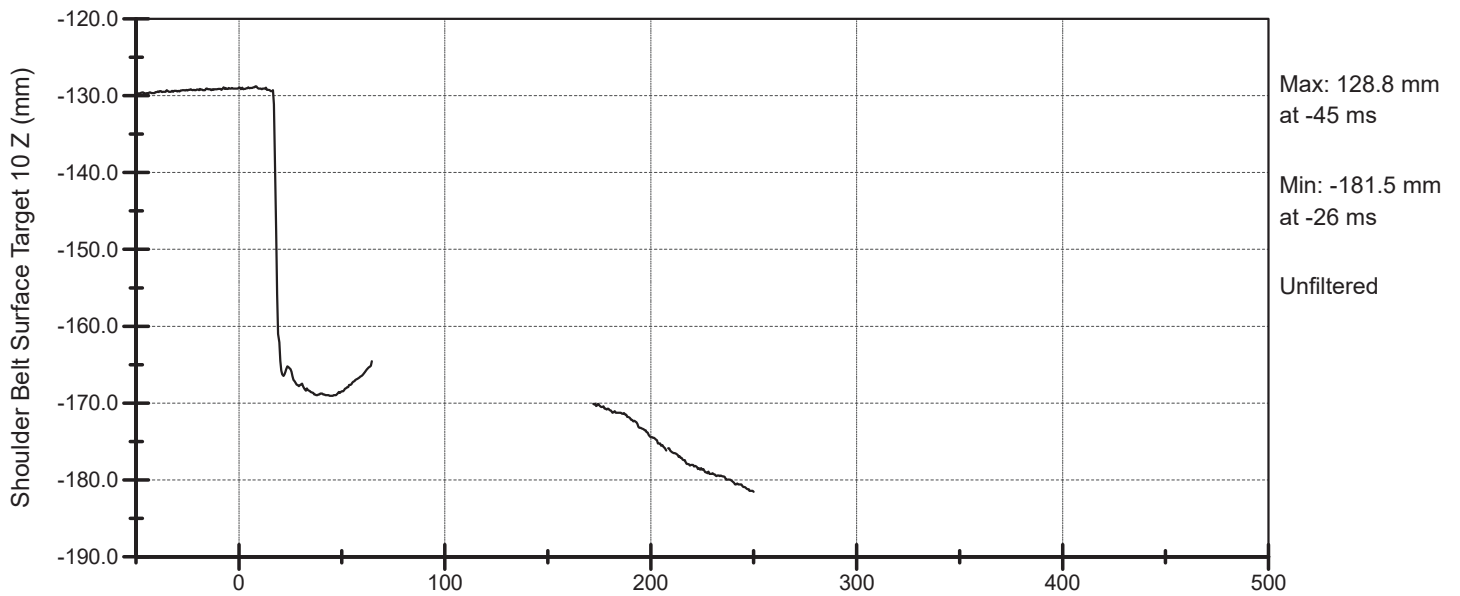


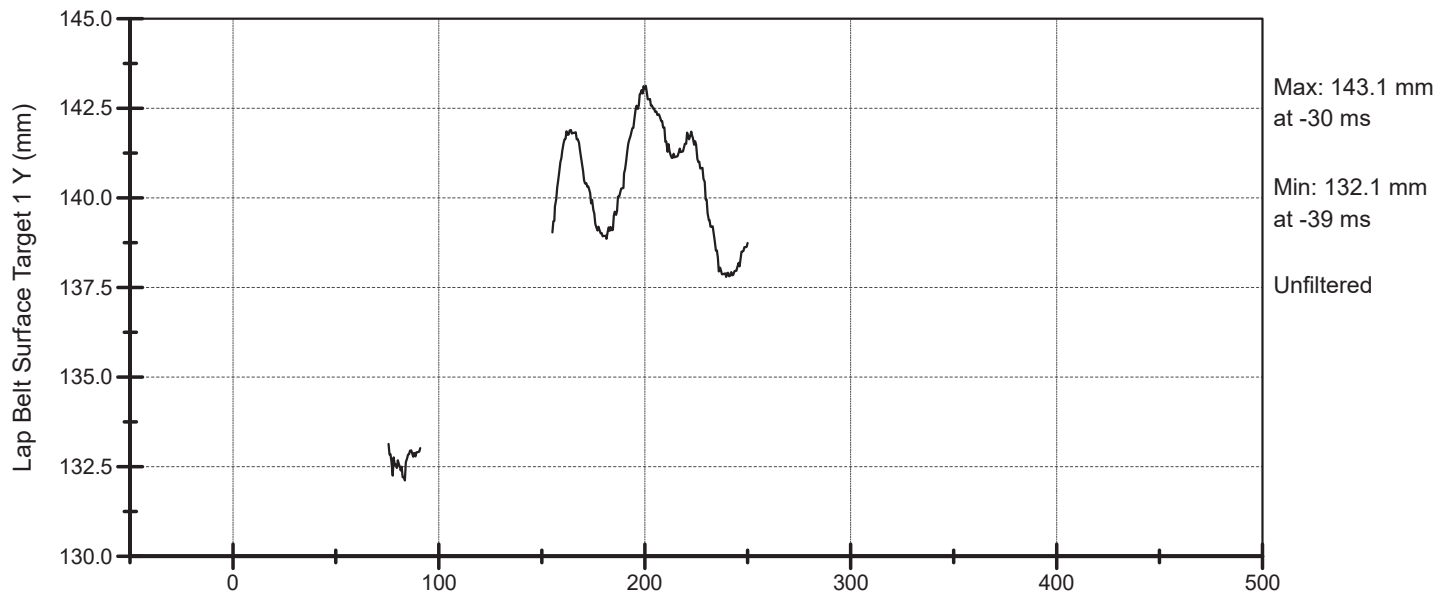
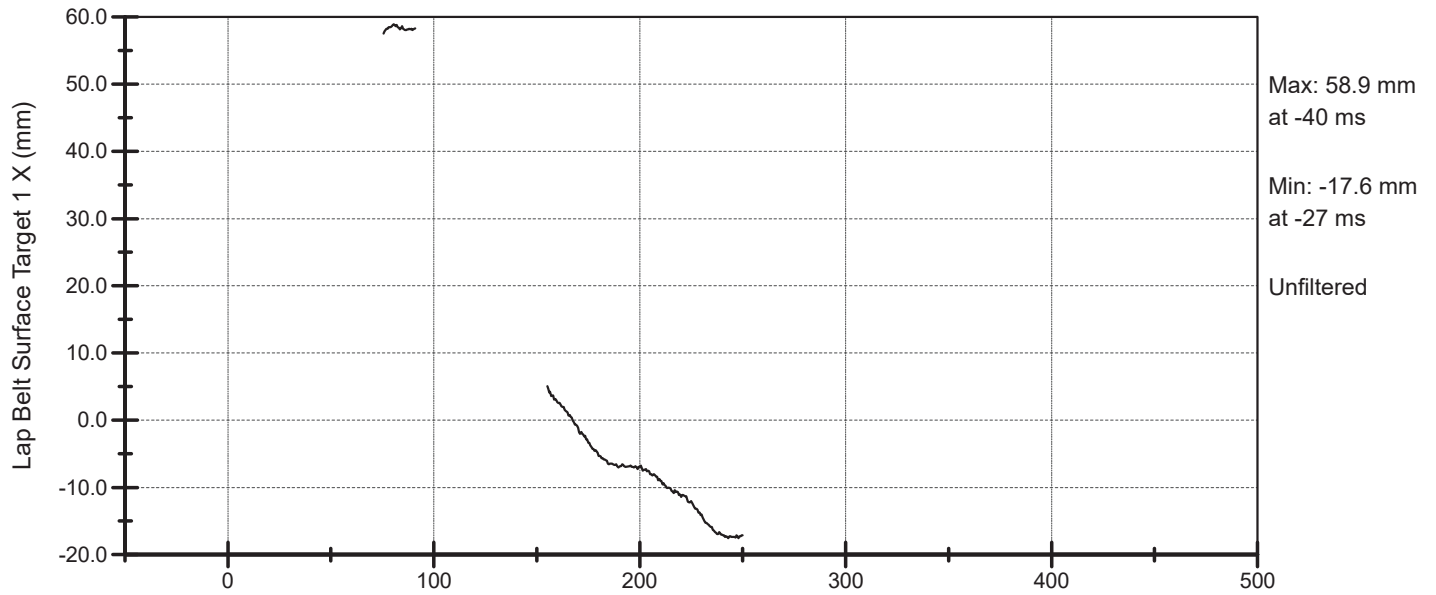
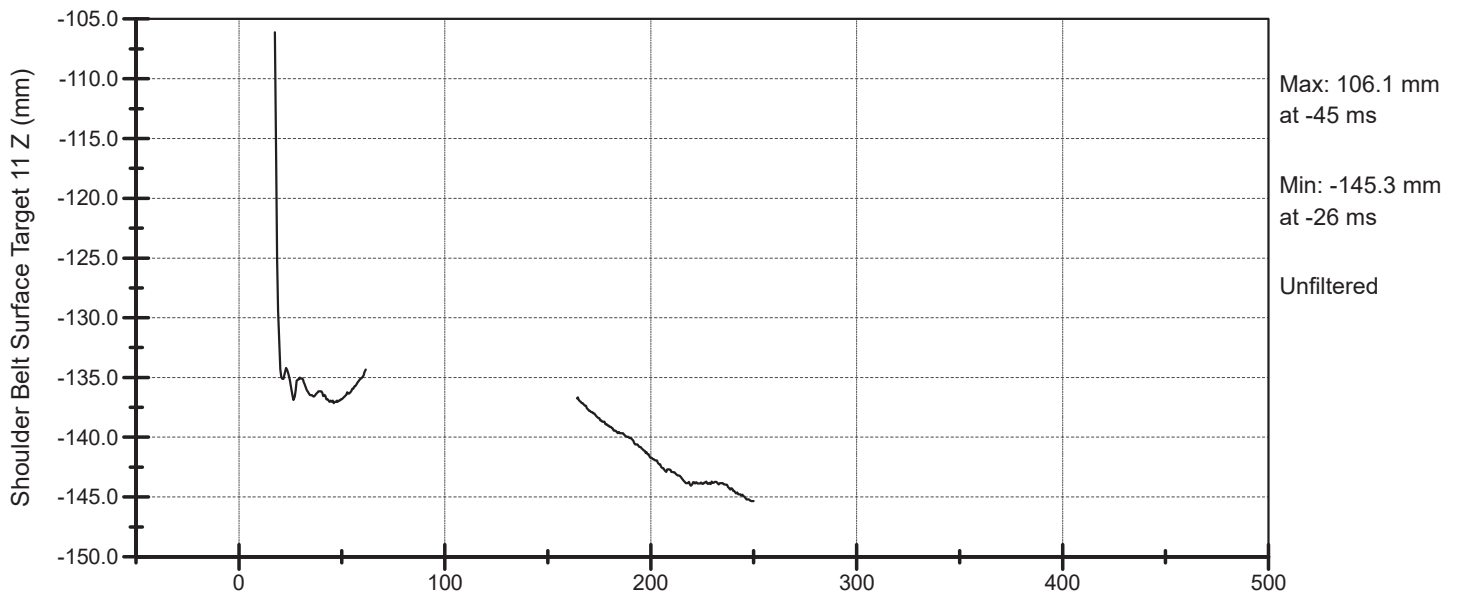


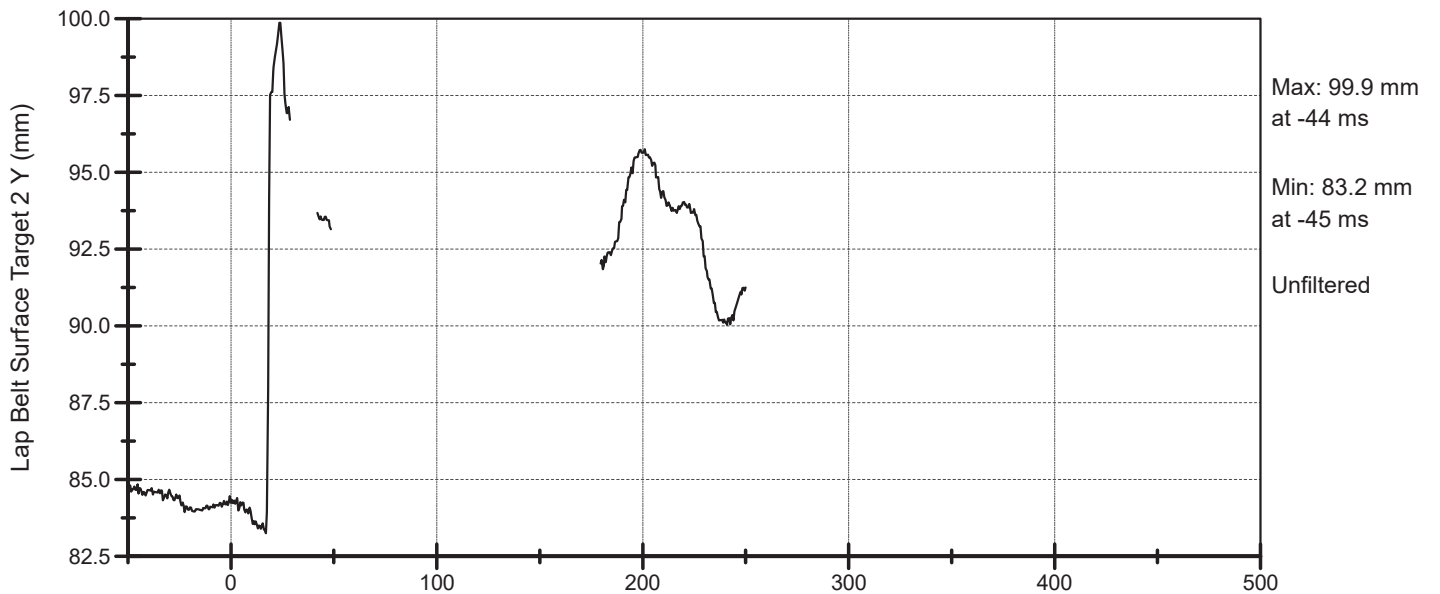
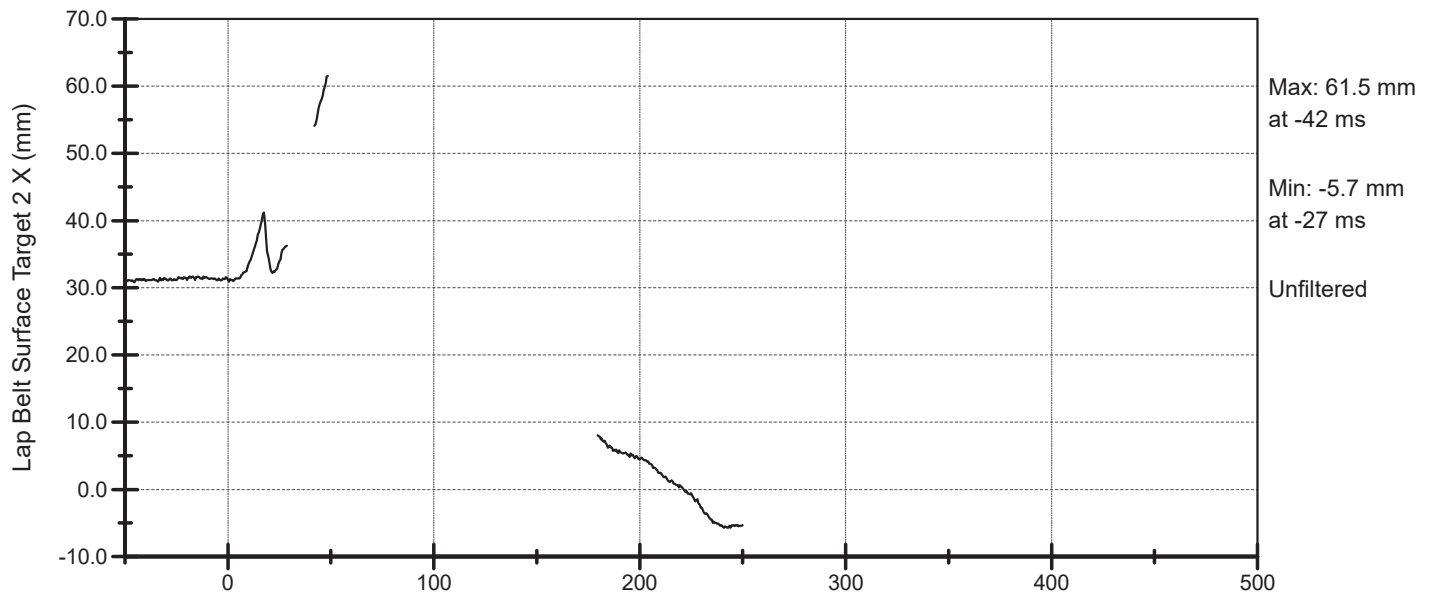
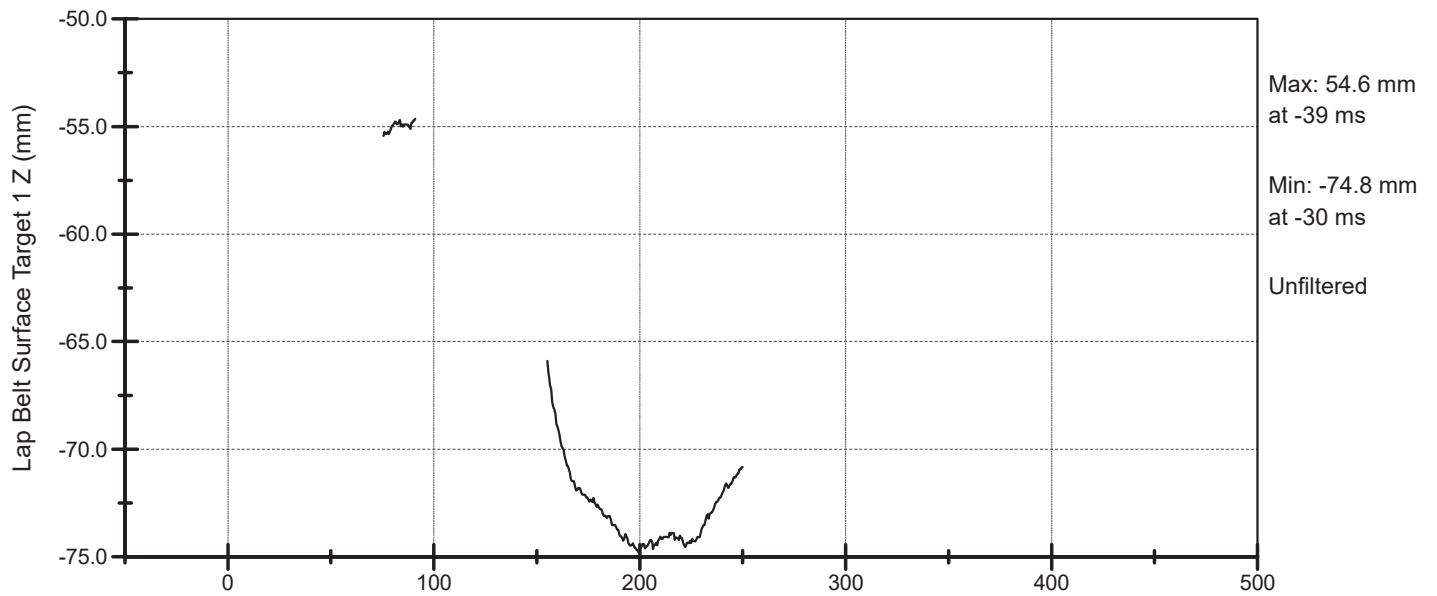


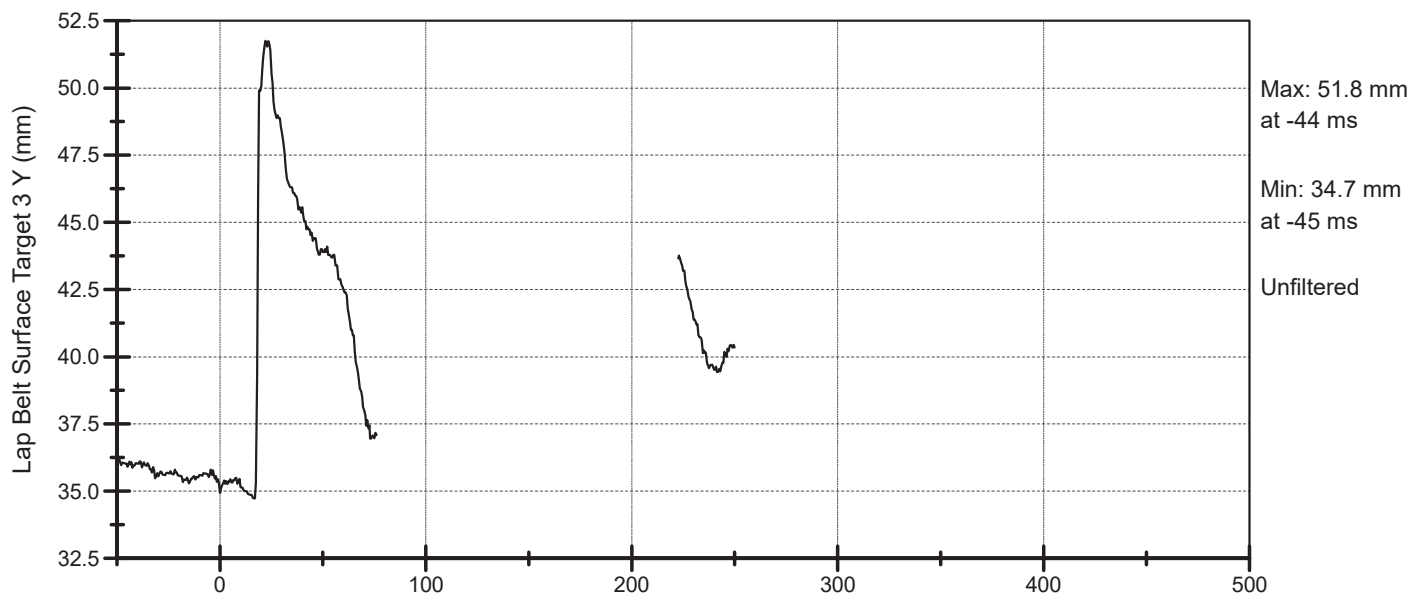
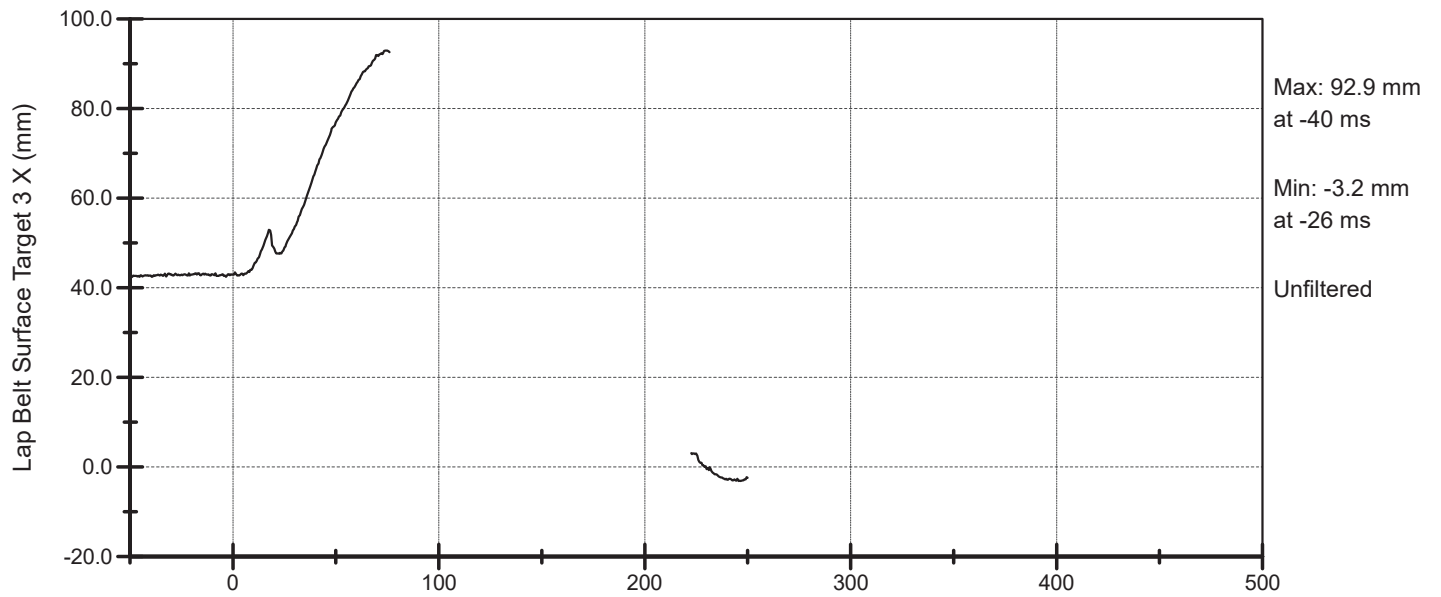
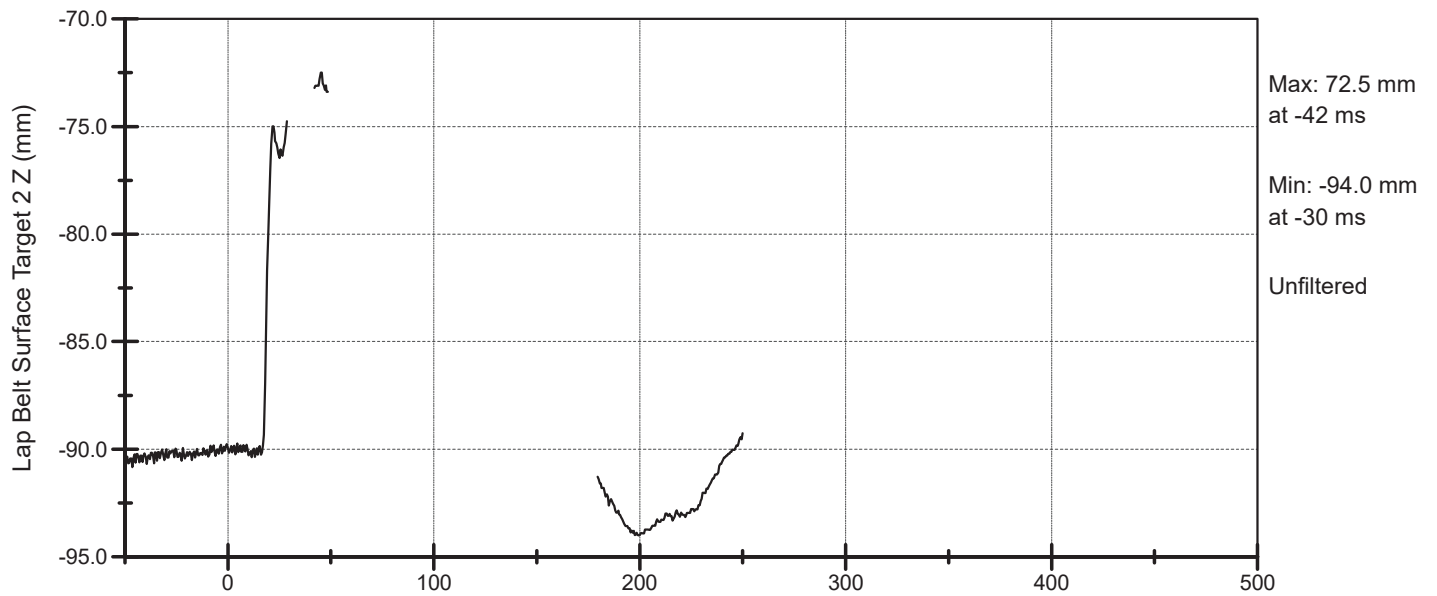


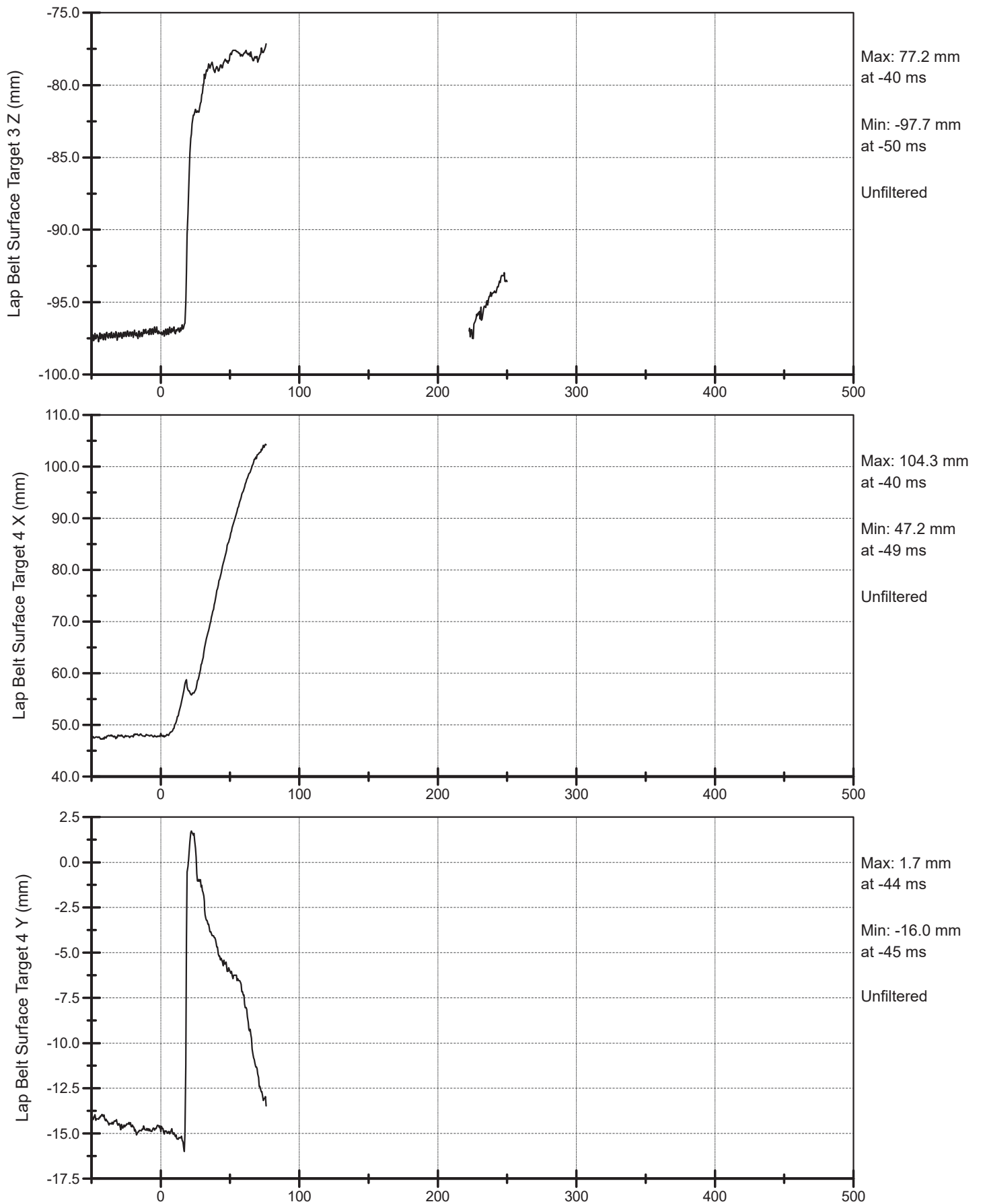


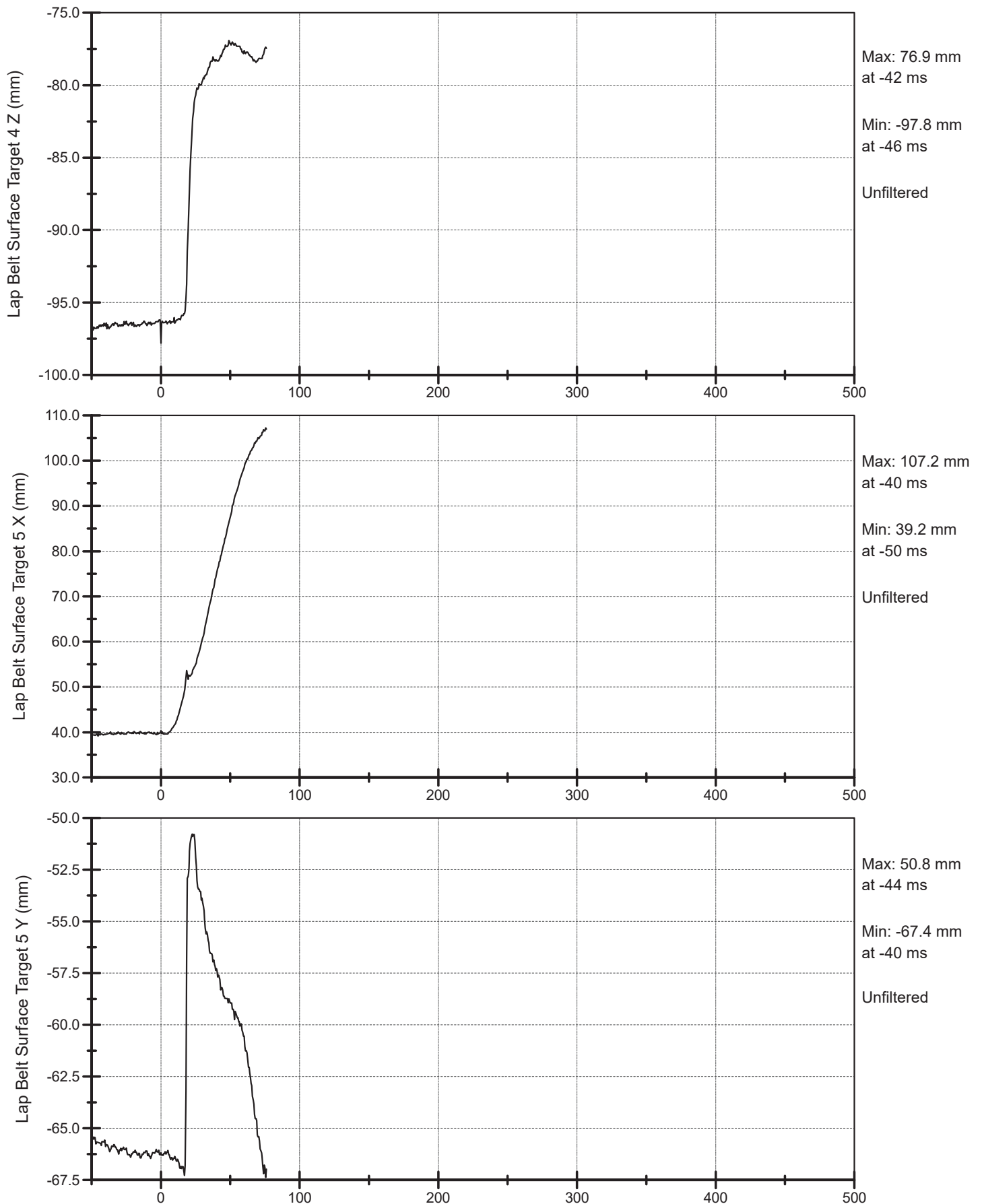


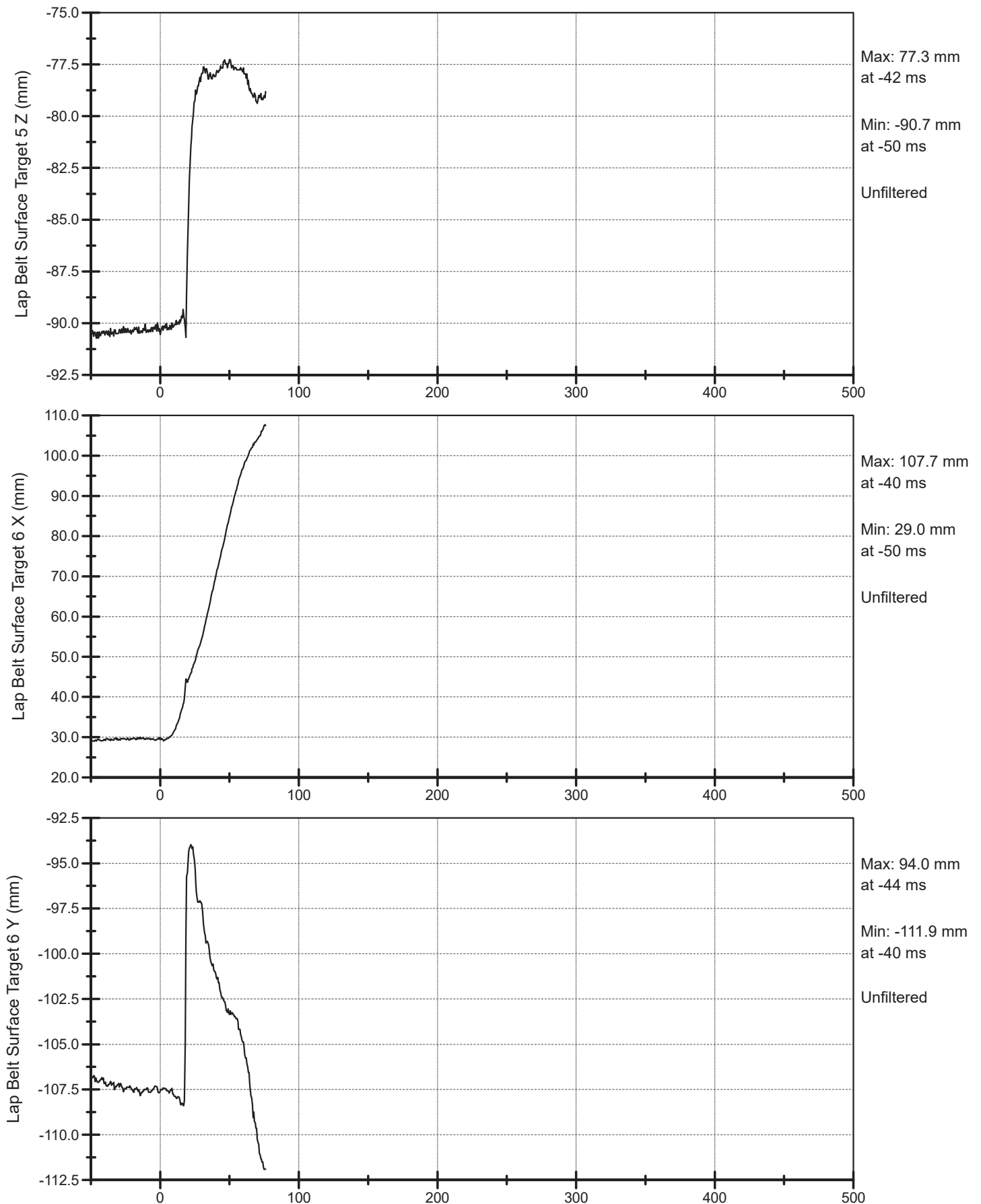


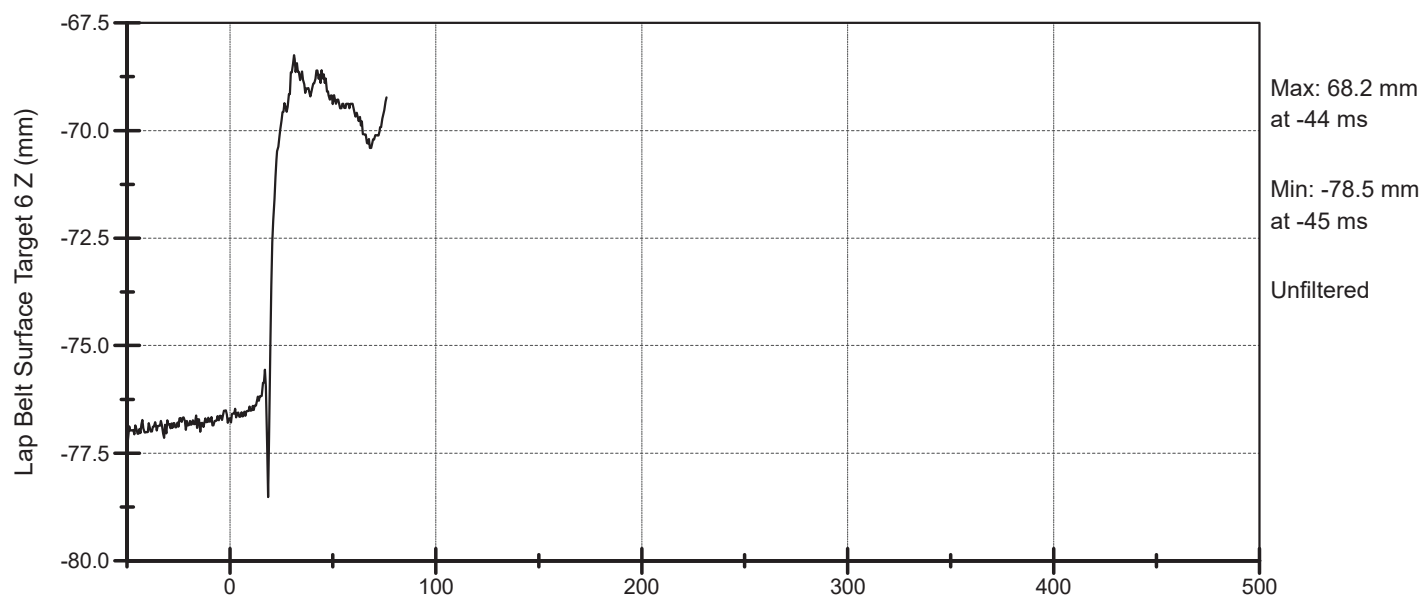












Appendix C

Channel Information

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
001.	Sled Acceleration Front Re	-	Unfiltered	25000	g
002.	Sled Acceleration Rear	-	Unfiltered	25000	g
003.	Sled Acceleration Front	-	Unfiltered	25000	g
004.	Sled Acceleration Rear Re	-	Unfiltered	25000	g
005.	Velocity Magnetic	-	Unfiltered	25000	mV
006.	Seat Rear Fx	-	Unfiltered	25000	N
007.	Seat Rear Fy	-	Unfiltered	25000	N
008.	Seat Rear Fz	-	Unfiltered	25000	N
009.	Seat Rear Ax	-	Unfiltered	25000	g
010.	Seat Rear Ay	-	Unfiltered	25000	g
011.	Seat Rear Az	-	Unfiltered	25000	g
012.	Seat Front Fx	-	Unfiltered	25000	N
013.	Seat Front Fy	-	Unfiltered	25000	N
014.	Seat Front Fz	-	Unfiltered	25000	N
015.	Seat Front Ay	-	Unfiltered	25000	g
016.	Seat Front Ax	-	Unfiltered	25000	g
017.	Seat Front Az	-	Unfiltered	25000	g
018.	Left Lap Belt Fz	-	Unfiltered	25000	N
019.	Left Lap Belt Fx	-	Unfiltered	25000	N
020.	Left Lap Belt Fy	-	Unfiltered	25000	N
021.	Left Lap Belt Ax	-	Unfiltered	25000	g
022.	Right Lap Belt Fz	-	Unfiltered	25000	N
023.	Right Lap Belt Fx	-	Unfiltered	25000	N
024.	Right Lap Belt Fy	-	Unfiltered	25000	N
025.	Right Lap Belt Ax	-	Unfiltered	25000	g
026.	Shoulder Belt Fy	-	Unfiltered	25000	N
027.	Shoulder Belt Fx	-	Unfiltered	25000	N
028.	Shoulder Belt Fz	-	Unfiltered	25000	N
029.	Shoulder Belt Ax	-	Unfiltered	25000	g
030.	Shoulder Belt Ay	-	Unfiltered	25000	g
031.	Shoulder Belt Az	-	Unfiltered	25000	g
032.	Seat Pan Pot	-	Unfiltered	25000	Deg
033.	Anti Sub Pot	123002	Unfiltered	25000	Deg
034.	Left Shoulder Belt Load	-	Unfiltered	25000	N
035.	Left Rib 4 Strain	-	Unfiltered	25000	uE
036.	Right Rib 4 Strain	-	Unfiltered	25000	uE
037.	Left Rib 5 Strain	-	Unfiltered	25000	uE
038.	Right Rib 5 Strain	-	Unfiltered	25000	uE
039.	Left Rib 6 Strain	-	Unfiltered	25000	uE
040.	Right Rib 6 Strain	-	Unfiltered	25000	uE
041.	Left Rib 7 Strain	-	Unfiltered	25000	uE
042.	Right Rib 7 Strain	-	Unfiltered	25000	uE
043.	Clavicle Strain	-	Unfiltered	25000	uE
044.	Sternum Strain	-	Unfiltered	25000	uE
045.	Left Iliac Wing Strain	-	Unfiltered	25000	uE
046.	Right Iliac Wing Strain	-	Unfiltered	25000	uE
047.	Head Ax	-	Unfiltered	25000	g

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
048.	Head Ay	-	Unfiltered	25000	g
049.	Head Az	-	Unfiltered	25000	g
050.	Head ARx	-	Unfiltered	25000	deg/sec
051.	Head ARy	-	Unfiltered	25000	deg/sec
052.	Head ARz	-	Unfiltered	25000	deg/sec
053.	T1 Ax	-	Unfiltered	25000	g
054.	T1 Ay	-	Unfiltered	25000	g
055.	T1 Az	-	Unfiltered	25000	g
056.	T1 ARx	-	Unfiltered	25000	deg/sec
057.	T1 ARy	-	Unfiltered	25000	deg/sec
058.	T1 ARz	-	Unfiltered	25000	deg/sec
059.	T8 Ax	-	Unfiltered	25000	g
060.	T8 Ay	-	Unfiltered	25000	g
061.	T8 Az	-	Unfiltered	25000	g
062.	T8 ARx	-	Unfiltered	25000	deg/sec
063.	T8 ARy	-	Unfiltered	25000	deg/sec
064.	T8 ARz	-	Unfiltered	25000	deg/sec
065.	T12 Ax	-	Unfiltered	25000	g
066.	T12 Ay	-	Unfiltered	25000	g
067.	T12 Az	-	Unfiltered	25000	g
068.	T12 ARx	-	Unfiltered	25000	deg/sec
069.	T12 ARy	-	Unfiltered	25000	deg/sec
070.	T12 ARz	-	Unfiltered	25000	deg/sec
071.	L5 Ax	-	Unfiltered	25000	g
072.	L5 Ay	-	Unfiltered	25000	g
073.	L5 Az	-	Unfiltered	25000	g
074.	L5 ARx	-	Unfiltered	25000	deg/sec
075.	L5 ARy	-	Unfiltered	25000	deg/sec
076.	L5 ARz	-	Unfiltered	25000	deg/sec
077.	Left Iliac Wing Ax	-	Unfiltered	25000	g
078.	Left Iliac Wing Ay	-	Unfiltered	25000	g
079.	Left Iliac Wing Az	-	Unfiltered	25000	g
080.	Left Iliac Wing ARx	-	Unfiltered	25000	deg/sec
081.	Left Iliac Wing ARy	-	Unfiltered	25000	deg/sec
082.	Left Iliac Wing ARz	-	Unfiltered	25000	deg/sec
083.	Right Iliac Wing ARx	-	Unfiltered	25000	deg/sec
084.	Right Iliac Wing ARy	-	Unfiltered	25000	deg/sec
085.	Right Iliac Wing ARz	-	Unfiltered	25000	deg/sec
086.	Left Femur Ax	-	Unfiltered	25000	g
087.	Left Femur Ay	-	Unfiltered	25000	g
088.	Left Femur Az	-	Unfiltered	25000	g
089.	Left Femur ARx	-	Unfiltered	25000	deg/sec
090.	Left Femur ARy	-	Unfiltered	25000	deg/sec
091.	Left Femur ARz	-	Unfiltered	25000	deg/sec
092.	Right Femur Ax	-	Unfiltered	25000	g
093.	Right Femur Ay	-	Unfiltered	25000	g
094.	Right Femur Az	-	Unfiltered	25000	g
095.	Right Femur ARx	-	Unfiltered	25000	deg/sec
096.	Right Femur ARy	-	Unfiltered	25000	deg/sec

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
097.	Right Femur ARz	-	Unfiltered	25000	deg/sec
098.	Left Tibia Ax	-	Unfiltered	25000	g
099.	Left Tibia Ay	-	Unfiltered	25000	g
100.	Left Tibia Az	-	Unfiltered	25000	g
101.	Left Tibia ARx	-	Unfiltered	25000	deg/sec
102.	Left Tibia ARy	-	Unfiltered	25000	deg/sec
103.	Left Tibia ARz	-	Unfiltered	25000	deg/sec
104.	Right Tibia Ax	-	Unfiltered	25000	g
105.	Right Tibia Ay	-	Unfiltered	25000	g
106.	Right Tibia Az	-	Unfiltered	25000	g
107.	Right Tibia ARx	-	Unfiltered	25000	deg/sec
108.	Right Tibia ARy	-	Unfiltered	25000	deg/sec
109.	Right Tibia ARz	-	Unfiltered	25000	deg/sec
110.	Shoulder Belt Pretensioner - Fire Voltage (DC Cap Discharge)	-	Unfiltered	25000	Volts
111.	Shoulder Belt Pretensioner - Fire Current (DC Cap Discharge)	-	Unfiltered	25000	Amps
112.	Sled Acceleration Average	-	60	25000	g
113.	Integrated Velocity	-	60	25000	m/s
114.	Seat Rear Fx_IC	-	600	25000	N
115.	Seat Rear Fy_IC	-	600	25000	N
116.	Seat Rear Fz_IC	-	600	25000	N
117.	Seat Front Fx_IC	-	600	25000	N
118.	Seat Front Fy_IC	-	600	25000	N
119.	Seat Front Fz_IC	-	600	25000	N
120.	Shoulder Belt Fx_IC	-	60	25000	N
121.	Shoulder Belt Fy_IC	-	60	25000	N
122.	Shoulder Belt Fz_IC	-	60	25000	N
123.	Left Lap Belt Fx_IC	-	60	25000	N
124.	Right Lap Belt Fx_IC	-	60	25000	N
125.	Head Ax Filtered & Transformed	-	180	25000	g
126.	Head Ay Filtered & Transformed	-	180	25000	g
127.	Head Az Filtered & Transformed	-	180	25000	g
128.	Head ARx Filtered & Transformed	-	180	25000	deg/sec
129.	Head ARy Filtered & Transformed	-	180	25000	deg/sec
130.	Head ARz Filtered & Transformed	-	180	25000	deg/sec
131.	T1 Ax Filtered & Transformed-	-	180	25000	g
132.	T1 Ay Filtered & Transformed-	-	180	25000	g
133.	T1 Az Filtered & Transformed-	-	180	25000	g
134.	T1 ARx Filtered & Transformed	-	180	25000	deg/sec
135.	T1 ARy Filtered & Transformed	-	180	25000	deg/sec
136.	T1 ARz Filtered & Transformed	-	180	25000	deg/sec
137.	T8 Ax Filtered & Transformed-	-	180	25000	g
138.	T8 Ay Filtered & Transformed-	-	180	25000	g
139.	T8 Az Filtered & Transformed-	-	180	25000	g
140.	T8 ARx Filtered & Transformed	-	180	25000	deg/sec
141.	T8 ARy Filtered & Transformed	-	180	25000	deg/sec
142.	T8 ARz Filtered & Transformed	-	180	25000	deg/sec
143.	T12 Ax Filtered & Transformed	-	180	25000	g
144.	T12 Ay Filtered & Transformed	-	180	25000	g
145.	T12 Az Filtered & Transformed	-	180	25000	g

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
146.	T12 ARx Filtered & Transformed		180	25000	deg/sec
147.	T12 ARy Filtered & Transformed		180	25000	deg/sec
148.	T12 ARz Filtered & Transformed		180	25000	deg/sec
149.	L4 Ax Filtered & Transformed-		180	25000	g
150.	L4 Ay Filtered & Transformed-		180	25000	g
151.	L4 Az Filtered & Transformed-		180	25000	g
152.	L4 ARx Filtered & Transformed		180	25000	deg/sec
153.	L4 ARy Filtered & Transformed		180	25000	deg/sec
154.	L4 ARz Filtered & Transformed		180	25000	deg/sec
155.	Left Iliac Wing Ax Filtered & Transformed		180	25000	g
156.	Left Iliac Wing Ay Filtered & Transformed		180	25000	g
157.	Left Iliac Wing Az Filtered & Transformed		180	25000	g
158.	Left Iliac Wing ARx Filtered & Transformed		180	25000	deg/sec
159.	Left Iliac Wing ARy Filtered & Transformed		180	25000	deg/sec
160.	Left Iliac Wing ARz Filtered & Transformed		180	25000	deg/sec
161.	Right Iliac Wing ARx Filtered & Transformed		180	25000	deg/sec
162.	Right Iliac Wing ARy Filtered & Transformed		180	25000	deg/sec
163.	Right Iliac Wing ARz Filtered & Transformed		180	25000	deg/sec
164.	Left Femur Ax Filtered & Transformed		180	25000	g
165.	Left Femur Ay Filtered & Transformed		180	25000	g
166.	Left Femur Az Filtered & Transformed		180	25000	g
167.	Left Femur ARx Filtered & Transformed		180	25000	deg/sec
168.	Left Femur ARy Filtered & Transformed		180	25000	deg/sec
169.	Left Femur ARz Filtered & Transformed		180	25000	deg/sec
170.	Right Femur Ax Filtered & Transformed		180	25000	g
171.	Right Femur Ay Filtered & Transformed		180	25000	g
172.	Right Femur Az Filtered & Transformed		180	25000	g
173.	Right Femur ARx Filtered & Transformed		180	25000	deg/sec
174.	Right Femur ARy Filtered & Transformed		180	25000	deg/sec
175.	Right Femur ARz Filtered & Transformed		180	25000	deg/sec
176.	Left Tibia Ax Filtered & Transformed		180	25000	g
177.	Left Tibia Ay Filtered & Transformed		180	25000	g
178.	Left Tibia Az Filtered & Transformed		180	25000	g
179.	Left Tibia ARx Filtered & Transformed		180	25000	deg/sec
180.	Left Tibia ARy Filtered & Transformed		180	25000	deg/sec
181.	Left Tibia ARz Filtered & Transformed		180	25000	deg/sec
182.	Right Tibia Ax Filtered & Transformed		180	25000	g
183.	Right Tibia Ay Filtered & Transformed		180	25000	g
184.	Right Tibia Az Filtered & Transformed		180	25000	g
185.	Right Tibia ARx Filtered & Transformed		180	25000	deg/sec
186.	Right Tibia ARy Filtered & Transformed		180	25000	deg/sec
187.	Right Tibia ARz Filtered & Transformed		180	25000	deg/sec
188.	Head CG X	-	Unfiltered	2000	mm
189.	Head CG Y	-	Unfiltered	2000	mm
190.	Head CG Z	-	Unfiltered	2000	mm
191.	Head CG Yaw	-	Unfiltered	2000	deg
192.	Head CG Pitch	-	Unfiltered	2000	deg
193.	Head CG Roll	-	Unfiltered	2000	deg
194.	Sternum Center X	-	Unfiltered	2000	mm

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
195.	Sternum Center Y	-	Unfiltered	2000	mm
196.	Sternum Center Z	-	Unfiltered	2000	mm
197.	Sternum Center Yaw	-	Unfiltered	2000	deg
198.	Sternum Center Pitch	-	Unfiltered	2000	deg
199.	Sternum Center Roll	-	Unfiltered	2000	deg
200.	Left Rib 4 X	-	Unfiltered	2000	mm
201.	Left Rib 4 Y	-	Unfiltered	2000	mm
202.	Left Rib 4 Z	-	Unfiltered	2000	mm
203.	Left Rib 4 Yaw	-	Unfiltered	2000	deg
204.	Left Rib 4 Pitch	-	Unfiltered	2000	deg
205.	Left Rib 4 Roll	-	Unfiltered	2000	deg
206.	Left Rib 7 X	-	Unfiltered	2000	mm
207.	Left Rib 7 Y	-	Unfiltered	2000	mm
208.	Left Rib 7 Z	-	Unfiltered	2000	mm
209.	Left Rib 7 Yaw	-	Unfiltered	2000	deg
210.	Left Rib 7 Pitch	-	Unfiltered	2000	deg
211.	Left Rib 7 Roll	-	Unfiltered	2000	deg
212.	T1 X	-	Unfiltered	2000	mm
213.	T1 Y	-	Unfiltered	2000	mm
214.	T1 Z	-	Unfiltered	2000	mm
215.	T1 Yaw	-	Unfiltered	2000	deg
216.	T1 Pitch	-	Unfiltered	2000	deg
217.	T1 Roll	-	Unfiltered	2000	deg
218.	T8 X	-	Unfiltered	2000	mm
219.	T8 Y	-	Unfiltered	2000	mm
220.	T8 Z	-	Unfiltered	2000	mm
221.	T8 Yaw	-	Unfiltered	2000	deg
222.	T8 Pitch	-	Unfiltered	2000	deg
223.	T8 Roll	-	Unfiltered	2000	deg
224.	T12 X	-	Unfiltered	2000	mm
225.	T12 Y	-	Unfiltered	2000	mm
226.	T12 Z	-	Unfiltered	2000	mm
227.	T12 Yaw	-	Unfiltered	2000	deg
228.	T12 Pitch	-	Unfiltered	2000	deg
229.	T12 Roll	-	Unfiltered	2000	deg
230.	L4 X	-	Unfiltered	2000	mm
231.	L4 Y	-	Unfiltered	2000	mm
232.	L4 Z	-	Unfiltered	2000	mm
233.	L4 Yaw	-	Unfiltered	2000	deg
234.	L4 Pitch	-	Unfiltered	2000	deg
235.	L4 Roll	-	Unfiltered	2000	deg
236.	Left Midshaft Femur X	-	Unfiltered	2000	mm
237.	Left Midshaft Femur Y	-	Unfiltered	2000	mm
238.	Left Midshaft Femur Z	-	Unfiltered	2000	mm
239.	Left Midshaft Femur Yaw	-	Unfiltered	2000	deg
240.	Left Midshaft Femur Pitch	-	Unfiltered	2000	deg
241.	Left Midshaft Femur Roll	-	Unfiltered	2000	deg
242.	Right Midshaft Femur X	-	Unfiltered	2000	mm
243.	Right Midshaft Femur Y	-	Unfiltered	2000	mm

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
244.	Right Midshaft Femur Z	-	Unfiltered	2000	mm
245.	Right Midshaft Femur Yaw	-	Unfiltered	2000	deg
246.	Right Midshaft Femur Pitch	-	Unfiltered	2000	deg
247.	Right Midshaft Femur Roll	-	Unfiltered	2000	deg
248.	Left Hip X	-	Unfiltered	2000	mm
249.	Left Hip Y	-	Unfiltered	2000	mm
250.	Left Hip Z	-	Unfiltered	2000	mm
251.	Left Hip Yaw	-	Unfiltered	2000	deg
252.	Left Hip Pitch	-	Unfiltered	2000	deg
253.	Left Hip Roll	-	Unfiltered	2000	deg
254.	Right Hip X	-	Unfiltered	2000	mm
255.	Right Hip Y	-	Unfiltered	2000	mm
256.	Right Hip Z	-	Unfiltered	2000	mm
257.	Right Hip Yaw	-	Unfiltered	2000	deg
258.	Right Hip Pitch	-	Unfiltered	2000	deg
259.	Right Hip Roll	-	Unfiltered	2000	deg
260.	Left Distal Femur X	-	Unfiltered	2000	mm
261.	Left Distal Femur Y	-	Unfiltered	2000	mm
262.	Left Distal Femur Z	-	Unfiltered	2000	mm
263.	Left Distal Femur Yaw	-	Unfiltered	2000	deg
264.	Left Distal Femur Pitch	-	Unfiltered	2000	deg
265.	Left Distal Femur Roll	-	Unfiltered	2000	deg
266.	Right Distal Femur X	-	Unfiltered	2000	mm
267.	Right Distal Femur Y	-	Unfiltered	2000	mm
268.	Right Distal Femur Z	-	Unfiltered	2000	mm
269.	Right Distal Femur Yaw	-	Unfiltered	2000	deg
270.	Right Distal Femur Pitch	-	Unfiltered	2000	deg
271.	Right Distal Femur Roll	-	Unfiltered	2000	deg
272.	Right Midshaft Tibia X	-	Unfiltered	2000	mm
273.	Right Midshaft Tibia Y	-	Unfiltered	2000	mm
274.	Right Midshaft Tibia Z	-	Unfiltered	2000	mm
275.	Right Midshaft Tibia Yaw	-	Unfiltered	2000	deg
276.	Right Midshaft Tibia Pitch	-	Unfiltered	2000	deg
277.	Right Midshaft Tibia Roll	-	Unfiltered	2000	deg
278.	Left Acromion X	-	Unfiltered	2000	mm
279.	Left Acromion Y	-	Unfiltered	2000	mm
280.	Left Acromion Z	-	Unfiltered	2000	mm
281.	Right Acromion X	-	Unfiltered	2000	mm
282.	Right Acromion Y	-	Unfiltered	2000	mm
283.	Right Acromion Z	-	Unfiltered	2000	mm
284.	Left Knee X	-	Unfiltered	2000	mm
285.	Left Knee Y	-	Unfiltered	2000	mm
286.	Left Knee Z	-	Unfiltered	2000	mm
287.	Right Knee X	-	Unfiltered	2000	mm
288.	Right Knee Y	-	Unfiltered	2000	mm
289.	Right Knee Z	-	Unfiltered	2000	mm
290.	Right Ankle X	-	Unfiltered	2000	mm
291.	Right Ankle Y	-	Unfiltered	2000	mm
292.	Right Ankle Z	-	Unfiltered	2000	mm

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
293.	Left Mid Tibia X	-	Unfiltered	2000	mm
294.	Left Mid Tibia Y	-	Unfiltered	2000	mm
295.	Left Mid Tibia Z	-	Unfiltered	2000	mm
296.	Right Mid Tibia X	-	Unfiltered	2000	mm
297.	Right Mid Tibia Y	-	Unfiltered	2000	mm
298.	Right Mid Tibia Z	-	Unfiltered	2000	mm
299.	Left Wrist X	-	Unfiltered	2000	mm
300.	Left Wrist Y	-	Unfiltered	2000	mm
301.	Left Wrist Z	-	Unfiltered	2000	mm
302.	Right Wrist X	-	Unfiltered	2000	mm
303.	Right Wrist Y	-	Unfiltered	2000	mm
304.	Right Wrist Z	-	Unfiltered	2000	mm
305.	Right Rib 4 X	-	Unfiltered	2000	mm
306.	Right Rib 4 Y	-	Unfiltered	2000	mm
307.	Right Rib 4 Z	-	Unfiltered	2000	mm
308.	Right Rib 7 X	-	Unfiltered	2000	mm
309.	Right Rib 7 Y	-	Unfiltered	2000	mm
310.	Right Rib 7 Z	-	Unfiltered	2000	mm
311.	Left Seatpan Aft X	-	Unfiltered	2000	mm
312.	Left Seatpan Aft Y	-	Unfiltered	2000	mm
313.	Left Seatpan Aft Z	-	Unfiltered	2000	mm
314.	Left Seatpan Fore X	-	Unfiltered	2000	mm
315.	Left Seatpan Fore Y	-	Unfiltered	2000	mm
316.	Left Seatpan Fore Z	-	Unfiltered	2000	mm
317.	Left Anitsub Aft X	-	Unfiltered	2000	mm
318.	Left Anitsub Aft Y	-	Unfiltered	2000	mm
319.	Left Anitsub Aft Z	-	Unfiltered	2000	mm
320.	Left Antisub Fore X	-	Unfiltered	2000	mm
321.	Left Antisub Fore Y	-	Unfiltered	2000	mm
322.	Left Antisub Fore Z	-	Unfiltered	2000	mm
323.	Right Seatpan Aft X	-	Unfiltered	2000	mm
324.	Right Seatpan Aft Y	-	Unfiltered	2000	mm
325.	Right Seatpan Aft Z	-	Unfiltered	2000	mm
326.	Right Seatpan Fore X	-	Unfiltered	2000	mm
327.	Right Seatpan Fore Y	-	Unfiltered	2000	mm
328.	Right Seatpan Fore Z	-	Unfiltered	2000	mm
329.	Right Anitsub Aft X	-	Unfiltered	2000	mm
330.	Right Anitsub Aft Y	-	Unfiltered	2000	mm
331.	Right Anitsub Aft Z	-	Unfiltered	2000	mm
332.	Right Antisub Fore X	-	Unfiltered	2000	mm
333.	Right Antisub Fore Y	-	Unfiltered	2000	mm
334.	Right Antisub Fore Z	-	Unfiltered	2000	mm
335.	Buckle X	-	Unfiltered	2000	mm
336.	Buckle Y	-	Unfiltered	2000	mm
337.	Buckle Z	-	Unfiltered	2000	mm
338.	Left Belt Anchorage X	-	Unfiltered	2000	mm
339.	Left Belt Anchorage Y	-	Unfiltered	2000	mm
340.	Left Belt Anchorage Z	-	Unfiltered	2000	mm
341.	Right Belt Anchorage X	-	Unfiltered	2000	mm

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
342.	Right Belt Anchorage Y	-	Unfiltered	2000	mm
343.	Right Belt Anchorage Z	-	Unfiltered	2000	mm
344.	Retractor Mount X	-	Unfiltered	2000	mm
345.	Retractor Mount Y	-	Unfiltered	2000	mm
346.	Retractor Mount Z	-	Unfiltered	2000	mm
347.	Shoulder Belt Surface Target 1 X		Unfiltered	2000	mm
348.	Shoulder Belt Surface Target 1 Y		Unfiltered	2000	mm
349.	Shoulder Belt Surface Target 1 Z		Unfiltered	2000	mm
350.	Shoulder Belt Surface Target 2 X		Unfiltered	2000	mm
351.	Shoulder Belt Surface Target 2 Y		Unfiltered	2000	mm
352.	Shoulder Belt Surface Target 2 Z		Unfiltered	2000	mm
353.	Shoulder Belt Surface Target 3 X		Unfiltered	2000	mm
354.	Shoulder Belt Surface Target 3 Y		Unfiltered	2000	mm
355.	Shoulder Belt Surface Target 3 Z		Unfiltered	2000	mm
356.	Shoulder Belt Surface Target 4 X		Unfiltered	2000	mm
357.	Shoulder Belt Surface Target 4 Y		Unfiltered	2000	mm
358.	Shoulder Belt Surface Target 4 Z		Unfiltered	2000	mm
359.	Shoulder Belt Surface Target 5 X		Unfiltered	2000	mm
360.	Shoulder Belt Surface Target 5 Y		Unfiltered	2000	mm
361.	Shoulder Belt Surface Target 5 Z		Unfiltered	2000	mm
362.	Shoulder Belt Surface Target 6 X		Unfiltered	2000	mm
363.	Shoulder Belt Surface Target 6 Y		Unfiltered	2000	mm
364.	Shoulder Belt Surface Target 6 Z		Unfiltered	2000	mm
365.	Shoulder Belt Surface Target 7 X		Unfiltered	2000	mm
366.	Shoulder Belt Surface Target 7 Y		Unfiltered	2000	mm
367.	Shoulder Belt Surface Target 7 Z		Unfiltered	2000	mm
368.	Shoulder Belt Surface Target 8 X		Unfiltered	2000	mm
369.	Shoulder Belt Surface Target 8 Y		Unfiltered	2000	mm
370.	Shoulder Belt Surface Target 8 Z		Unfiltered	2000	mm
371.	Shoulder Belt Surface Target 9 X		Unfiltered	2000	mm
372.	Shoulder Belt Surface Target 9 Y		Unfiltered	2000	mm
373.	Shoulder Belt Surface Target 9 Z		Unfiltered	2000	mm
374.	Shoulder Belt Surface Target 10 X		Unfiltered	2000	mm
375.	Shoulder Belt Surface Target 10 Y		Unfiltered	2000	mm
376.	Shoulder Belt Surface Target 10 Z		Unfiltered	2000	mm
377.	Shoulder Belt Surface Target 11 X		Unfiltered	2000	mm
378.	Shoulder Belt Surface Target 11 Y		Unfiltered	2000	mm
379.	Shoulder Belt Surface Target 11 Z		Unfiltered	2000	mm
380.	Lap Belt Surface Target 1 X	-	Unfiltered	2000	mm
381.	Lap Belt Surface Target 1 Y	-	Unfiltered	2000	mm
382.	Lap Belt Surface Target 1 Z	-	Unfiltered	2000	mm
383.	Lap Belt Surface Target 2 X	-	Unfiltered	2000	mm
384.	Lap Belt Surface Target 2 Y	-	Unfiltered	2000	mm
385.	Lap Belt Surface Target 2 Z	-	Unfiltered	2000	mm
386.	Lap Belt Surface Target 3 X	-	Unfiltered	2000	mm
387.	Lap Belt Surface Target 3 Y	-	Unfiltered	2000	mm
388.	Lap Belt Surface Target 3 Z	-	Unfiltered	2000	mm
389.	Lap Belt Surface Target 4 X	-	Unfiltered	2000	mm
390.	Lap Belt Surface Target 4 Y	-	Unfiltered	2000	mm



Instrumentation

AV2105

Channel	Description	Transducer	Filter (CFC)	Sampling Rate	EU
391.	Lap Belt Surface Target 4 Z -		Unfiltered	2000	mm
392.	Lap Belt Surface Target 5 X -		Unfiltered	2000	mm
393.	Lap Belt Surface Target 5 Y -		Unfiltered	2000	mm
394.	Lap Belt Surface Target 5 Z -		Unfiltered	2000	mm
395.	Lap Belt Surface Target 6 X -		Unfiltered	2000	mm
396.	Lap Belt Surface Target 6 Y -		Unfiltered	2000	mm
397.	Lap Belt Surface Target 6 Z -		Unfiltered	2000	mm