GTR7-06-14

# BioRID-II Head Restraint Certification Test Development

Paul Depinet, John Below,
John Arthur, Mike Beebe,
Alex Schmitt, Charlie Steinmetz,
Gus Serrano, Keith Alto

Feb. 28, 2011

HUMANETICS
Innovative Solutions

# Content

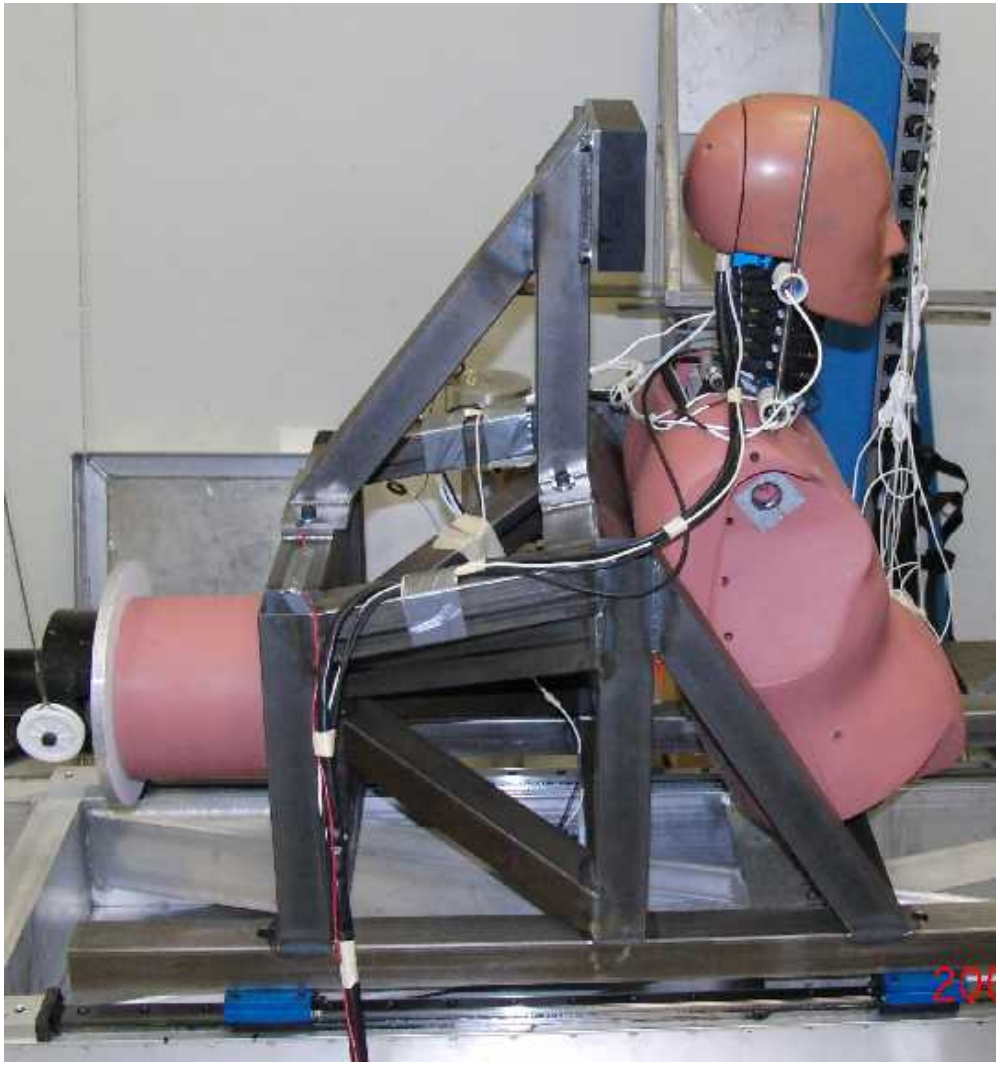
- Rationale for a Head Restraint Test
- Development of Pulse
- Safety of Current Test
- Changeover issues
- Where to go from here

HUMANETICS

# Rationale for a Head Restraint Test

- PDB paper at ESV 2009 indicated that biggest dummy to dummy reproducibility issues existed during head contact with headrest

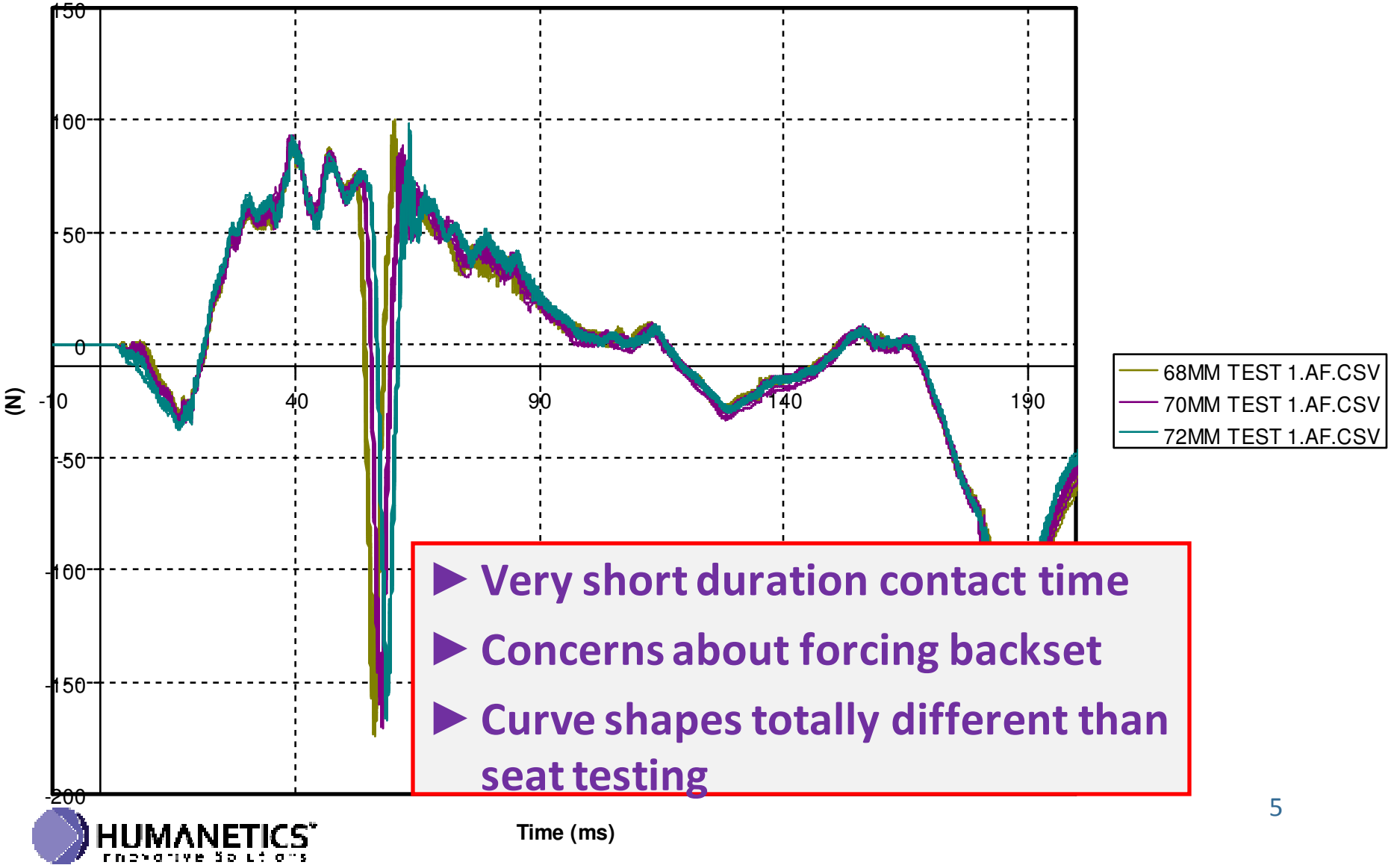
# Initial Head Restraint Test



- Fixed 70 mm backset
- Rigid head restraint
- Same probe and ETD as without head restraint test

HUMANETICS

# Initial Head Restraint Test



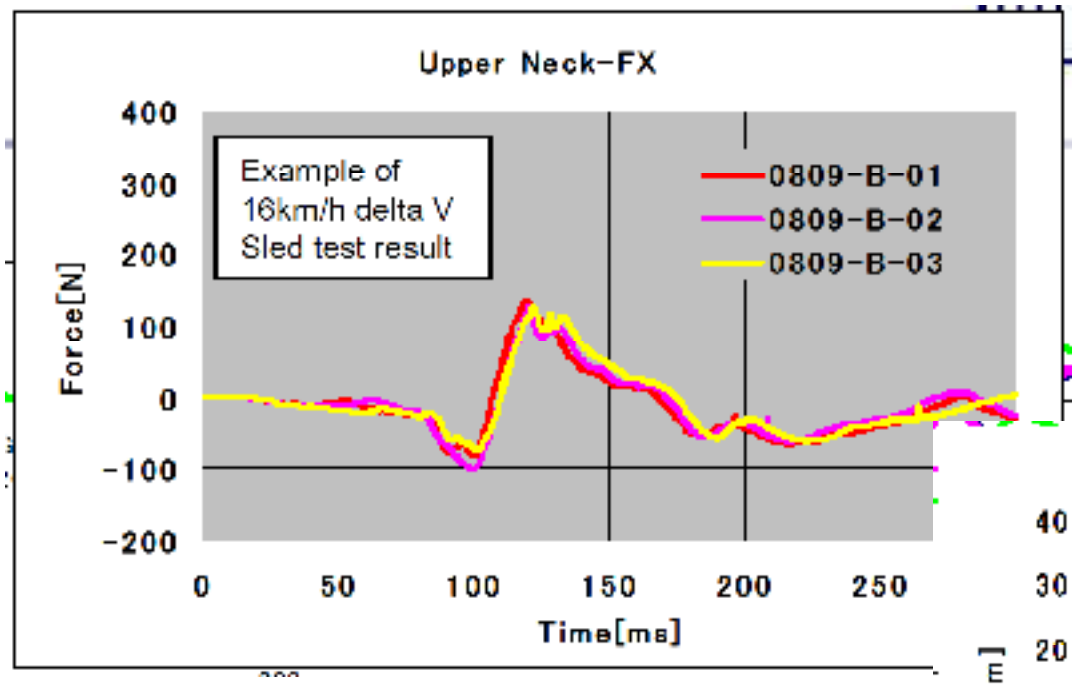

- Very short duration contact time
- Concerns about forcing backset
- Curve shapes totally different than seat testing

HUMANETICS

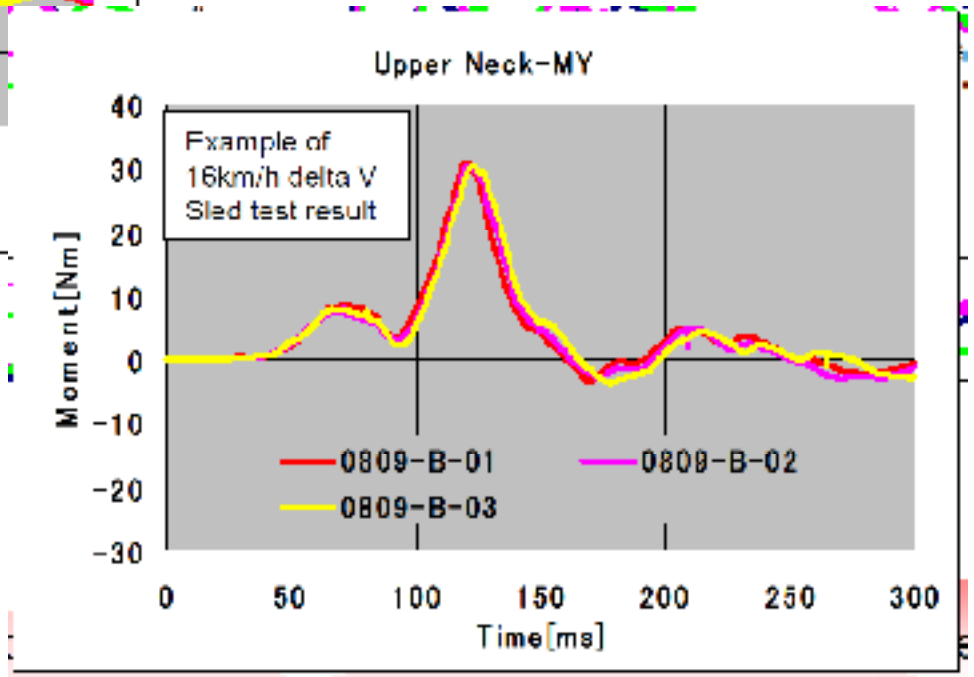
# Head Restraint Test Development

- Requested revisions
  - Padded head restraint
  - Adjustable head restraint
  - Tool to determine head restraint position adjustment from nominal
  - Upper and Lower neck forces and moment similar to car seat testing

# Head Restraint Test Development




- Target curves from **JASIC/Japan**
  - *Feb. 2010 GTR meeting Tokyo*



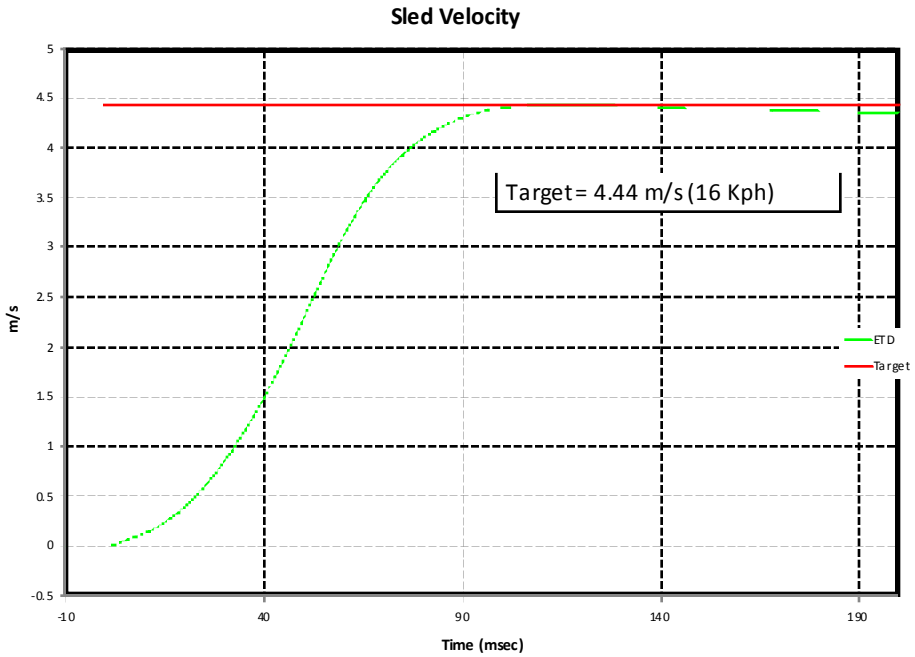

HUMANETICS

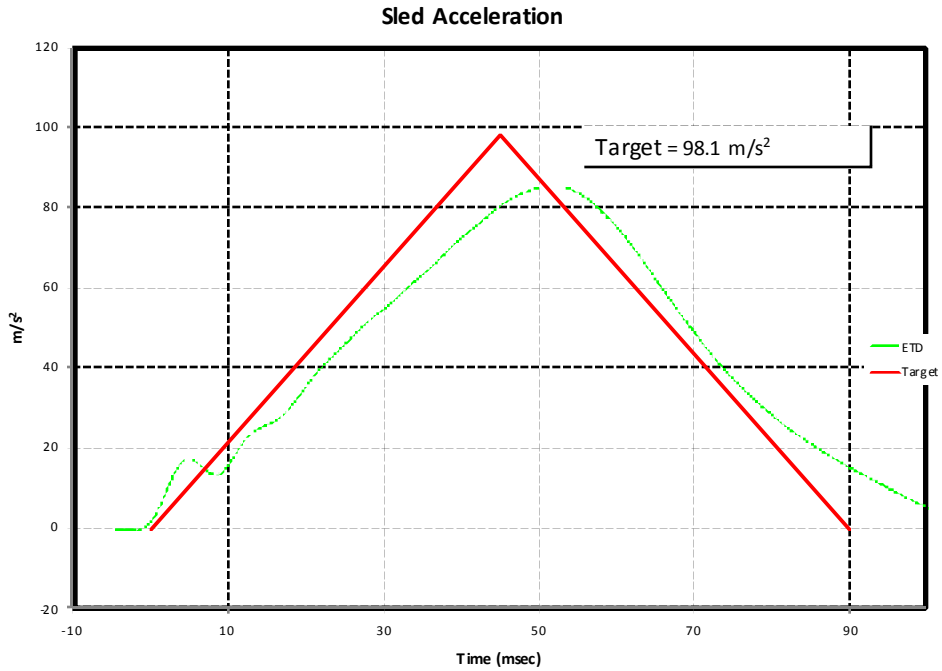
# Head Restraint Test Development

- Experimented with many conditions
  - Foam pad thickness
  - Foam pad stiffness
  - Input pulse amplitude and duration
- Best combination
  - 75 mm thick foam
  - Pulse proposed by Johann Davidson (16 kph, 10 g)

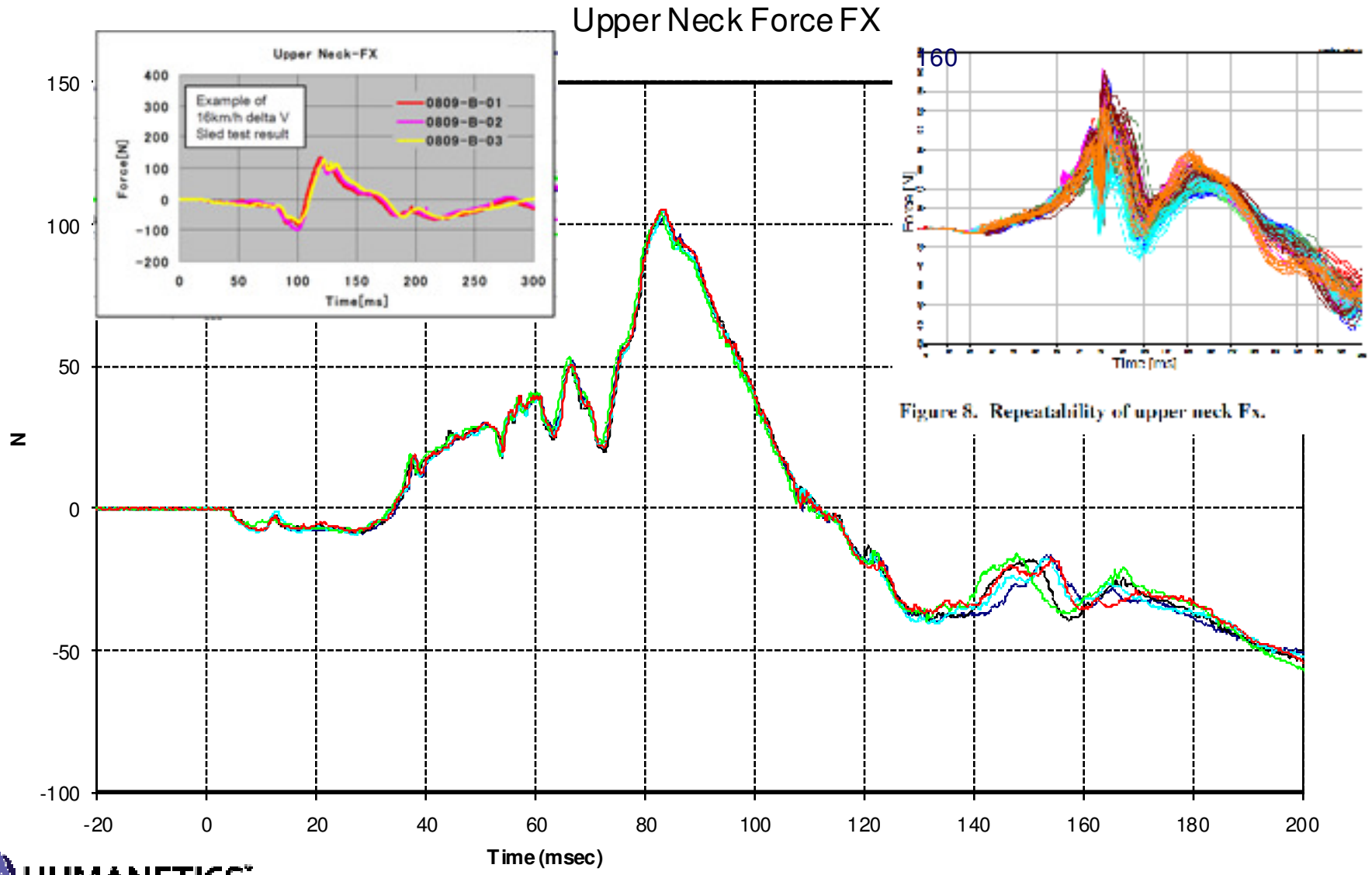
# Head Restraint Test – Selected Pulse

- Impact pulse of 16kph to match seat testing



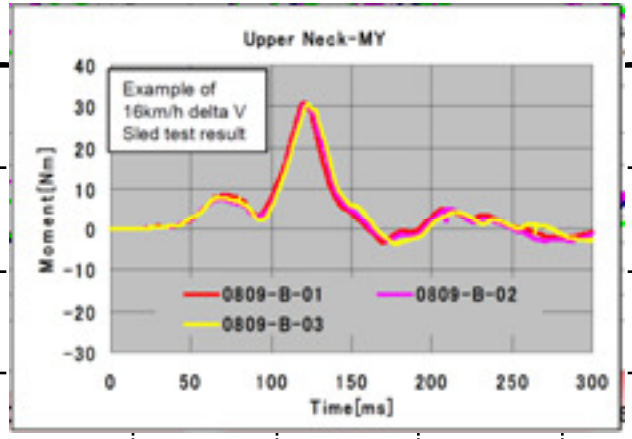
# Head Restraint Test vs JASIC & Sport Seat




HUMANETICS

# Head Restraint Test vs JASIC & Sport Seat

Upper Neck Moment MY



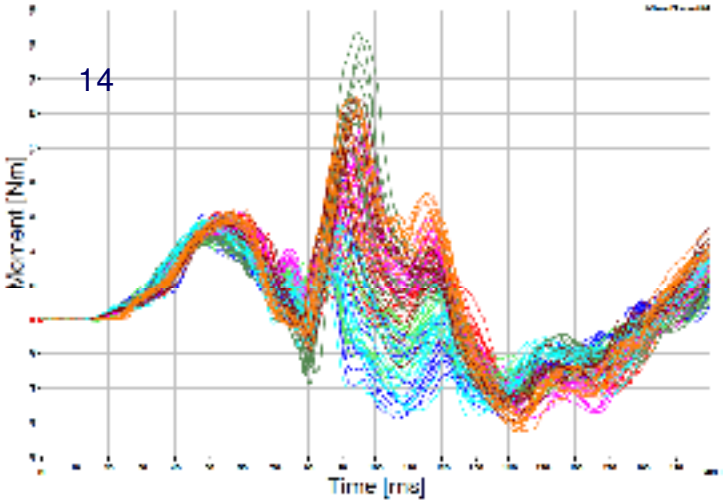
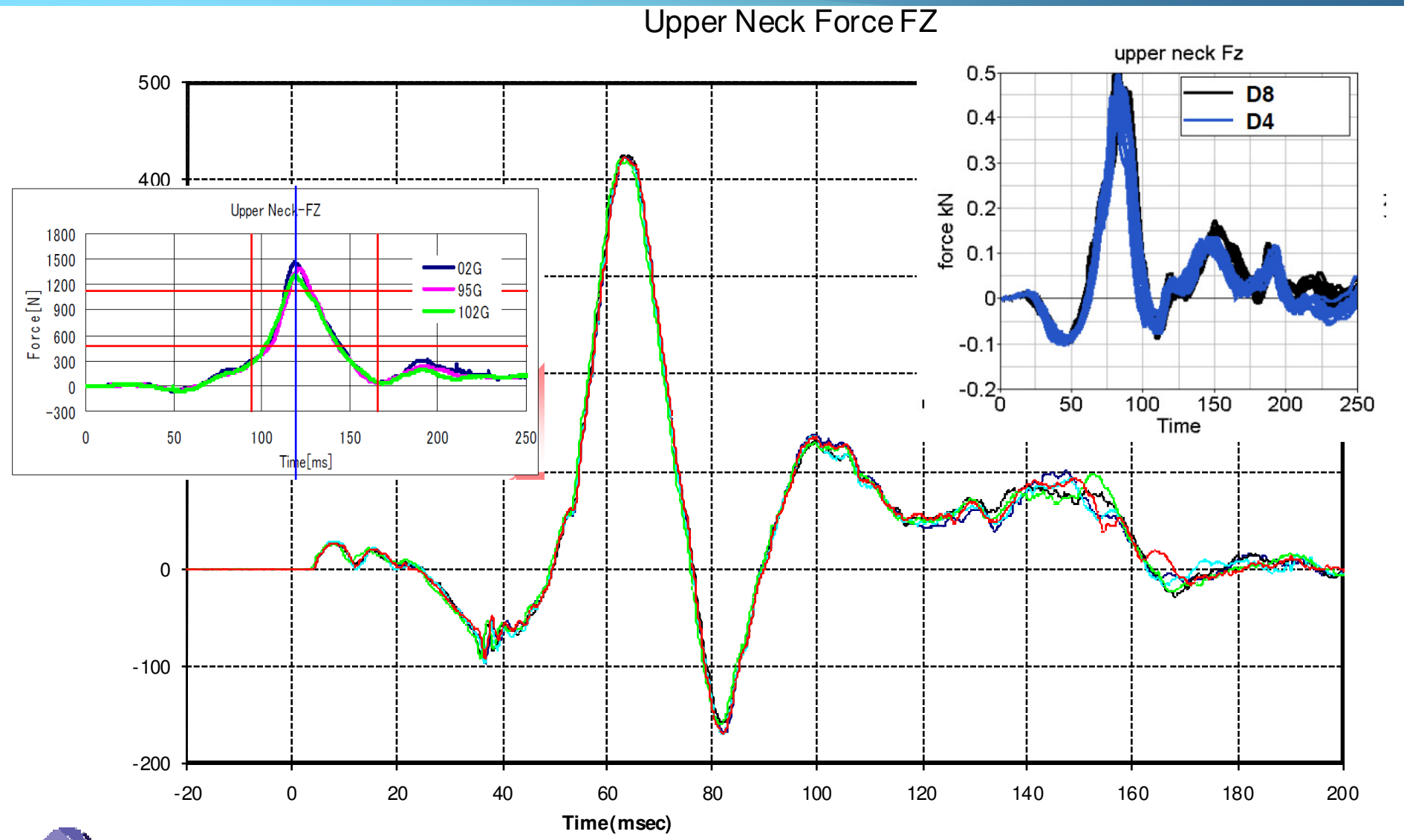




Figure 9. Repeatability of upper neck My.




HUMANETICS

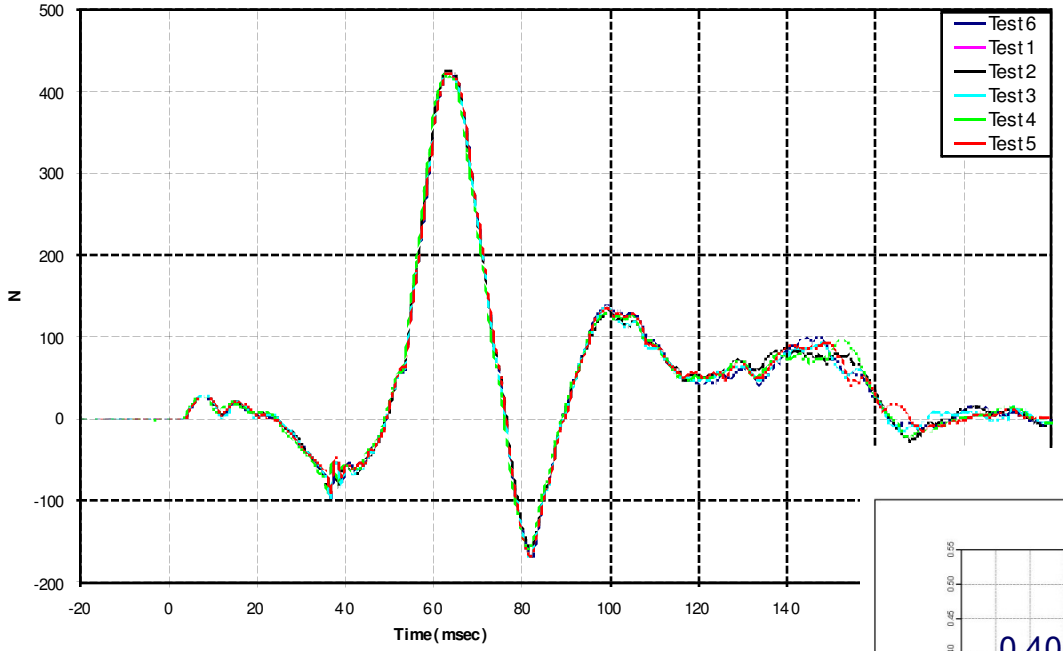
# Head Restraint Test vs JASIC & Sport Seat

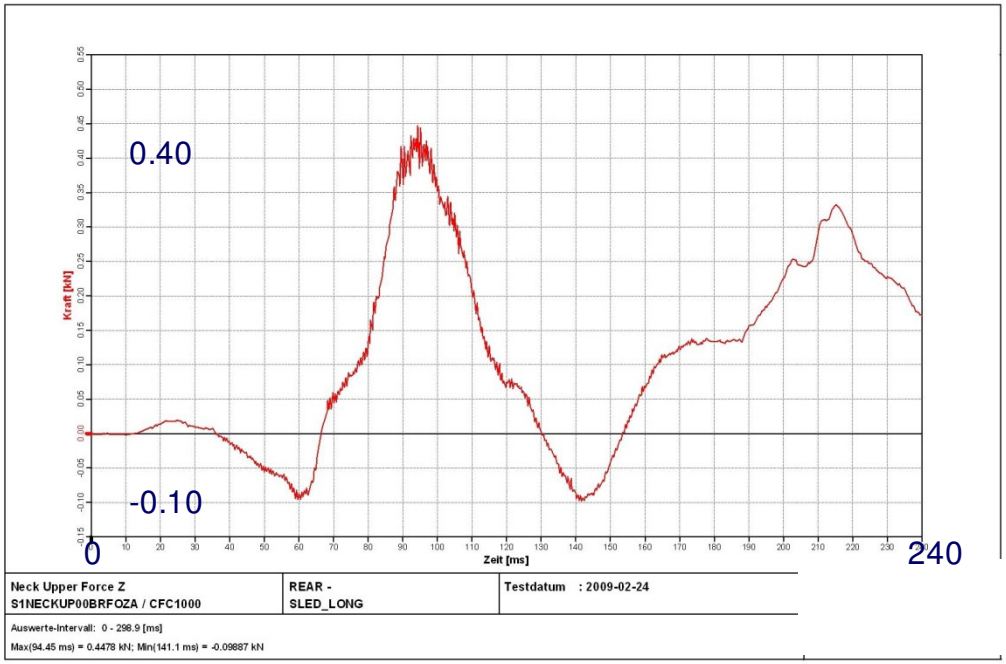



HUMANETICS

# Head Restraint Test vs German Seat

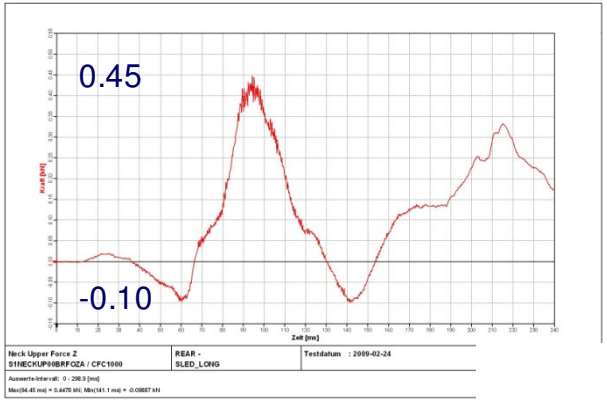
Upper Neck Force FZ

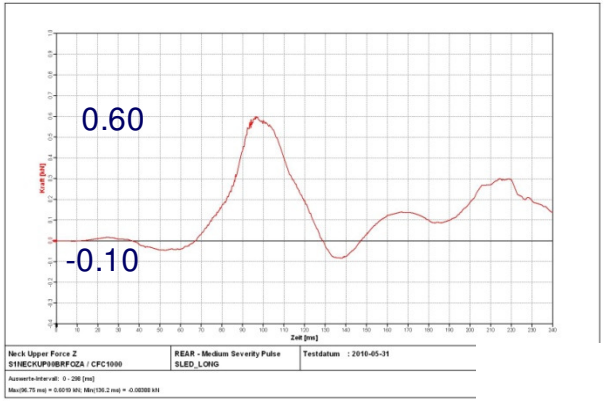


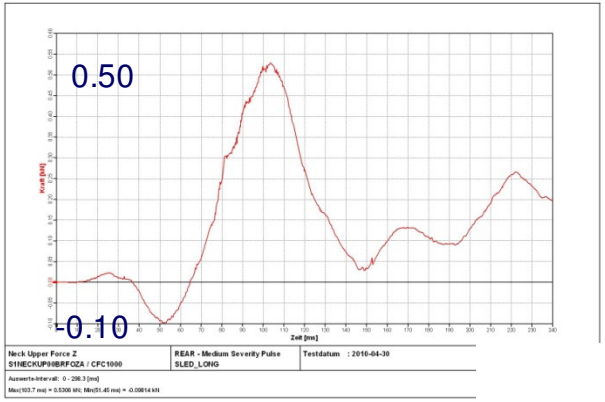



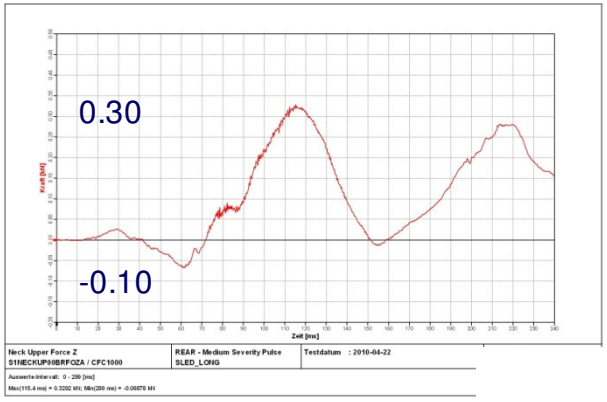

HUMANETICS

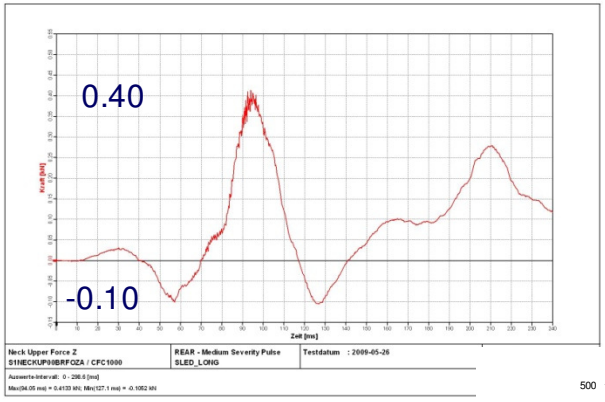
# German Car Seats – Upper Fz

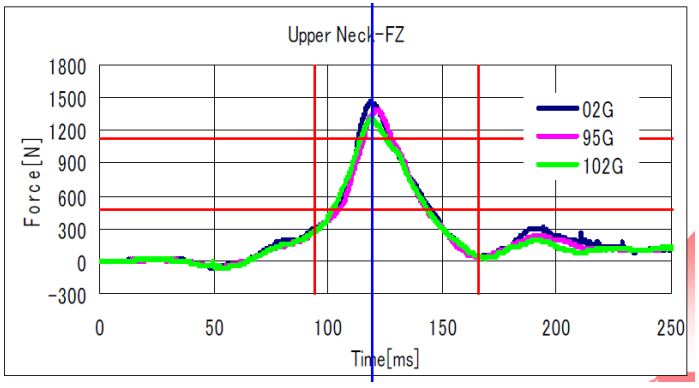


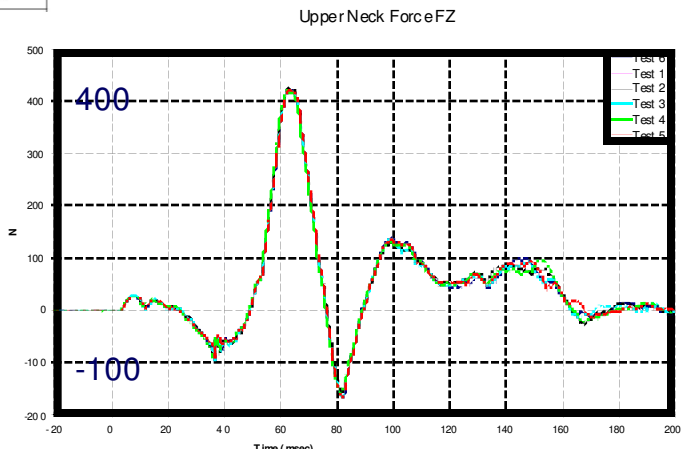



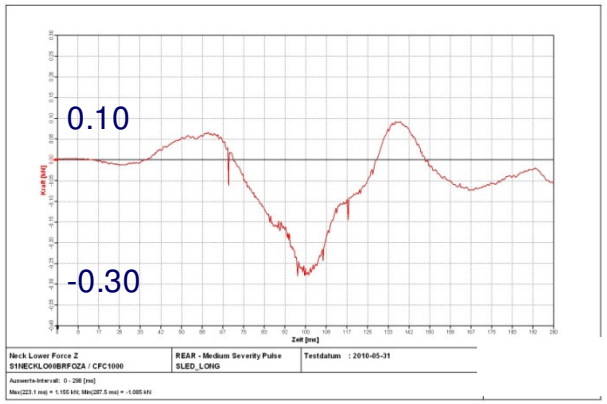



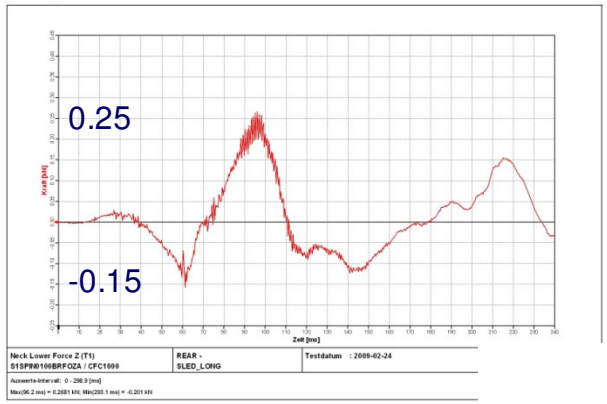



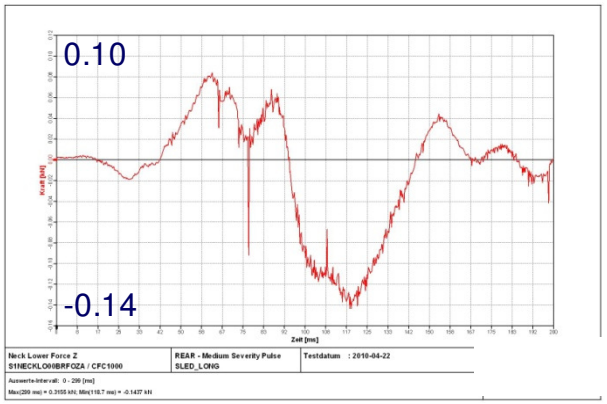



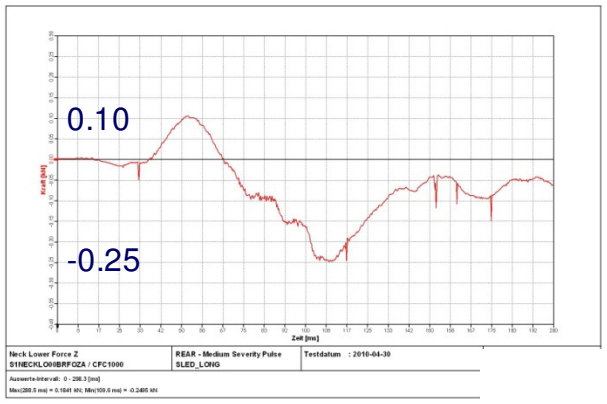



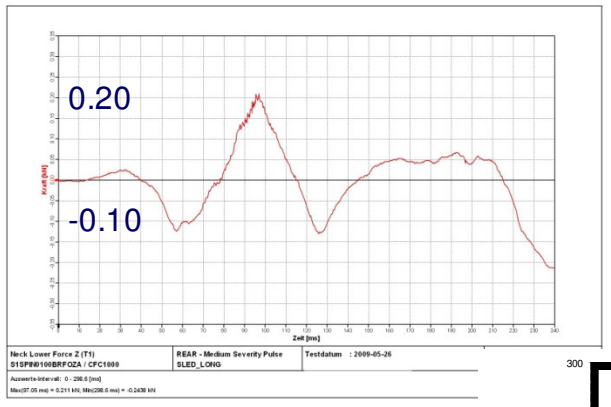
# German Car Seats – Lower Fz

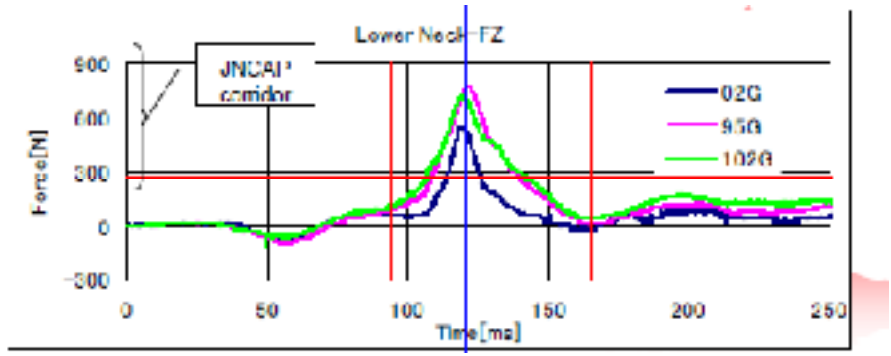


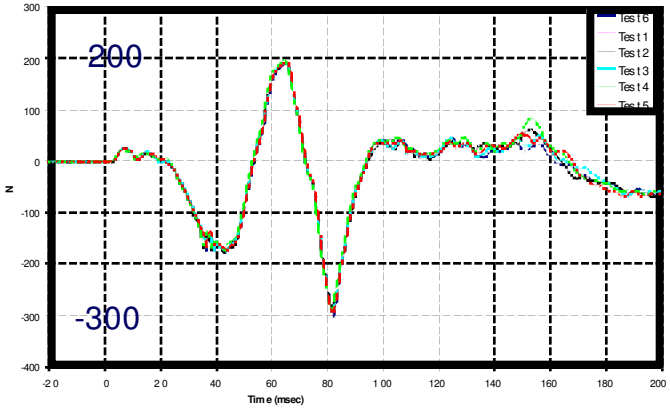



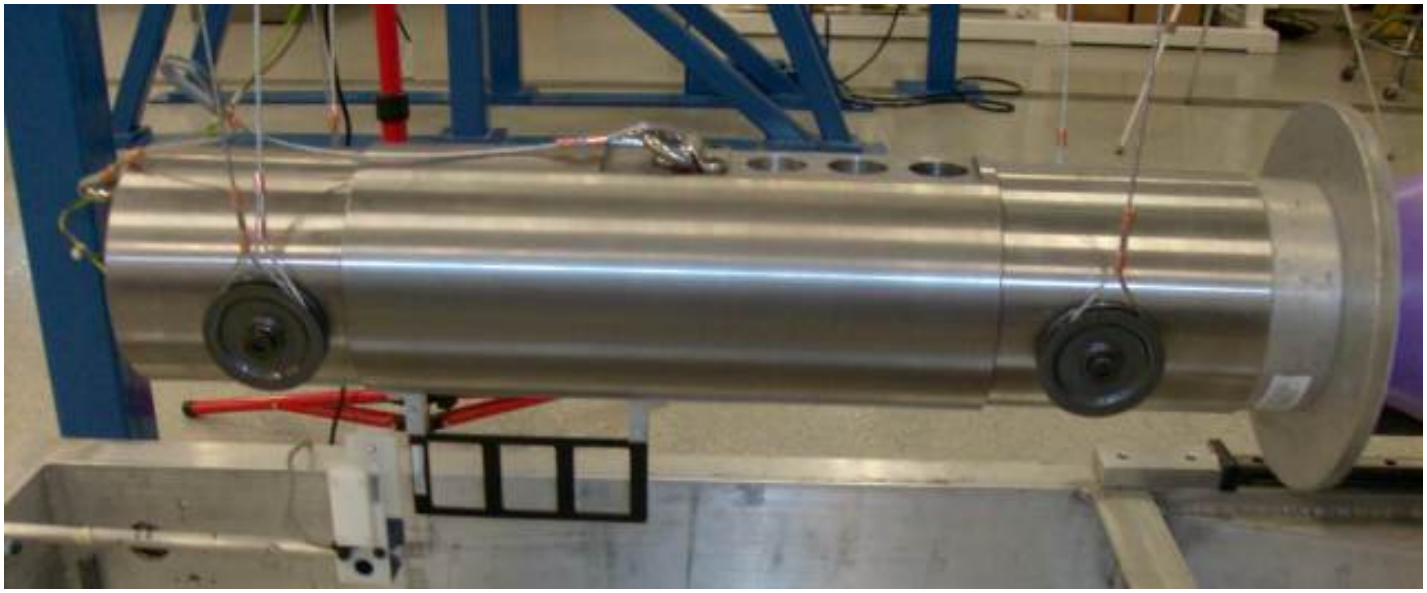

Lower Neck Force FZ (T1 load Cell)



# Head Restraint Test Development

-Longer, shaped ETD to get extended pulse

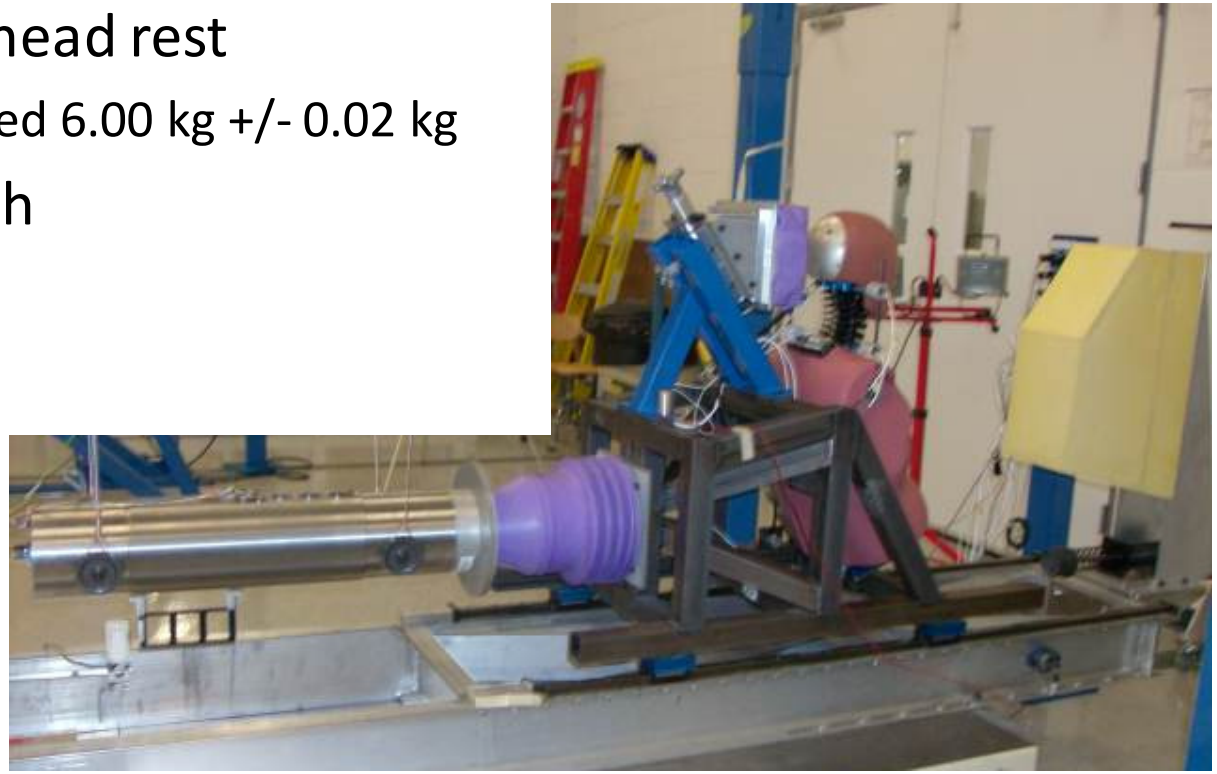
-Heavier probe necessary for sufficient energy



HUMANETICS

# BioRID Certification with Head Rest

- Head Rest Certification Test
  - Heavier probe with same impact face
    - Total probe mass = 118.5 kg +/- 0.1 kg (261.2lb)
  - Custom ETD for advanced pulse
  - Adjustable foam head rest
    - Mass added to sled 6.00 kg +/- 0.02 kg
  - Cap contact switch

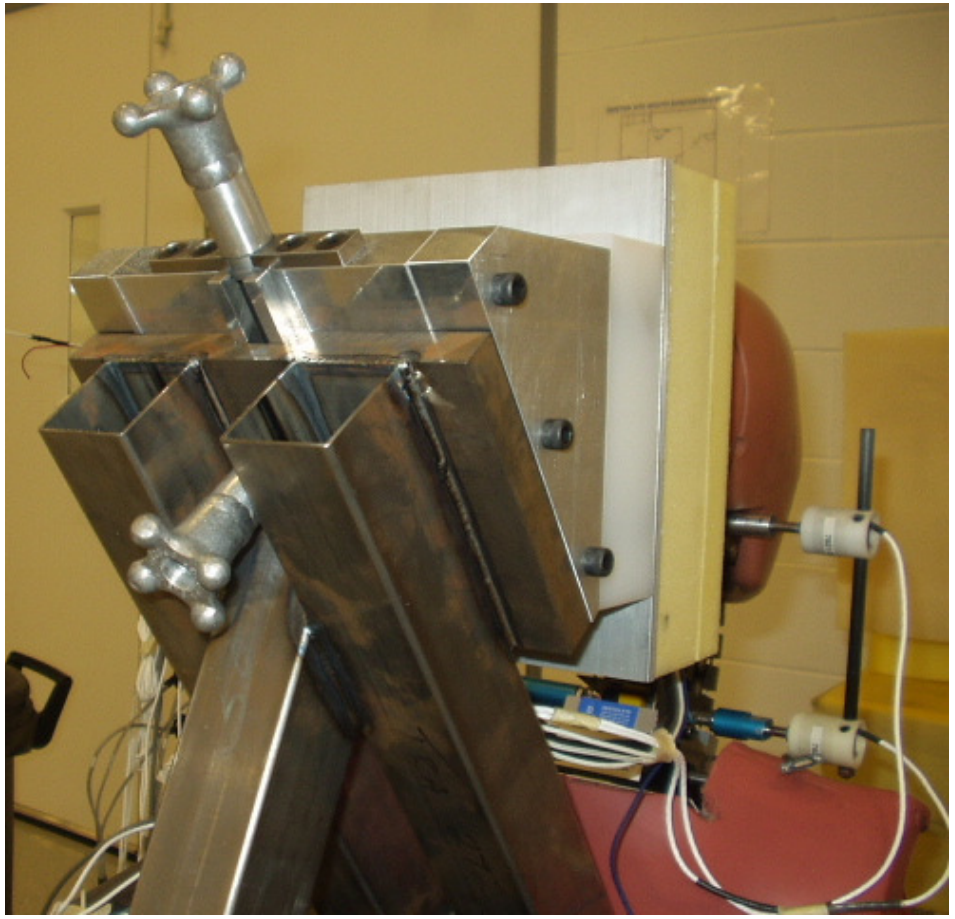


HUMANETICS

# Head Restraint Test Development

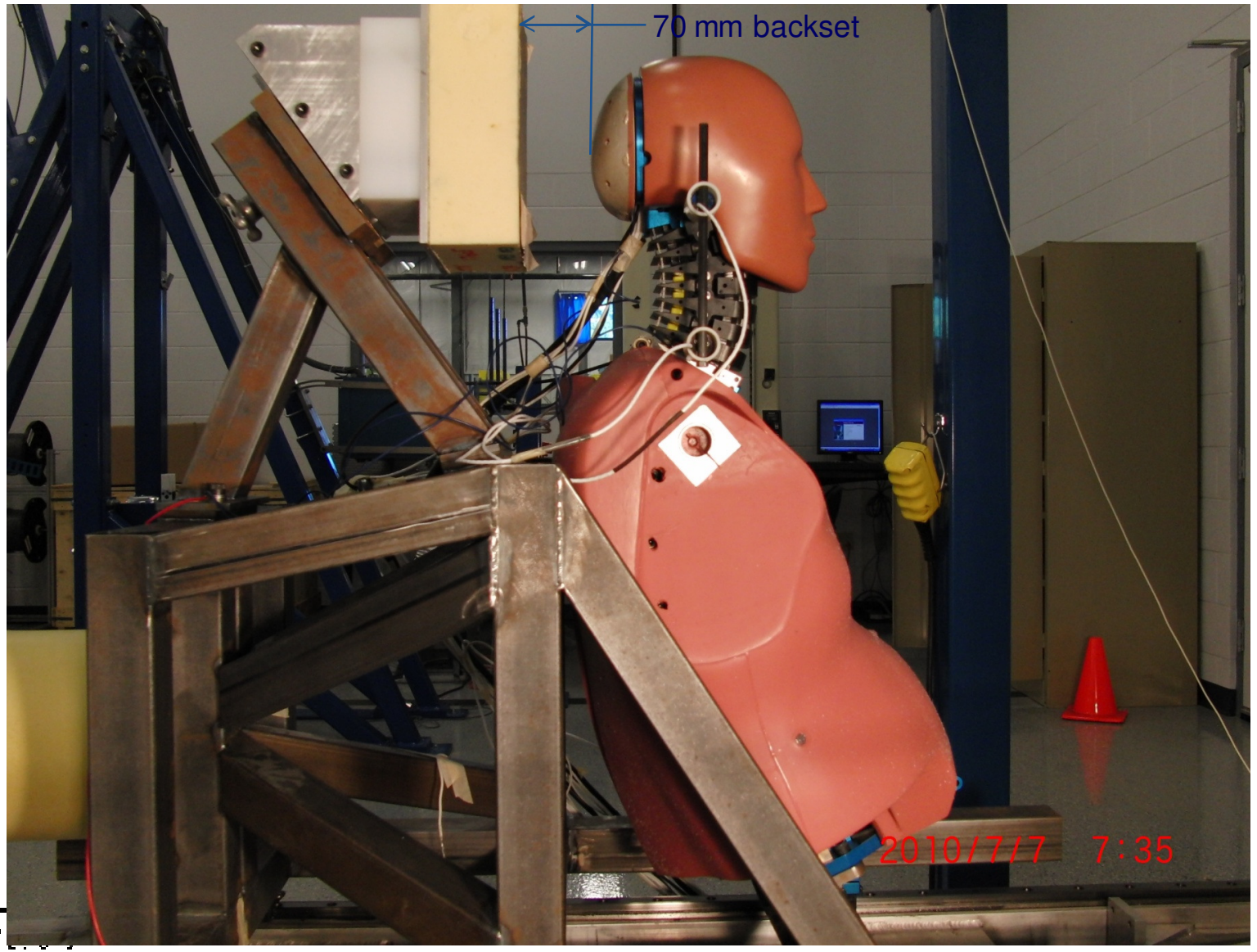
-Adjust head restraint for 70 mm backset with head level.

-75 mm thick foam pad

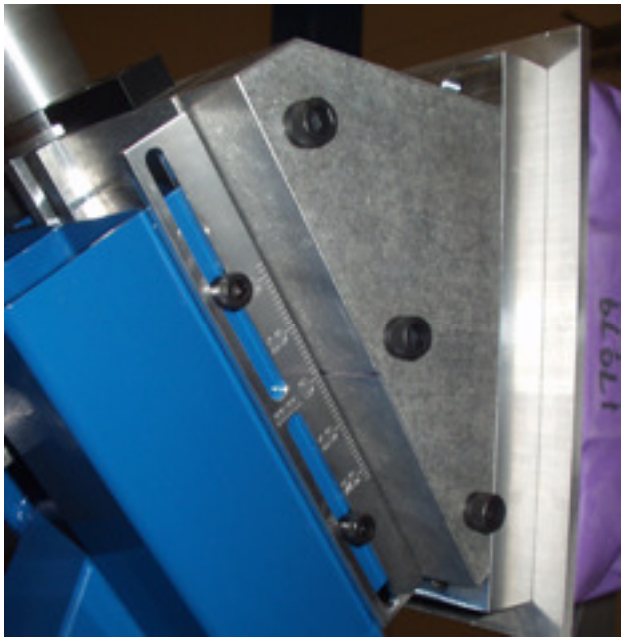


HUMANETICS

# Head Restraint Test – Setup Position



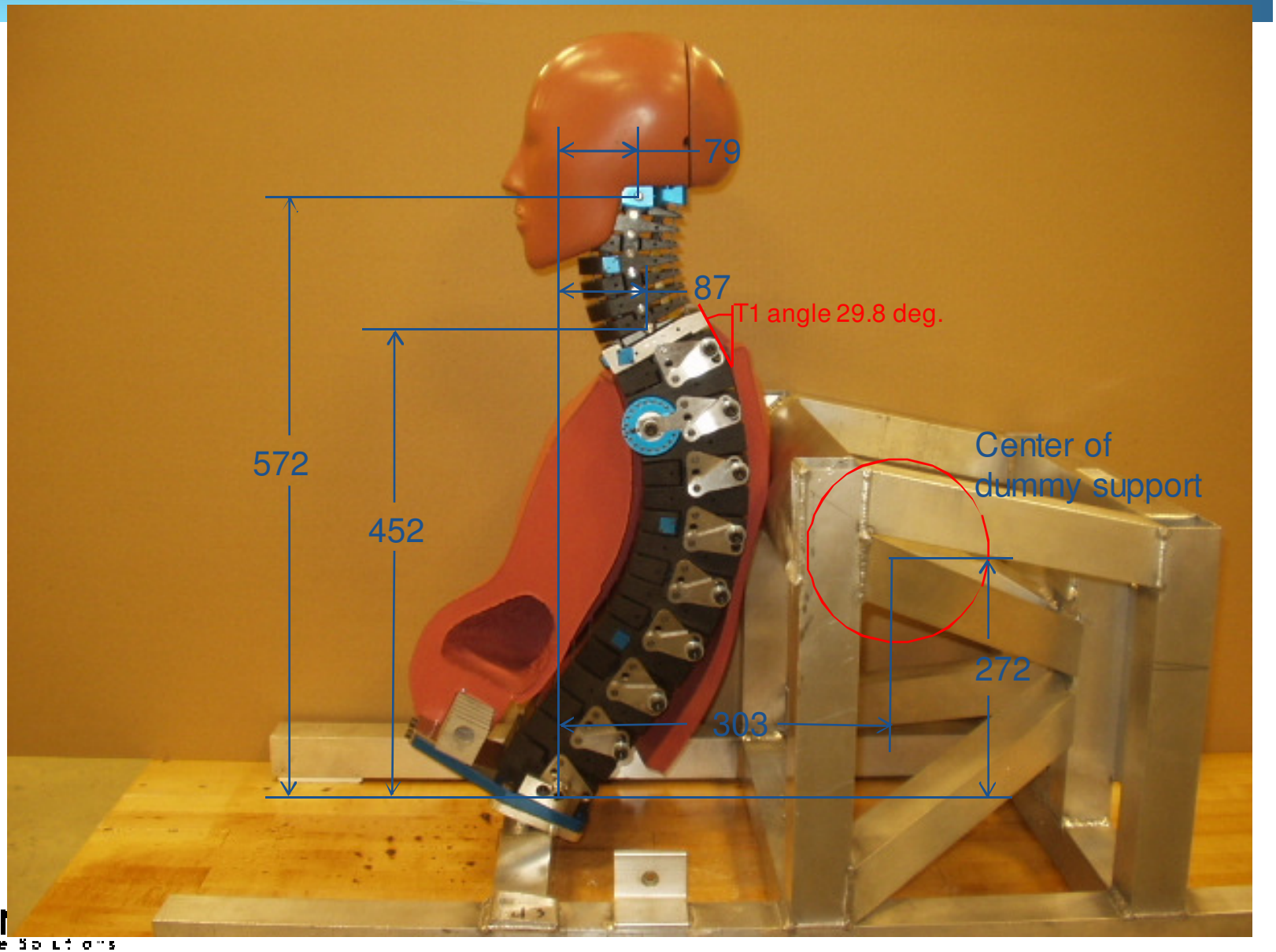
# Head Restraint Setup Zeroing Tool



- Tool allows setting nominal position of scale
- Scale measures adjustment from nominal position

HUMANETICS

# Head Restraint Test – Setup Position



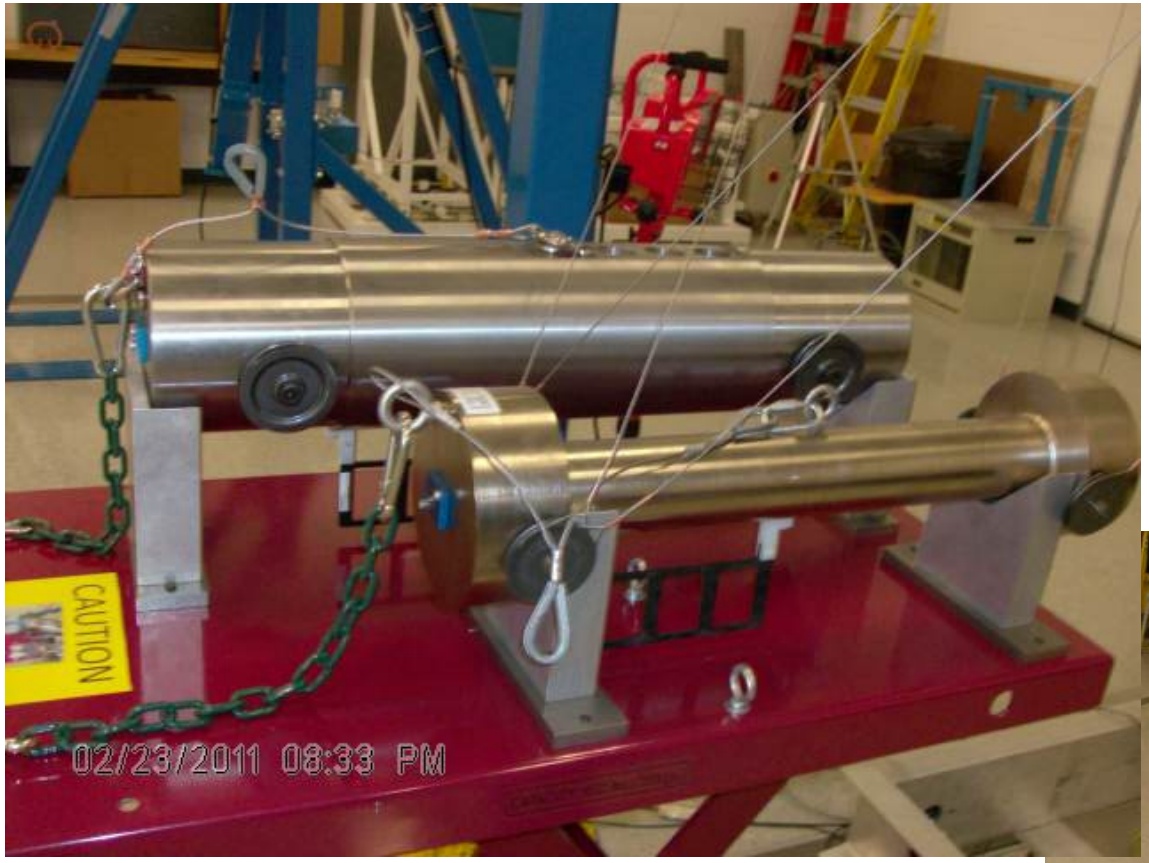
# Safety of Current Test

- Is 37.61 kg safer than 118.5 kg?
  - Getting hit by either probe would cause serious or fatal injuries
  - GREAT care must be exercised around either probe
- Can 118.5 kg probe be handled safely?

# Changeover Issues

- Heavier cables
- Stronger winch
- Strengthened attachments
- Lift cart for installing and removing probes
  - No lifting by hand is necessary!

# Changeover Issues




- Cart for
  - Probe handling
  - Storage
  - Installation
- No hand lifting of probes is necessary!


*Probe installation and removal videos.*

HUMANETICS

# Where to go from here

- Do we need so many test?
  - Takes far more time to certify dummy
    - Cost
    - Delays in testing
  - What is goal of project?
    - Reduce dummy to dummy variation?
    - Make certification testing faster and cheaper?
- Do we need two probes/ETD?

# Where to go from here

- Is this a reasonable number of tests for a dummy?

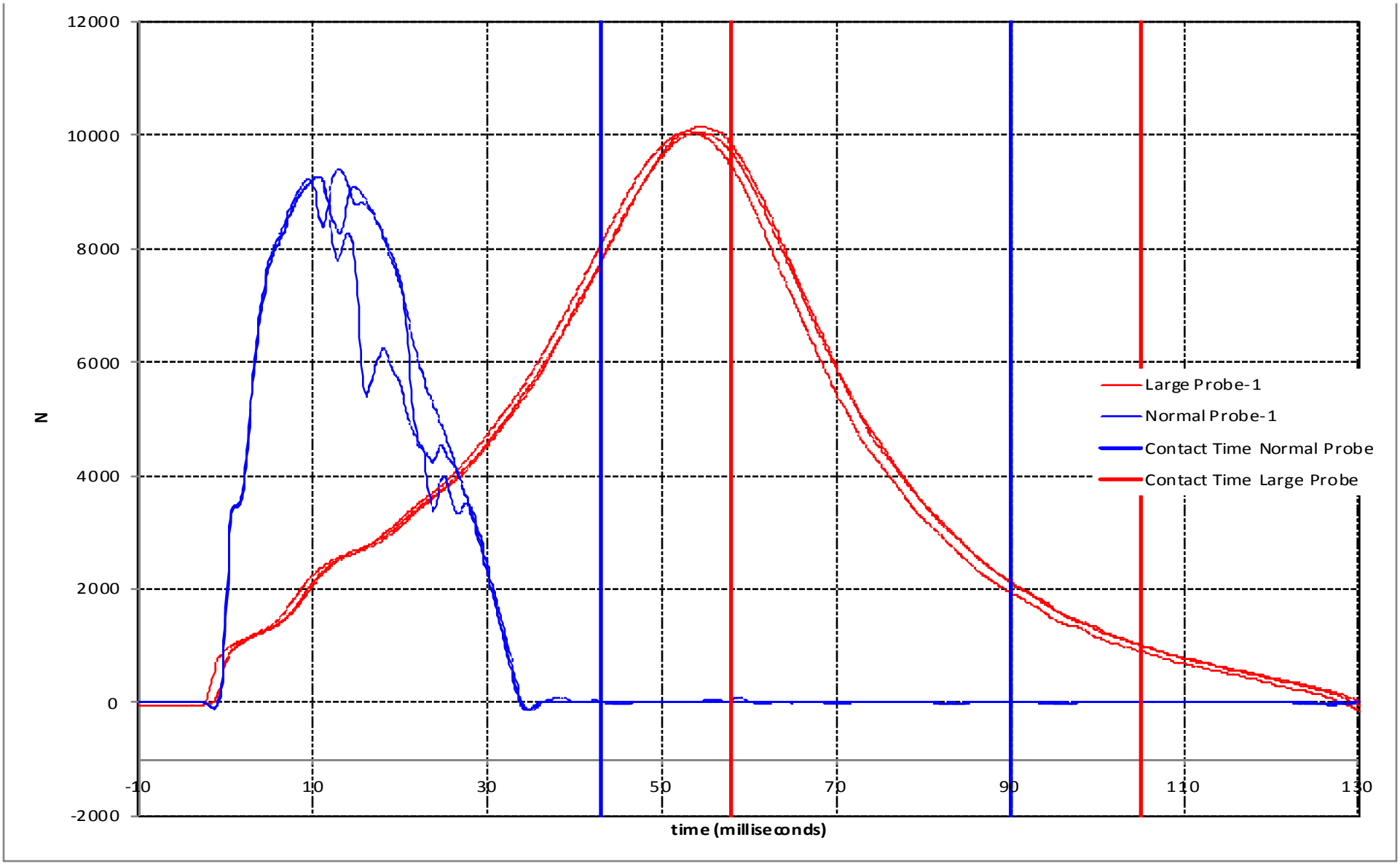
| SID-IIS | H-III50M | BioRID-II |
|---|---|---|
| Head drop | Head Drop | Sled w/o head restraint certification |
| Neck pendulum | Neck Flexion | Dummy w/o head restraint |
| shoulder | Neck Extension | Head restraint foam certification |
| Thorax without arm | Thorax low speed | Sled with head restraint certification |
| Thorax with arm | Thorax high speed | Dummy with head restraint certification |
| Abdomen | Hip ROM left | Jacket certification |
| Acetabulum | Hip ROM right | |
| Iliac | Knee impact left | |
| | Knee impact right | |
| | Knee slider left, low speed | |
| | Knee slider left, high speed | |
| | Knee slider, right low speed | |
| | Knee slider, right high speed | |

# Do we need two probes/ETD?

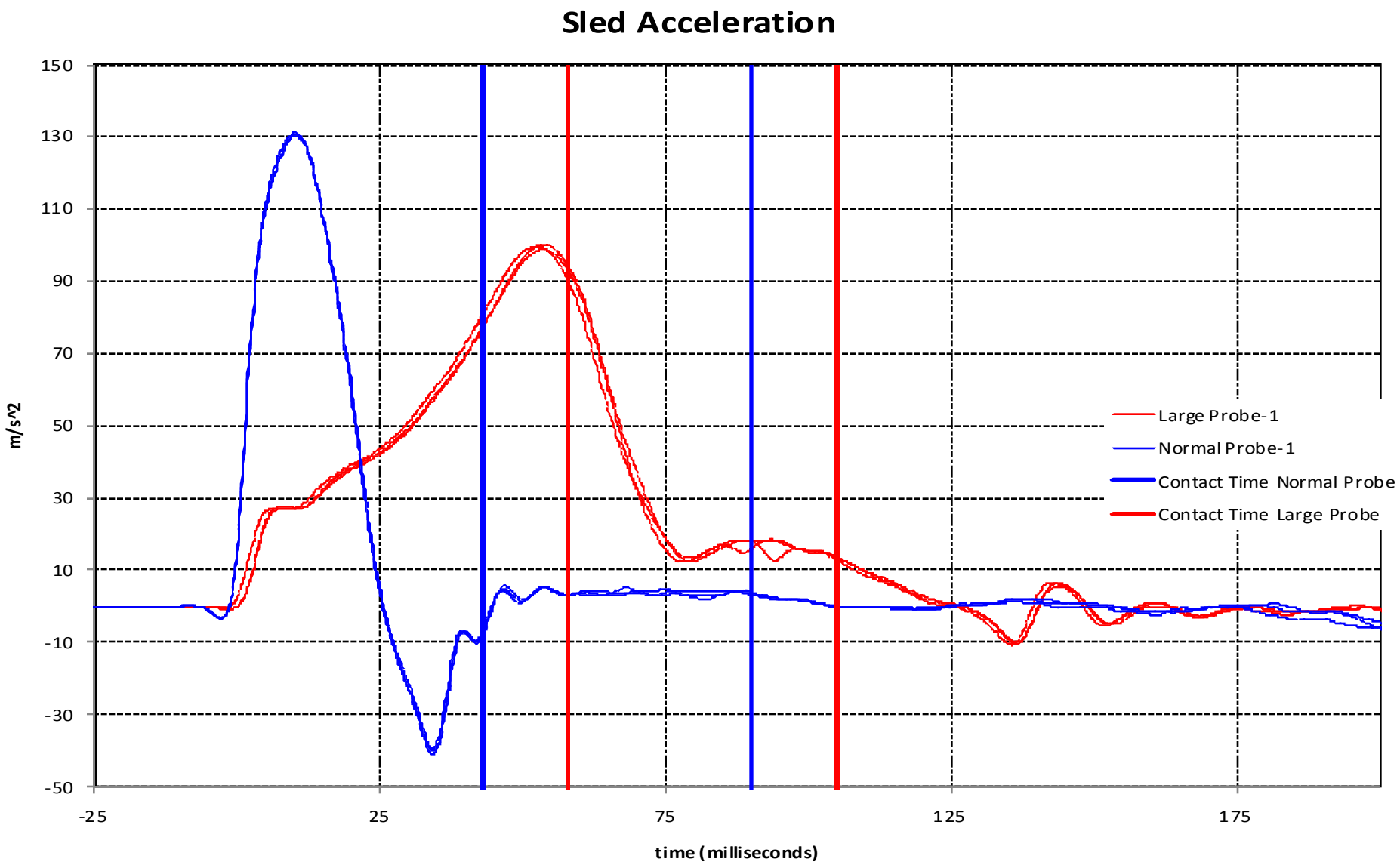
- Heavy probe / long ETD needed to get pulse shape
- Would it be acceptable to use same probe and ETD as “without Head Restraint” test?

# HEAVY
# *VS*
# STANDARD
# CERTIFICATION PROBE
# COMPARISON

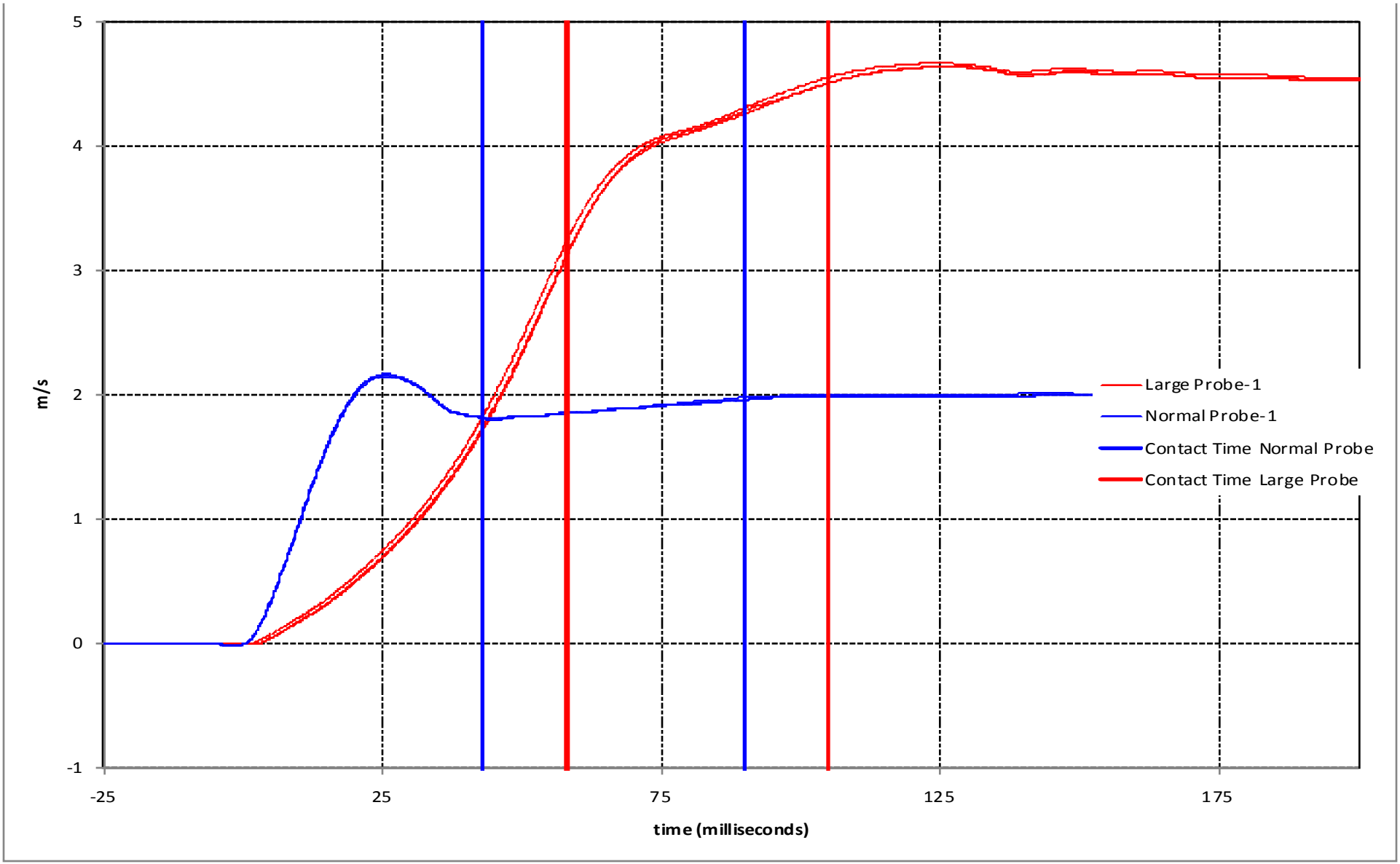
# Pendulum Force



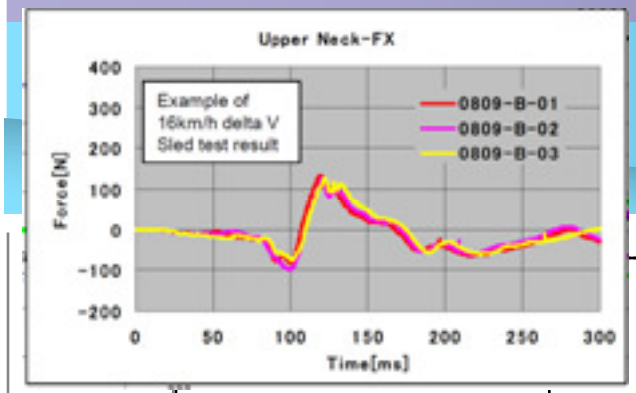
# Sled Acceleration



# Sled Velocity



# Upper Neck Force FX



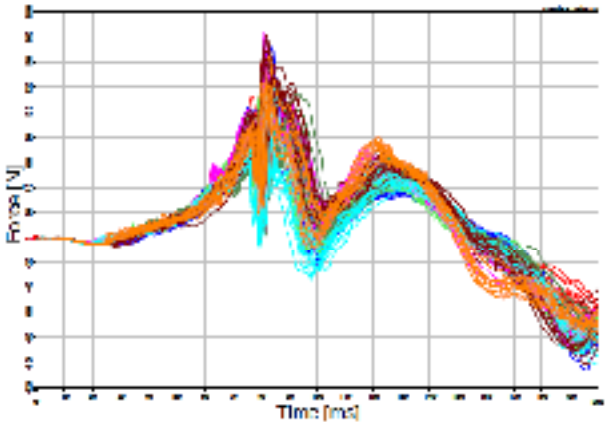
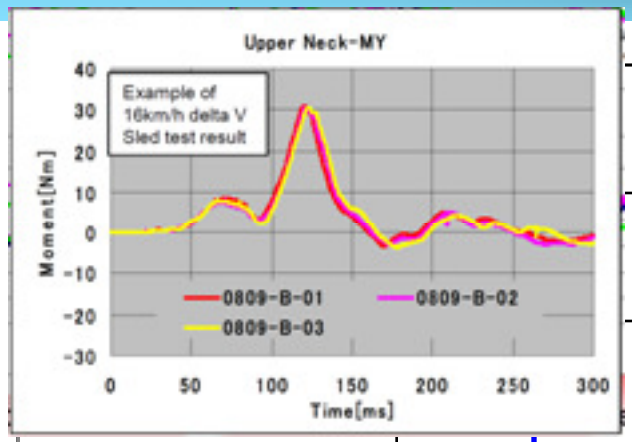




Figure 8. Repeatability of upper neck Fx.

# Upper Neck Moment MY



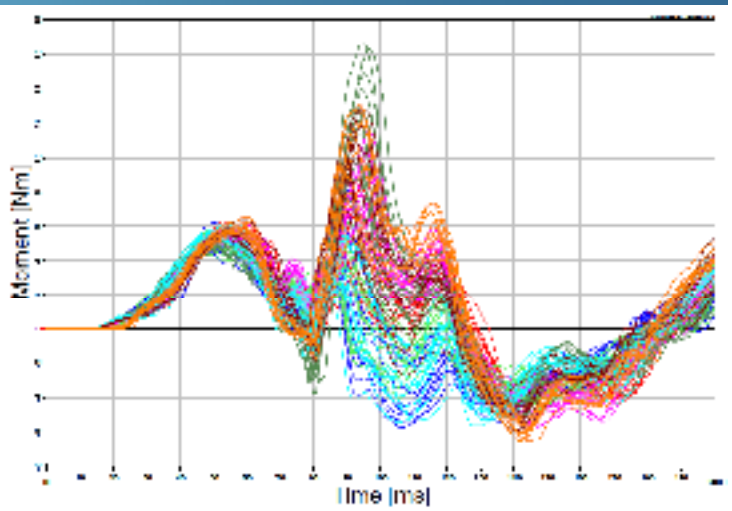




Figure 9. Repeatability of upper neck My.

Nm

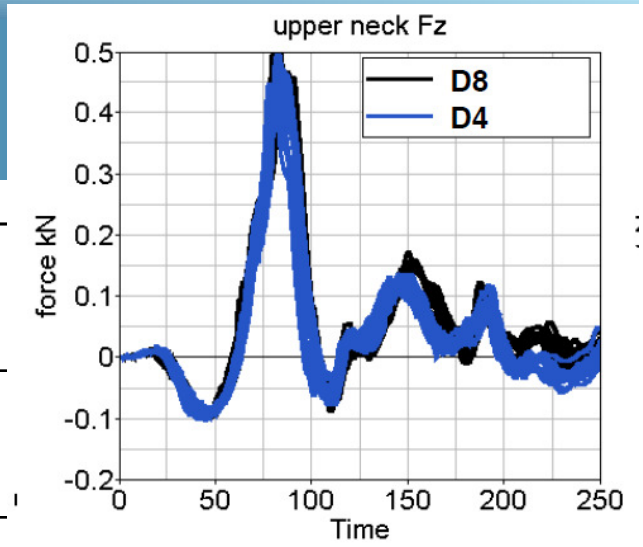
time (milliseconds)

Normal Probe-1

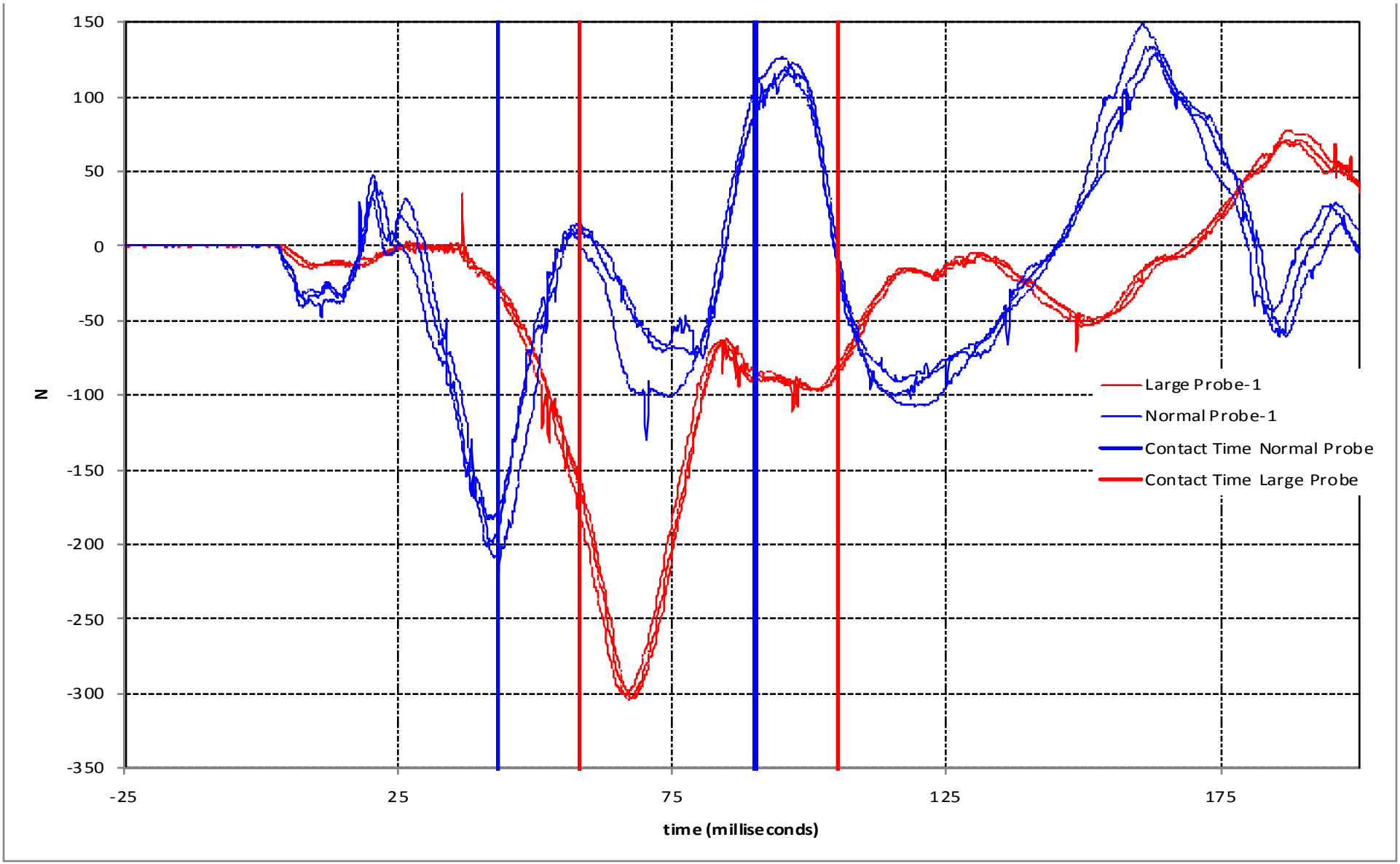
Contact Time Normal Probe

Contact Time Large Probe

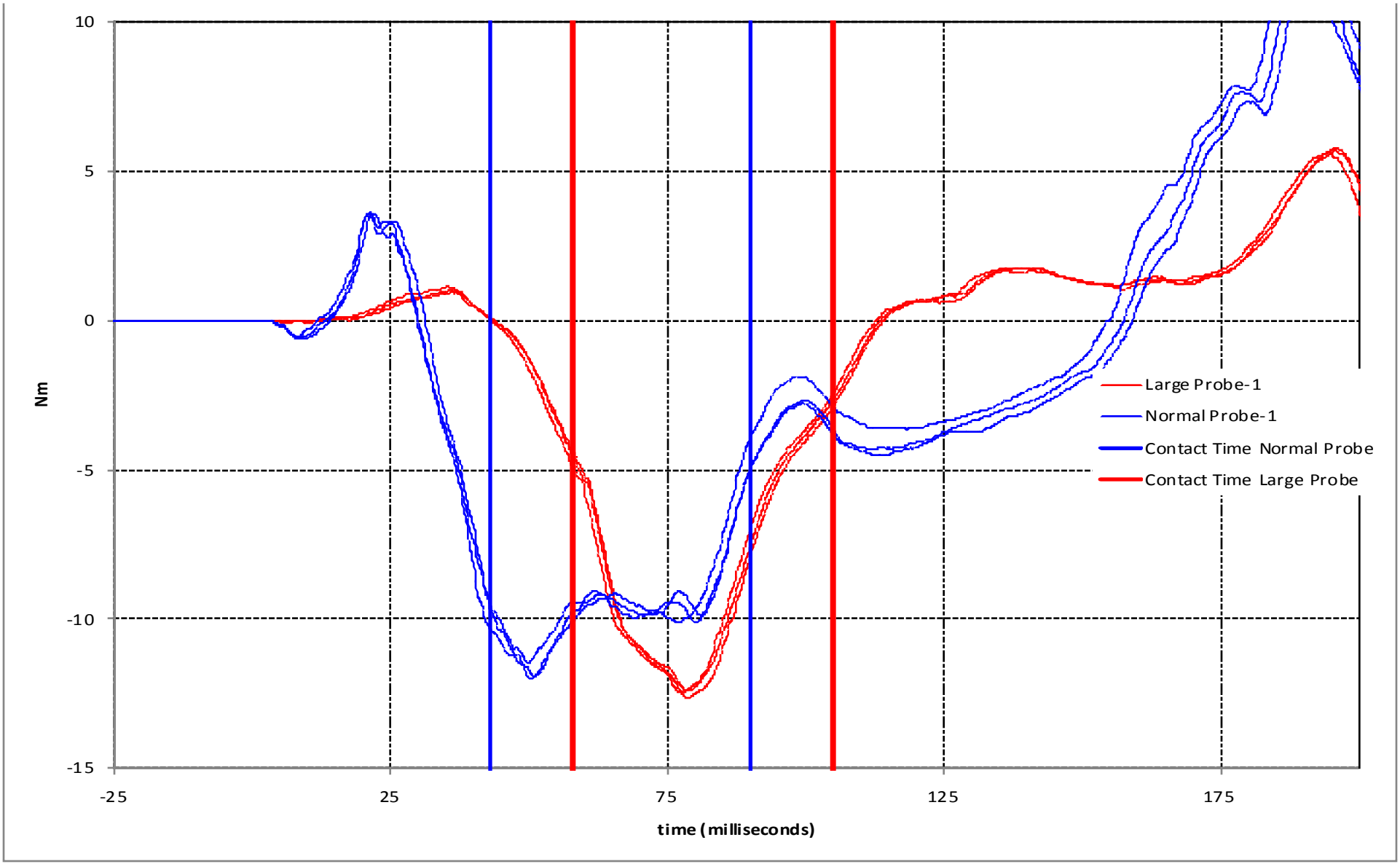
# Upper Neck Force FZ



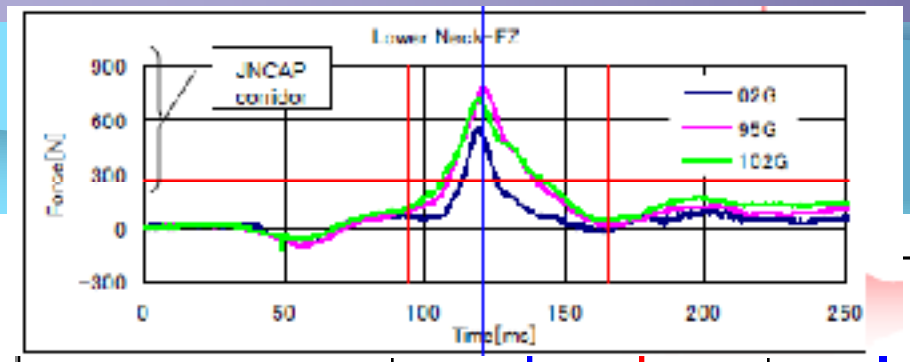
# Lower Neck Force FX (T1 load Cell)

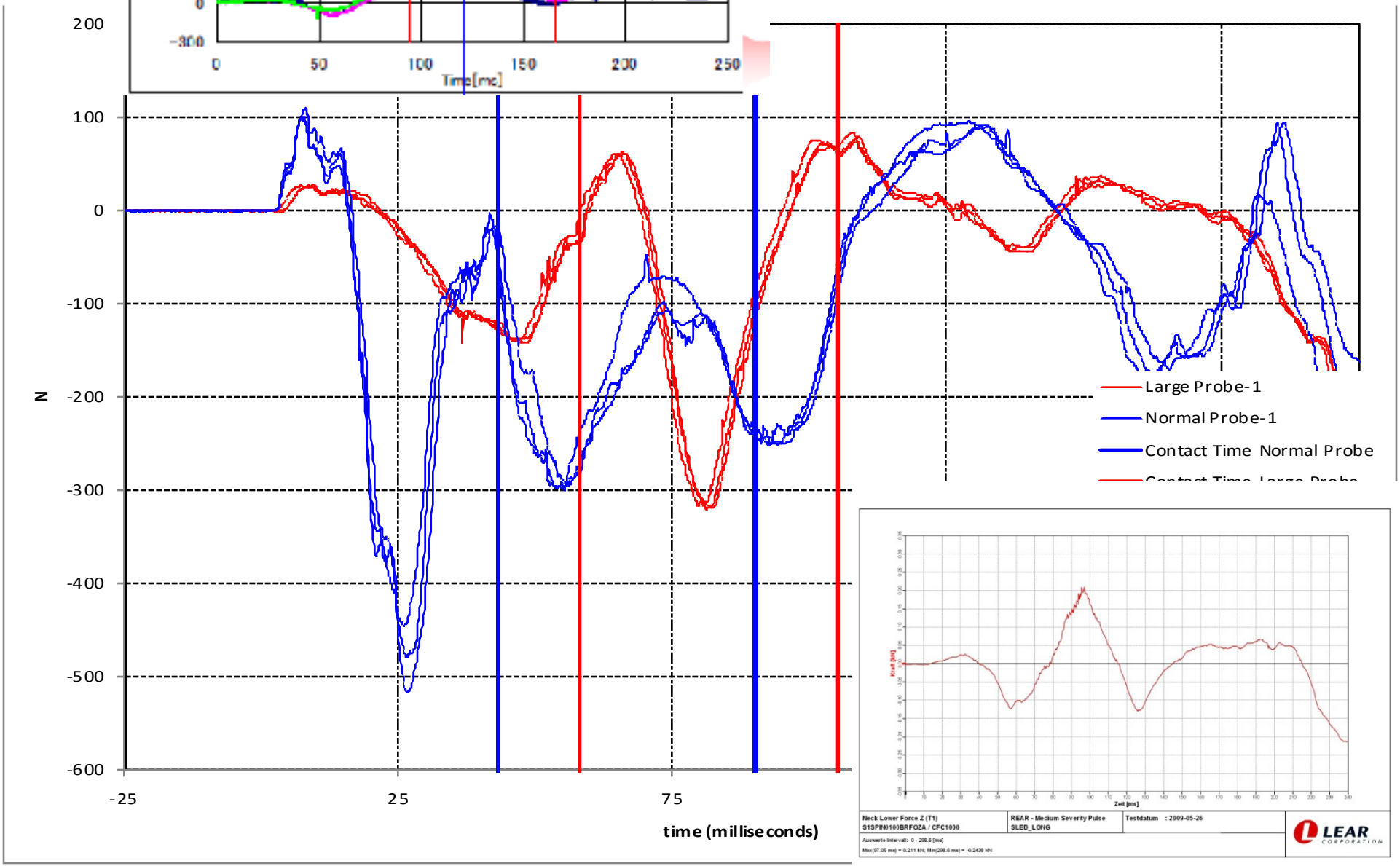


# Lower Neck Moment MY (T1 Load Cell)

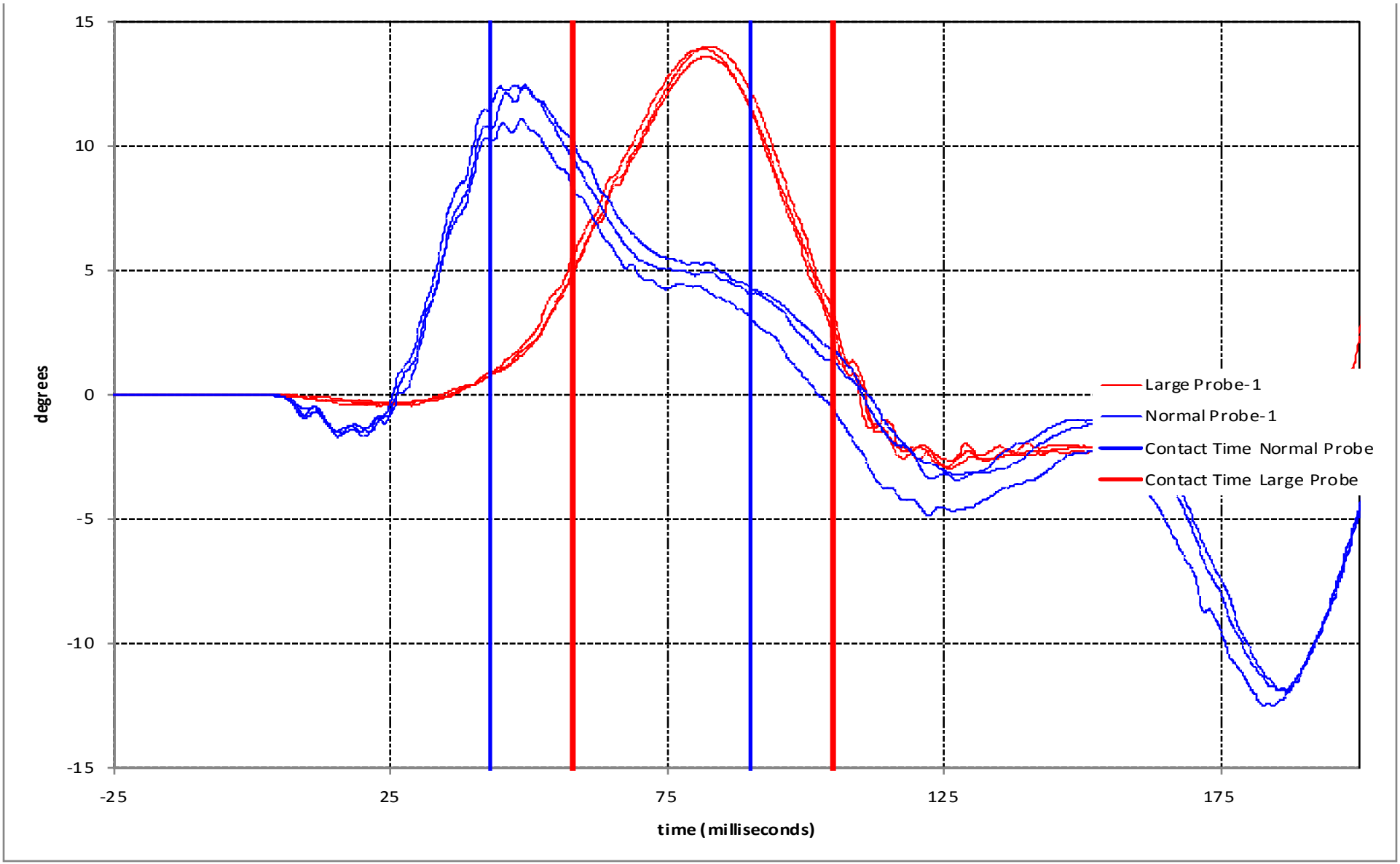


# Lower Neck Force

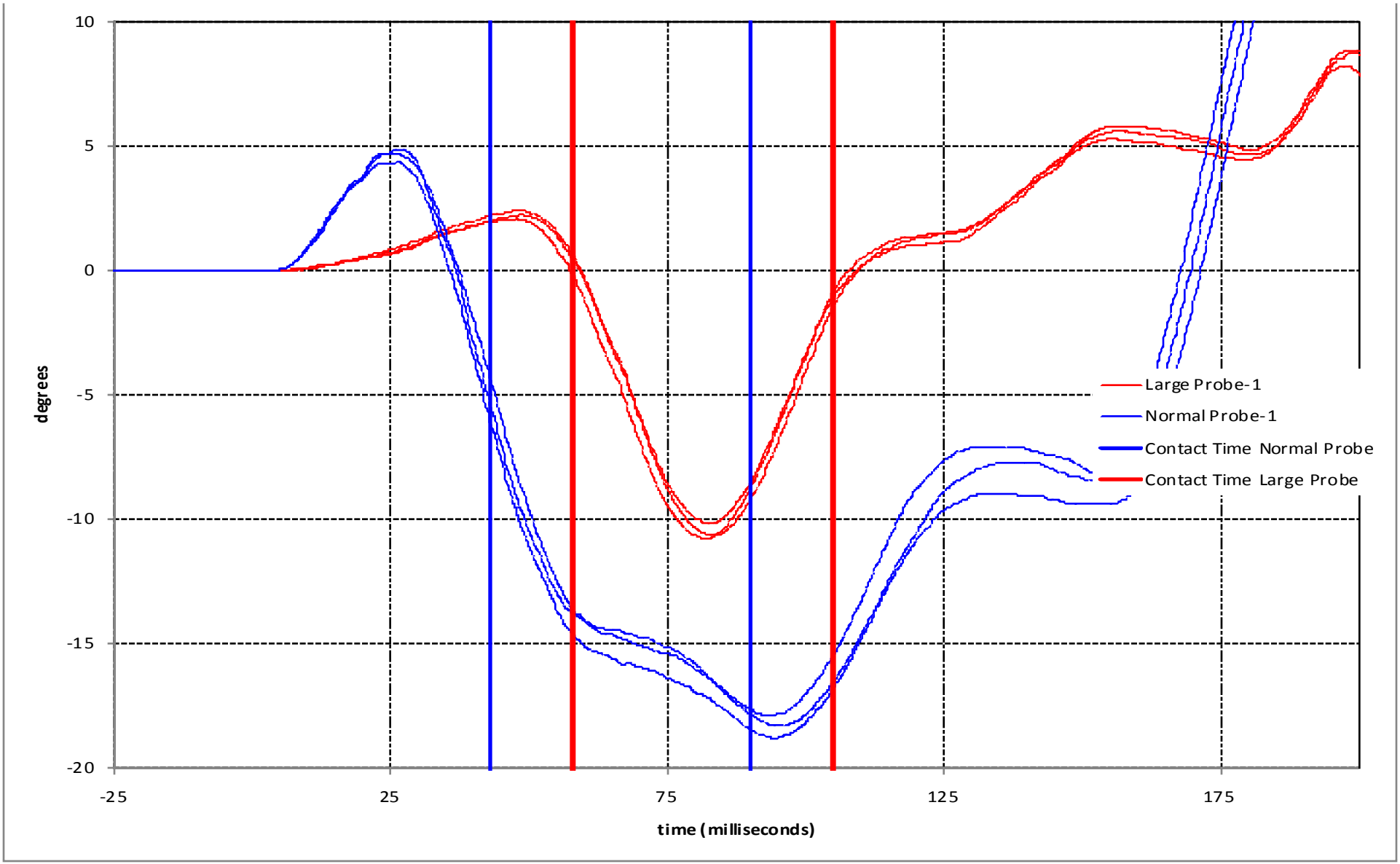


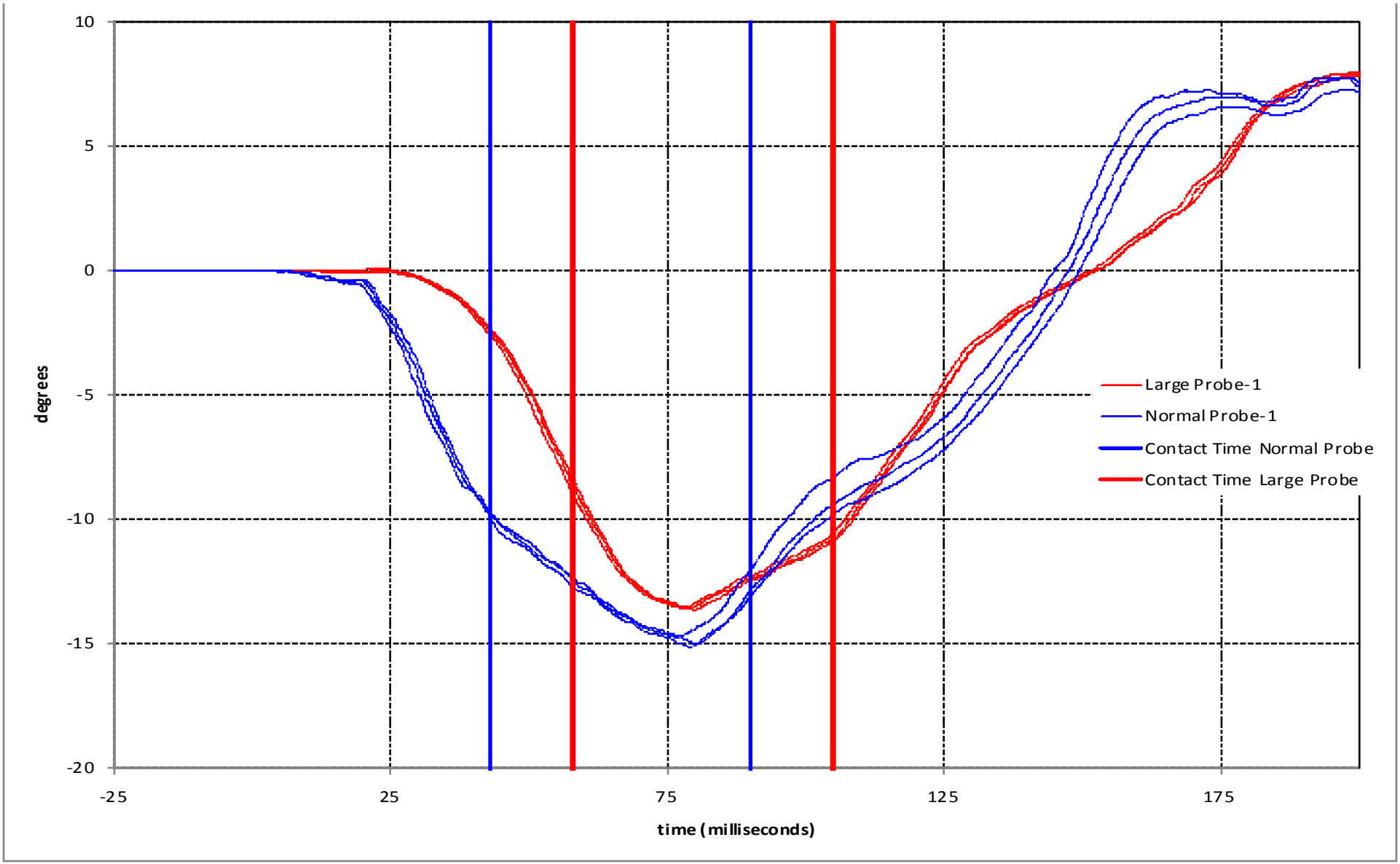
# Pot A - Head Pot



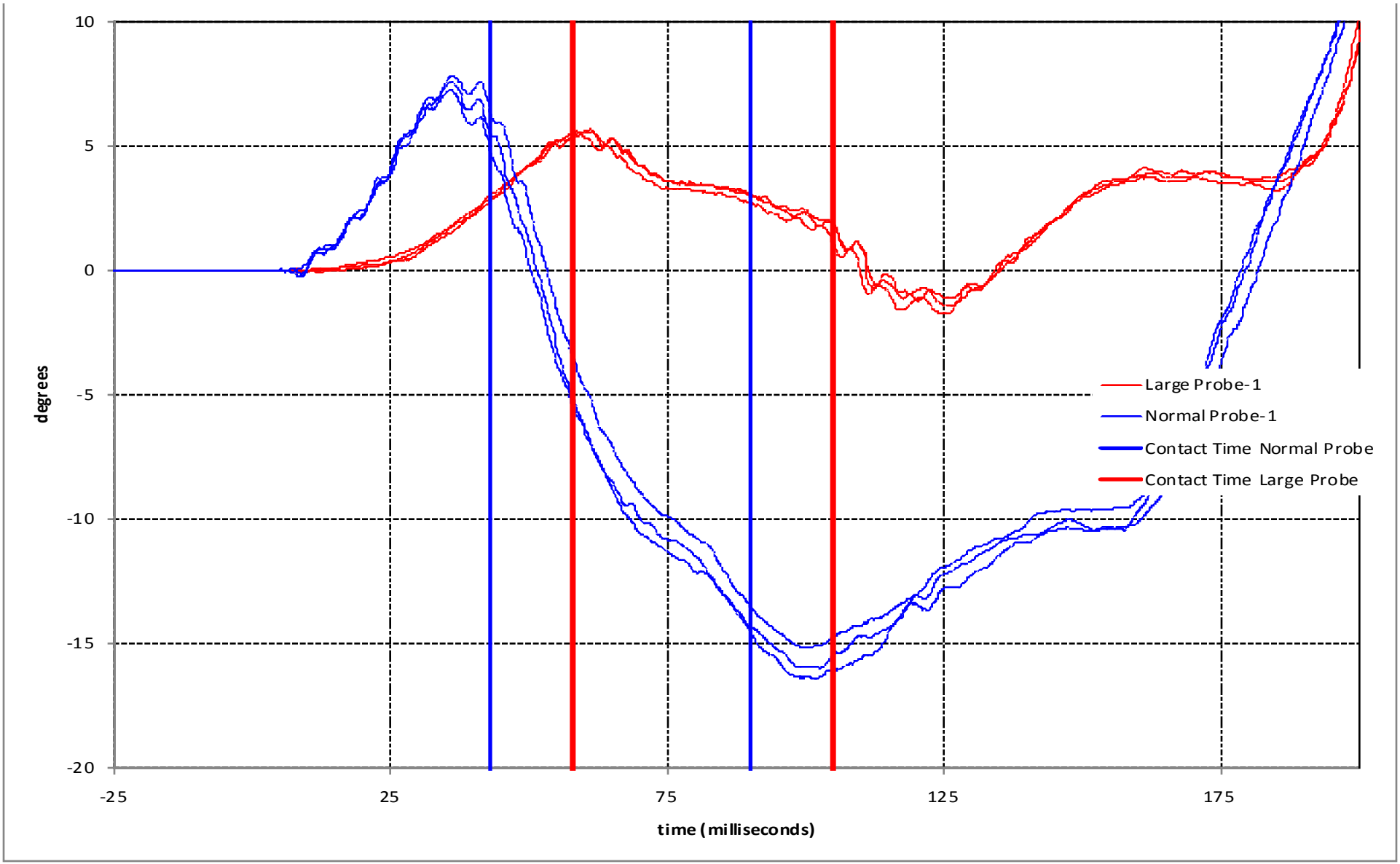
# Pot B - Neck Link Pot



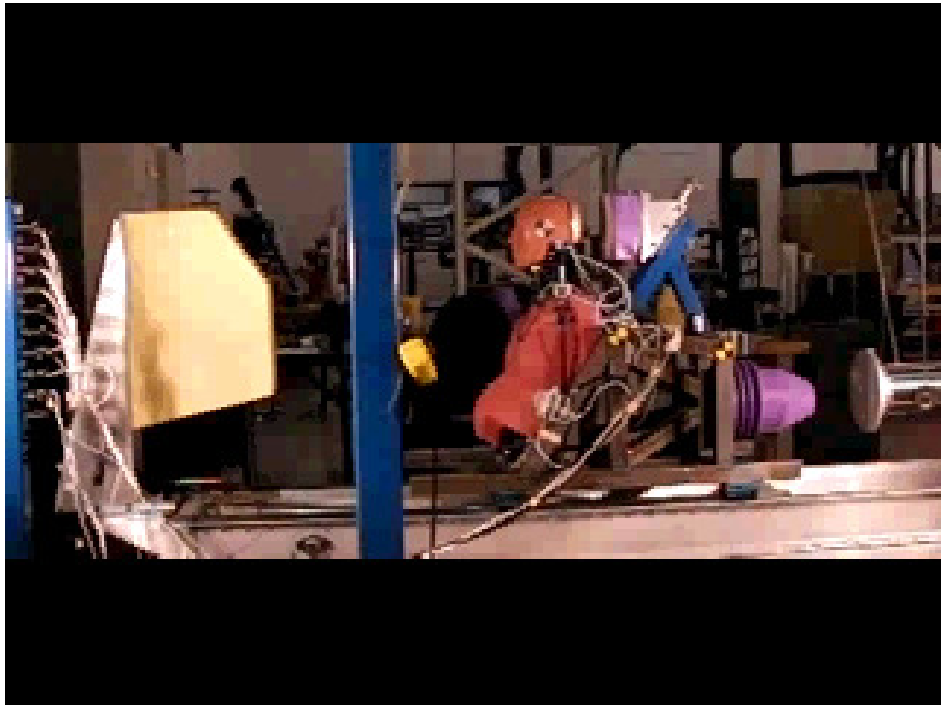
# Pot C - T1 Pot


10
5
0
-5
-10
-15
-20
degrees
-25
25
75
125
175
time (milliseconds)
Large Probe-1
Normal Probe-1
Contact Time Normal Probe
Contact Time Large Probe

# Total Head Rotation



# Comparison Kinematics



Heavy Probe Video

Light Probe Video

HUMANETICS

# Comparison Kinematics

Heavy Probe T0

Light Probe T0

HUMANETICS

# Comparison Kinematics

Heavy Probe 25 ms

Light Probe 25 ms

HUMANETICS

# Comparison Kinematics

Heavy Probe 50 ms

Light Probe 50 ms

HUMANETICS

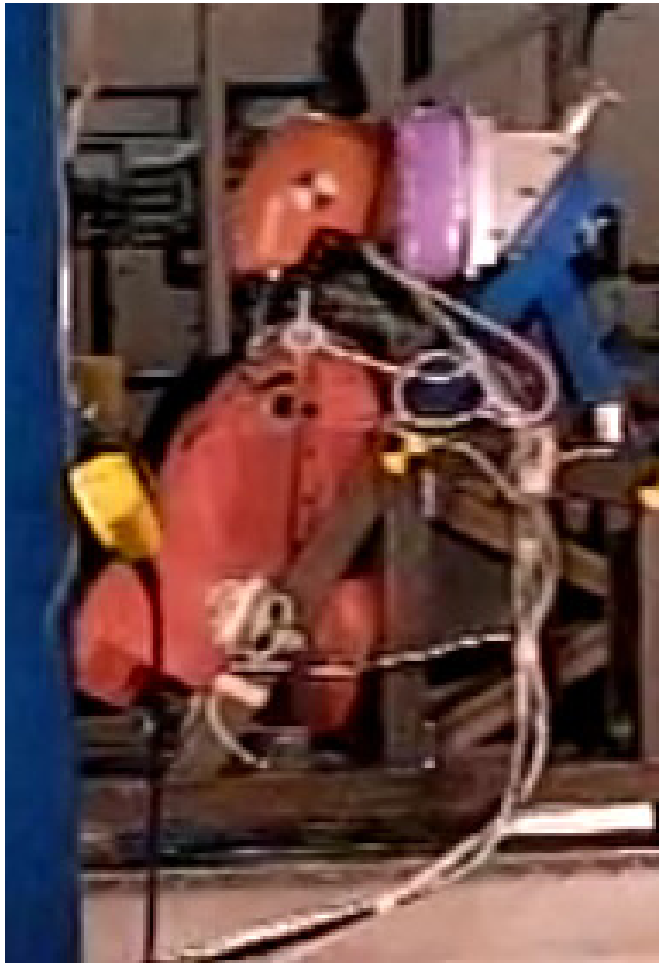
# Comparison Kinematics

Heavy Probe 75 ms

Light Probe 75 ms

HUMANETICS

# Comparison Kinematics

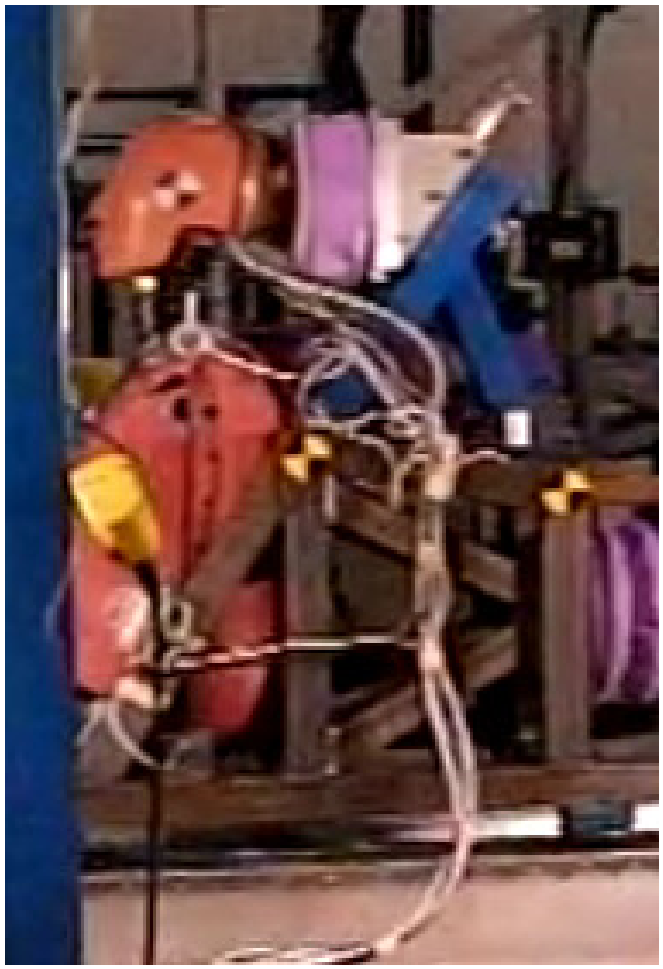


Heavy Probe 100 ms

Light Probe 100 ms

HUMANETICS

# Comparison Kinematics



Heavy Probe 125 ms

Light Probe 125 ms

HUMANETICS

# Heavy VS Standard Probe Comparison

- Force and moment curve shapes
  - Heavy probe
    - with range of car seat testing
    - Closest to Sports Seat from PDB R&R study
  - Standard Probe
    - Does not match any seat data
    - Quite different than heavy probe/car seat data
- Is it necessary to duplicate car seat loading regime?
- Using standard probe saves time in certification lab

# Decision Time!

- Continue with heavy probe?
- Continue using light probe?
- Continue testing using both probes?
- Do testing with both probes before making decision?

HUMANETICS
Innovative Solutions

# WHERE DO WE GO FROM HERE?

# Where to go from here

- Ship head restraint systems to all existing labs
  - Humanetics Huron, Heidelberg, Nagoya
  - Ford, IIHS
- Need to collect data
  - Multiple dummies which pass without headrest test
  - Multiple labs
  - Establish corridors on population of dummies that meets all other requirements
    - Find areas of curves that will exclude outlier dummies
  - GR&R study at least 3 labs
    - Make sure corridors widths ok with GR&R

HUMANETICS

HUMANETICS℠
Innovative Solutions

# QUESTIONS?