

Side Impact Child Dummy Development

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

Overview

- Side Child Dummy Concepts
- Biofidelity Evaluation Preliminary Review
- Development of Certification Procedures
- Preliminary Durability Concerns
- Current Developments
- Future Work

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- **Side Child Dummy Concepts**
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Side Child Dummy Concepts

- NHTSA evaluating two dummies
 - Q3s
 - Hybrid III 3 year-old with modified head/neck (HIII-3Cs)



Side Child Dummy Concepts

- Q3s Dummy
- Key Features
 - new fiberglass skull
 - improved shoulder design
 - improved pelvis design
 - improved arm design
- OSRP and NHTSA



Side Child Dummy Concepts

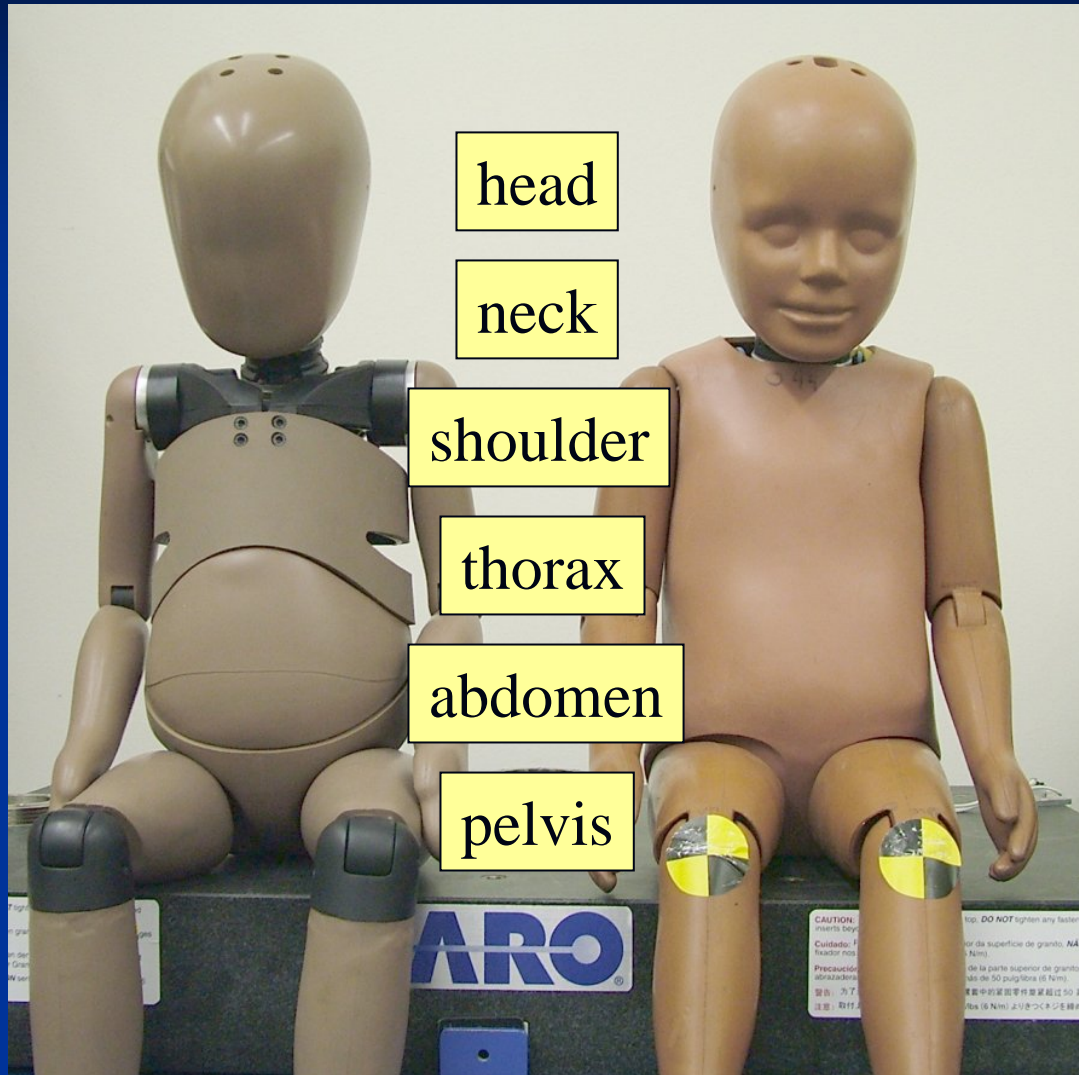
- Hybrid III 3Cs
- History/Development



Overview

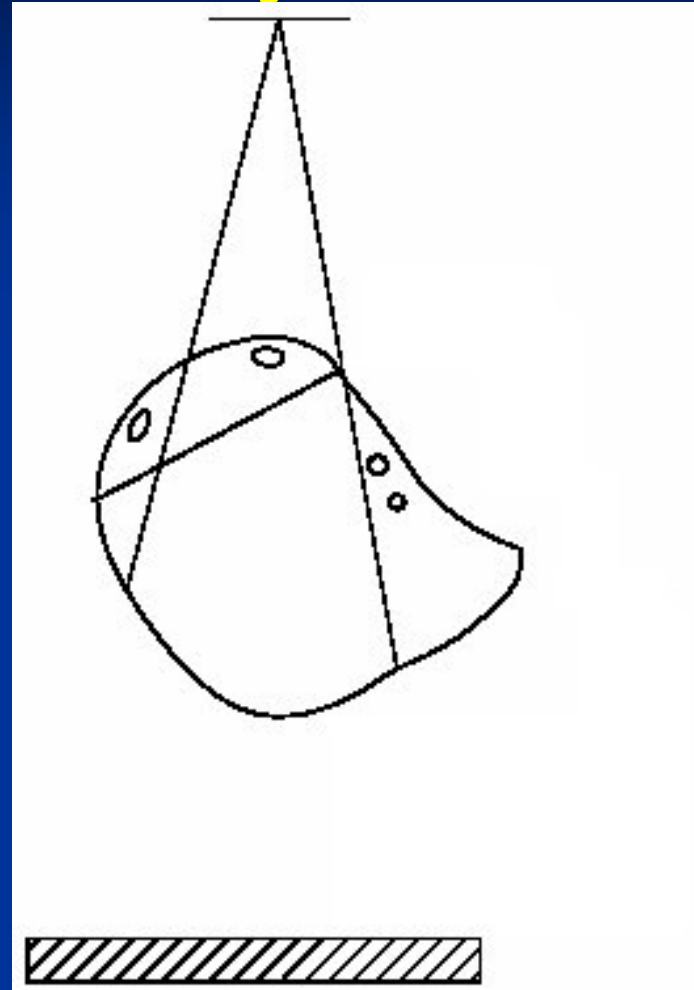
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Biofidelity Evaluation



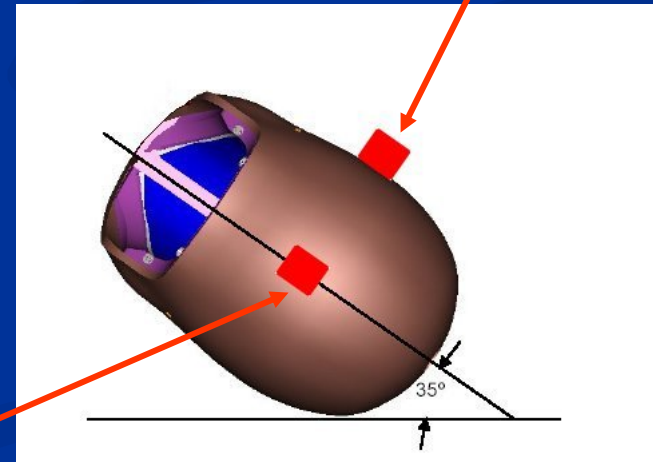
Head Biofidelity

- Frontal Drop
- Ref: Irwin (Stapp 973317)
- - 376 mm drop
- - peak resultant: 255 – 315 g

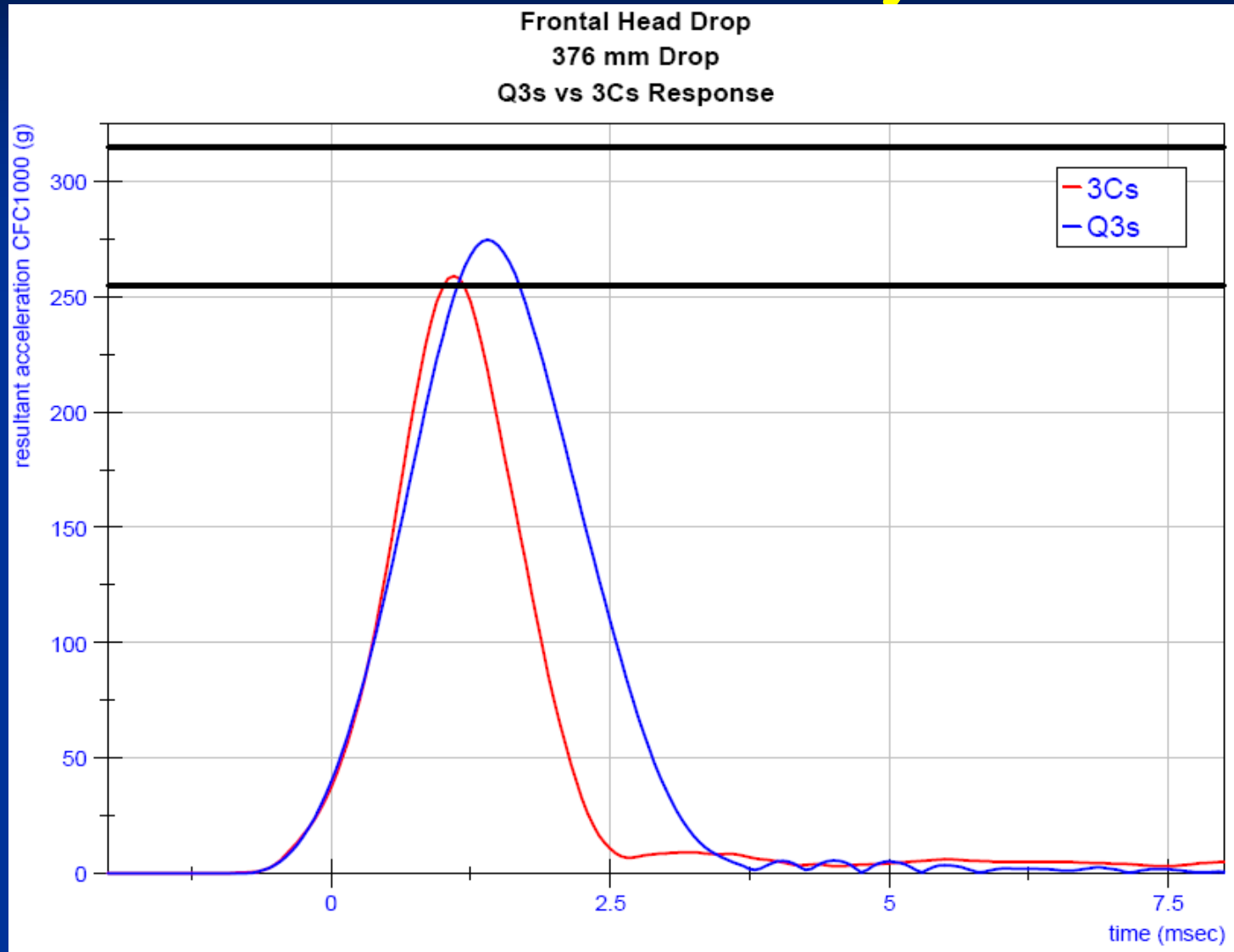


Head Biofidelity

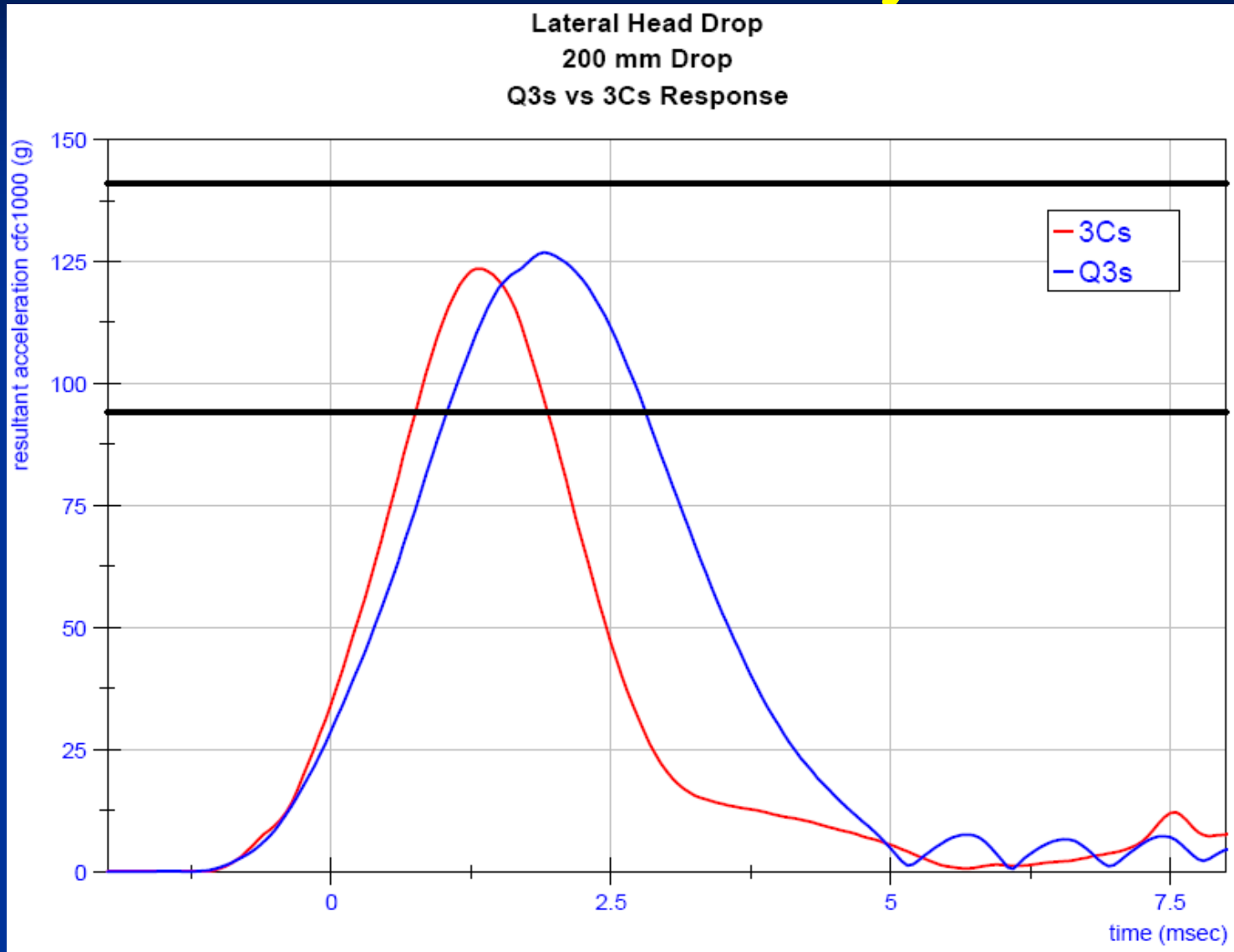
- Lateral Drop
- Ref: Irwin (Stapp 2002-22-0016)
 - 200 mm drop
 - 114 – 171 g, measured at non-struck side
 - 94 – 141 g, measured at CG



Head Biofidelity



Head Biofidelity



Neck Biofidelity

■ Biofidelity References

Lateral: Irwin (Stapp 2002-22-0016)

Frontal: Irwin (Stapp 973317)

Torsion: Mertz, personal communication

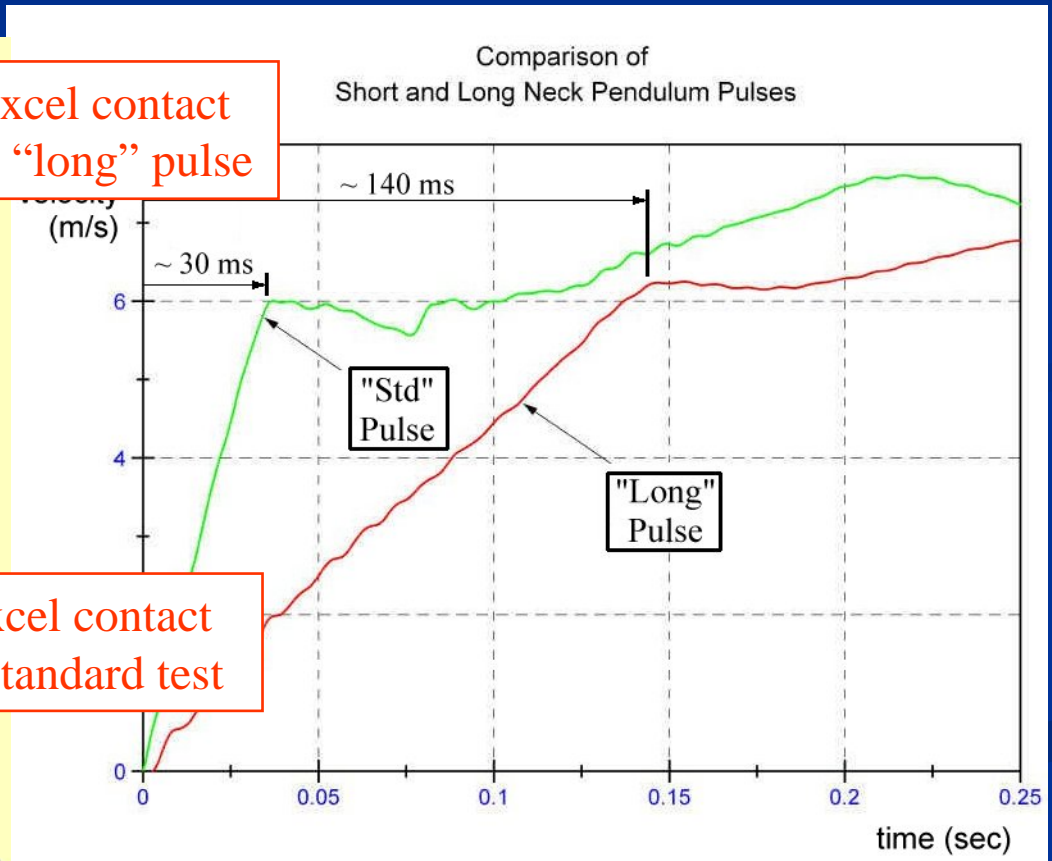
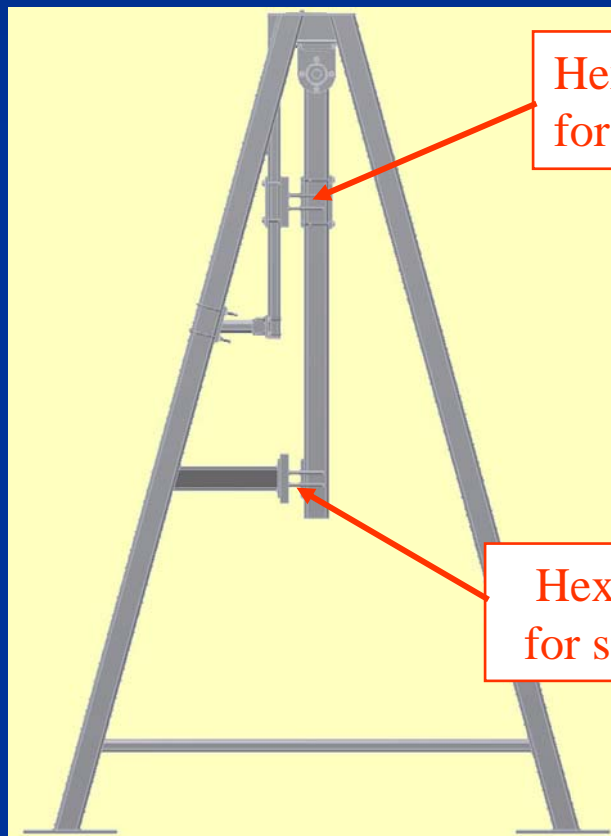


Evaluation Methods:

- Standard neck pendulum
- Modified neck pendulum
- Head/neck sled tests

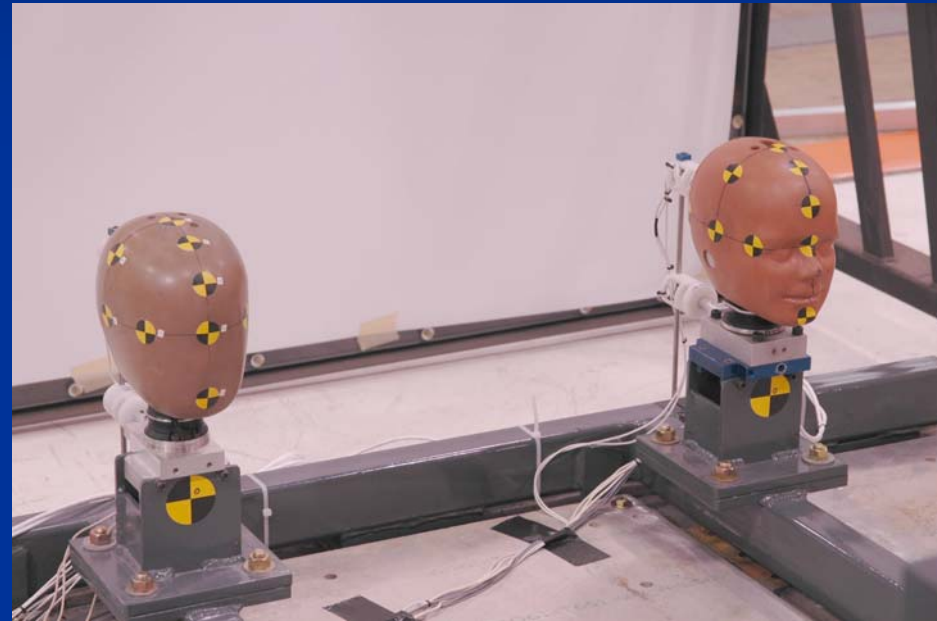
Neck Biofidelity

■ Neck Pendulum Pulse Duration Considerations



Neck Biofidelity

Head/Neck Sled Tests – allows for longer pulses



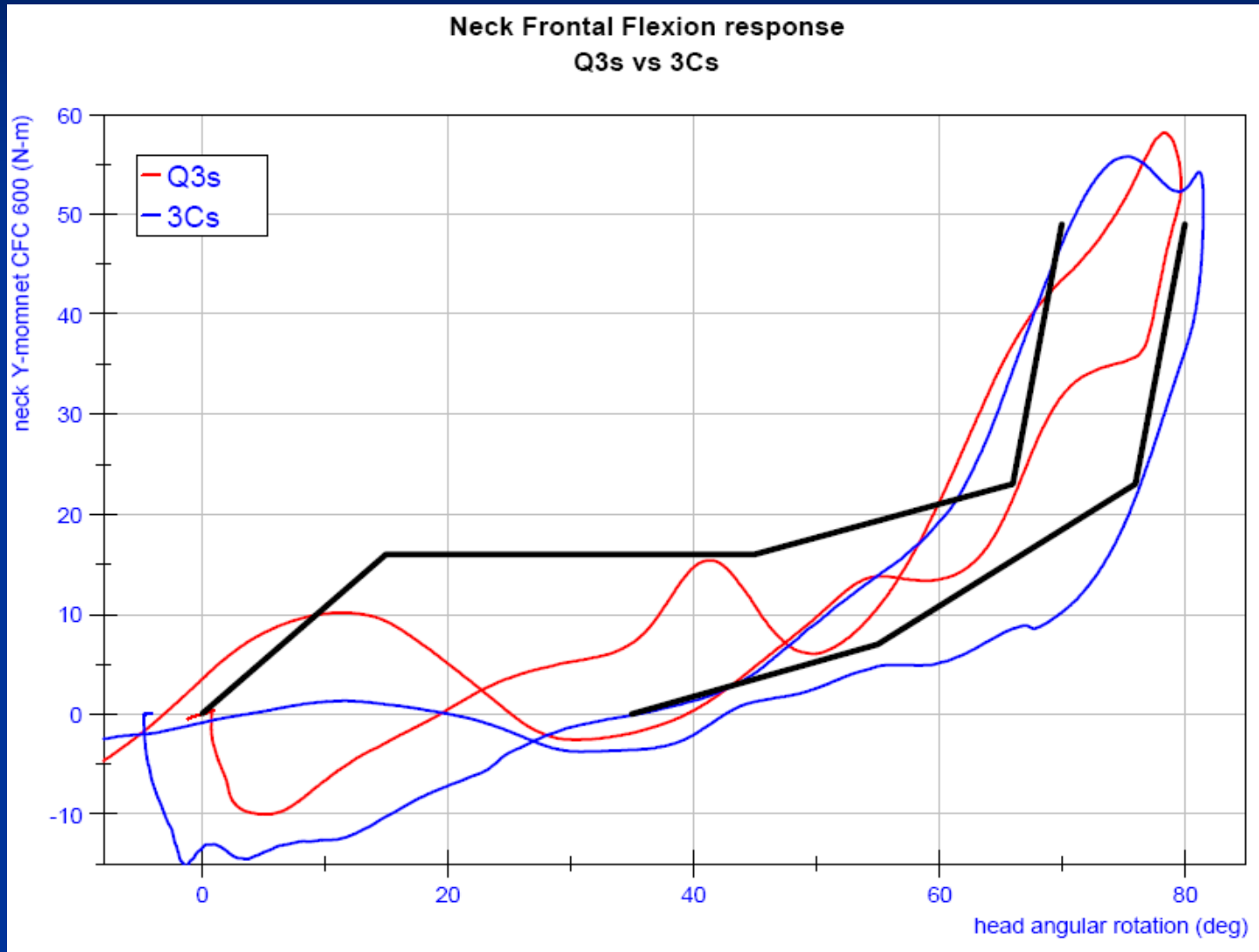
Neck Biofidelity

Results

Standard Neck Pendulum

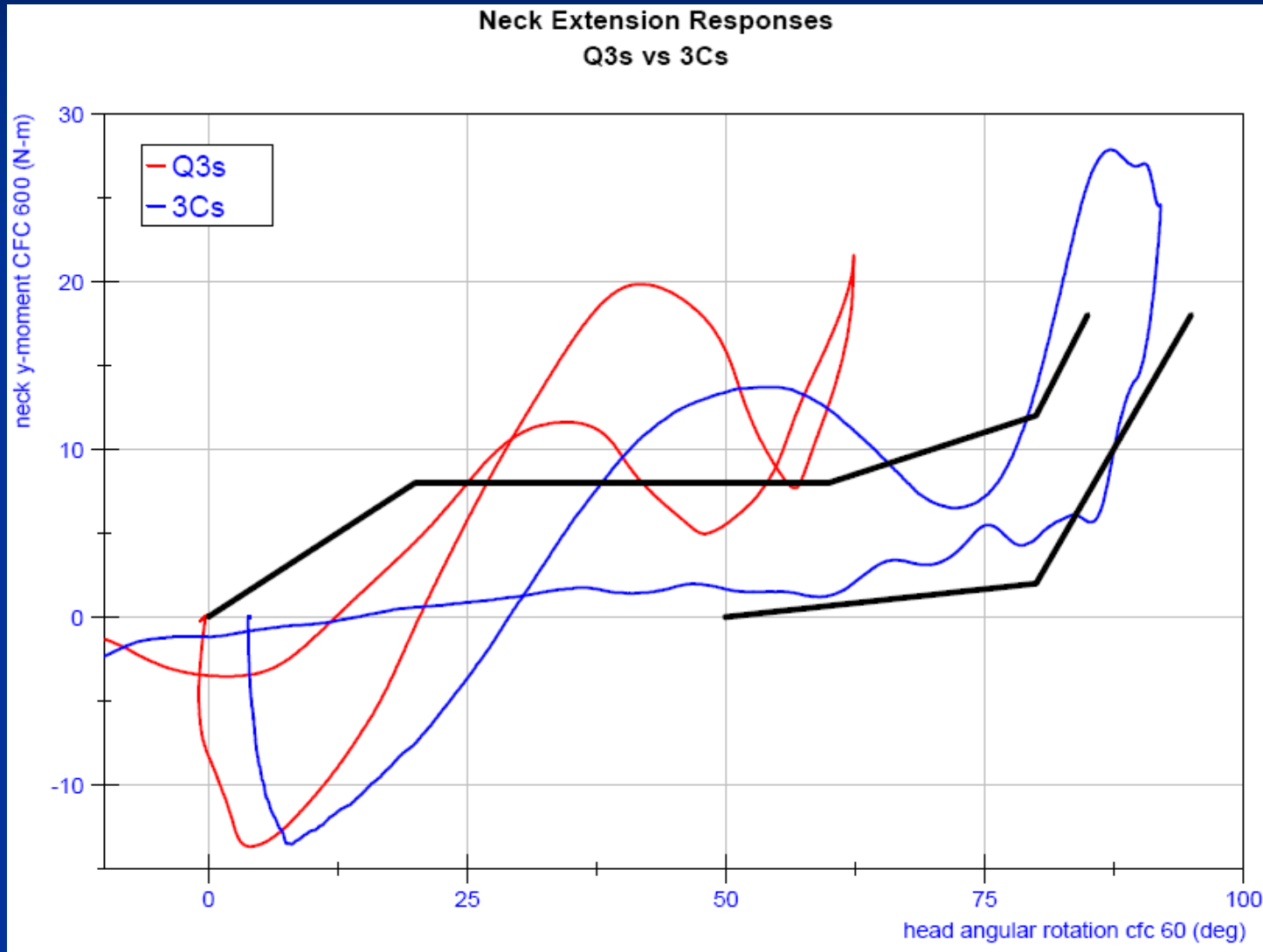
Neck Biofidelity

Standard Neck FLEXION Pendulum Results



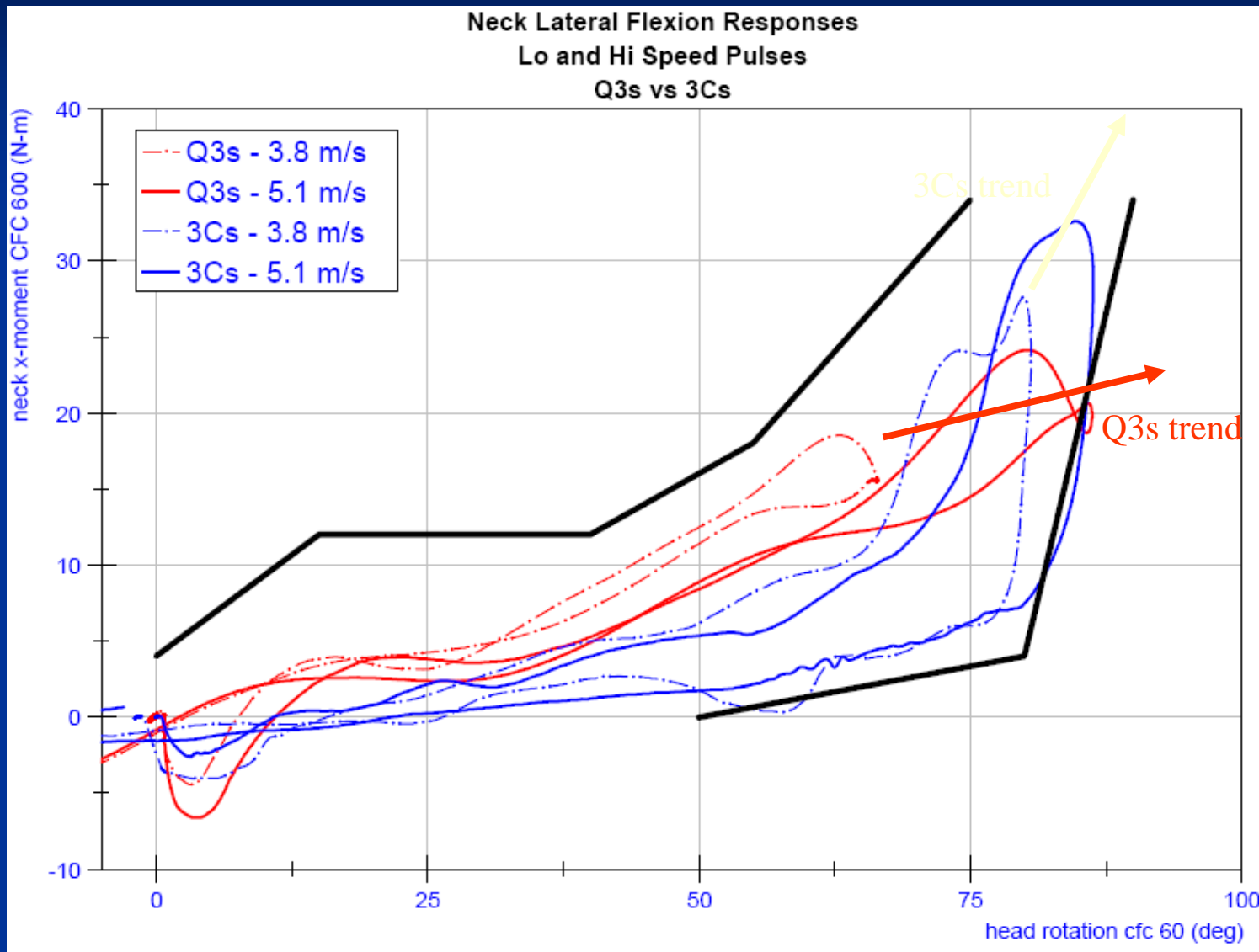
Neck Biofidelity

Standard Neck EXTENSION Pendulum Results



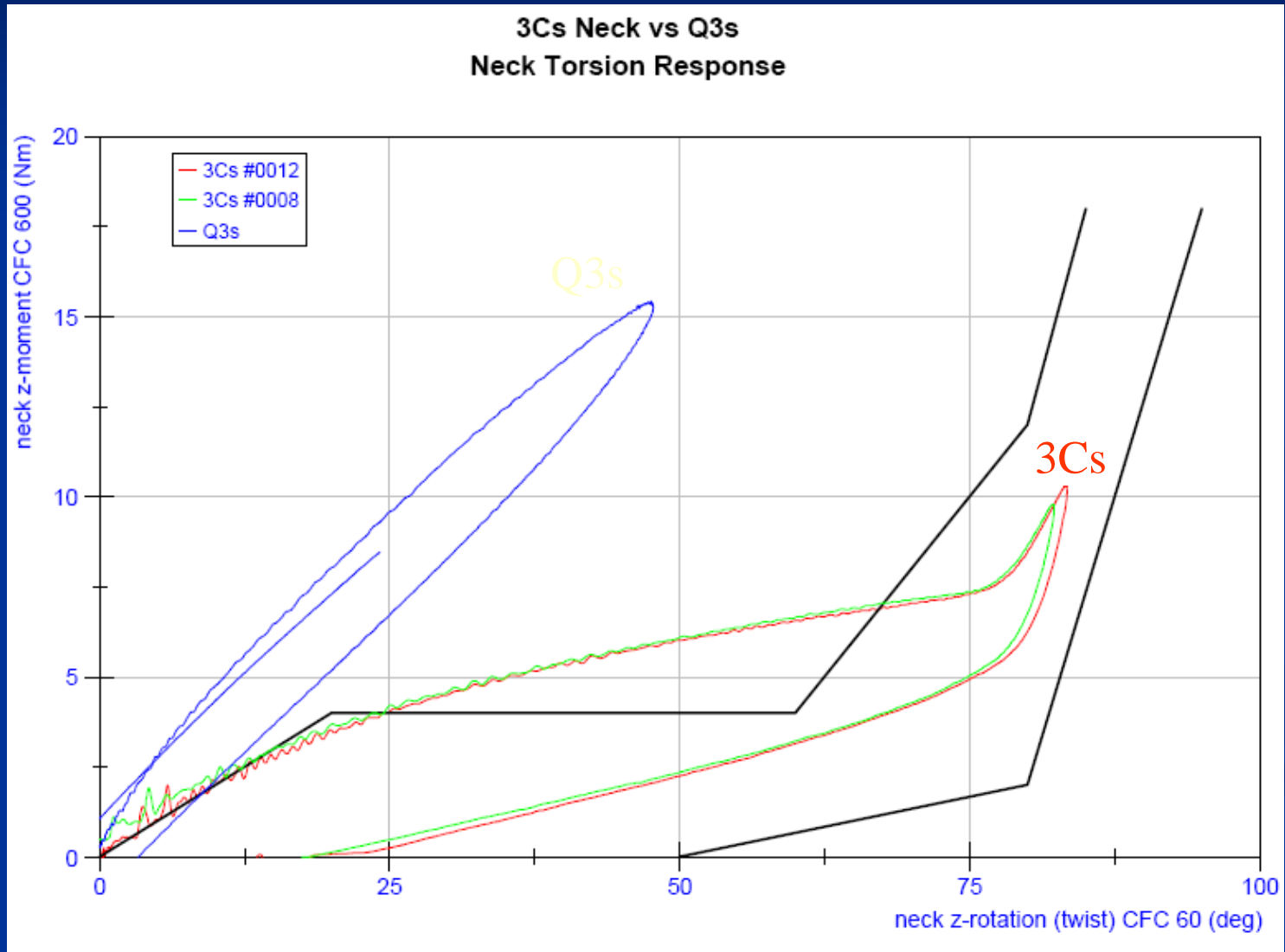
Neck Biofidelity

Standard LATERAL Neck FLEXION Pendulum Results



Neck Biofidelity

Standard Neck **TORSION** Pendulum Results



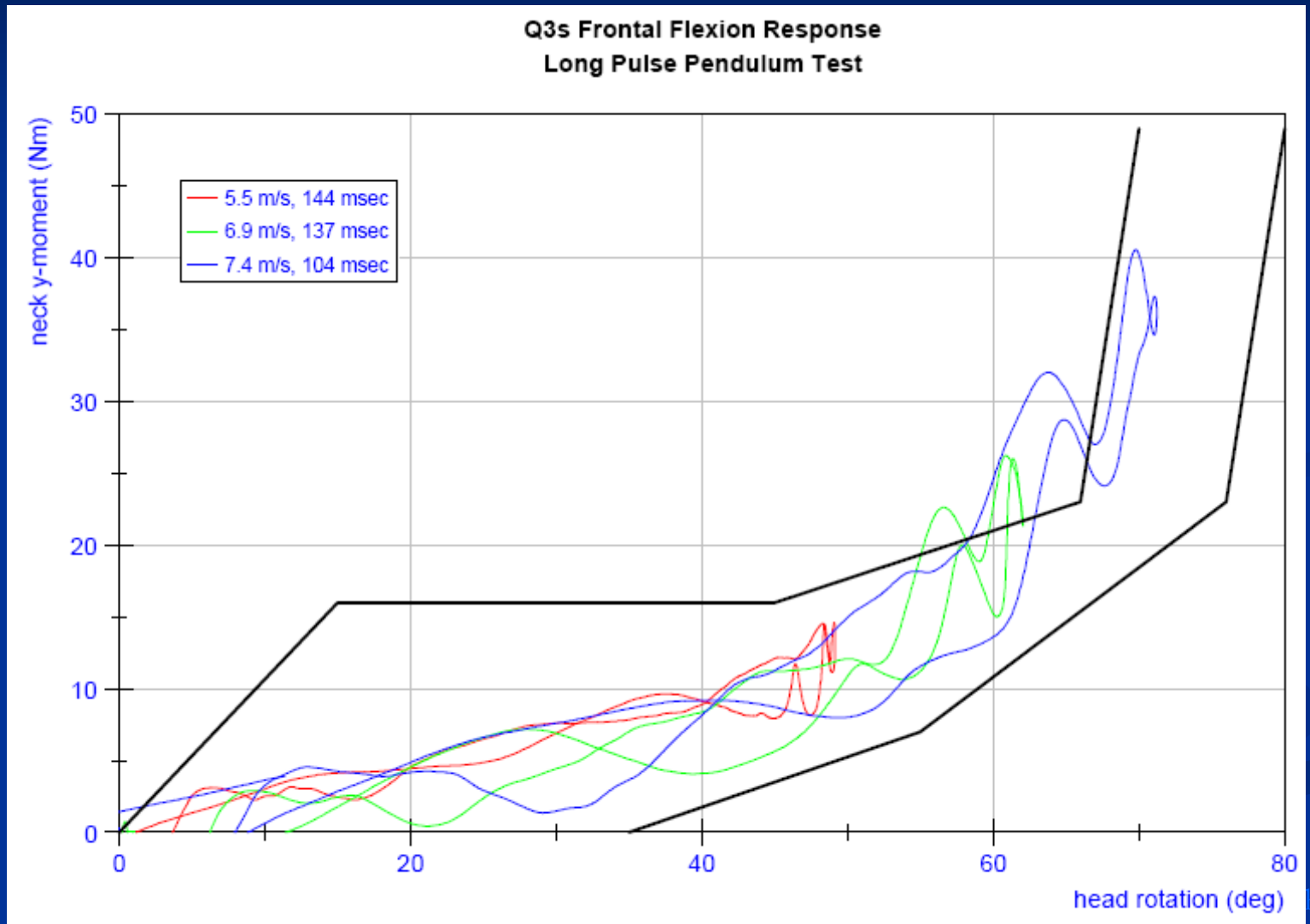
Neck Biofidelity

Results

Modified, Long Pulse Neck Pendulum

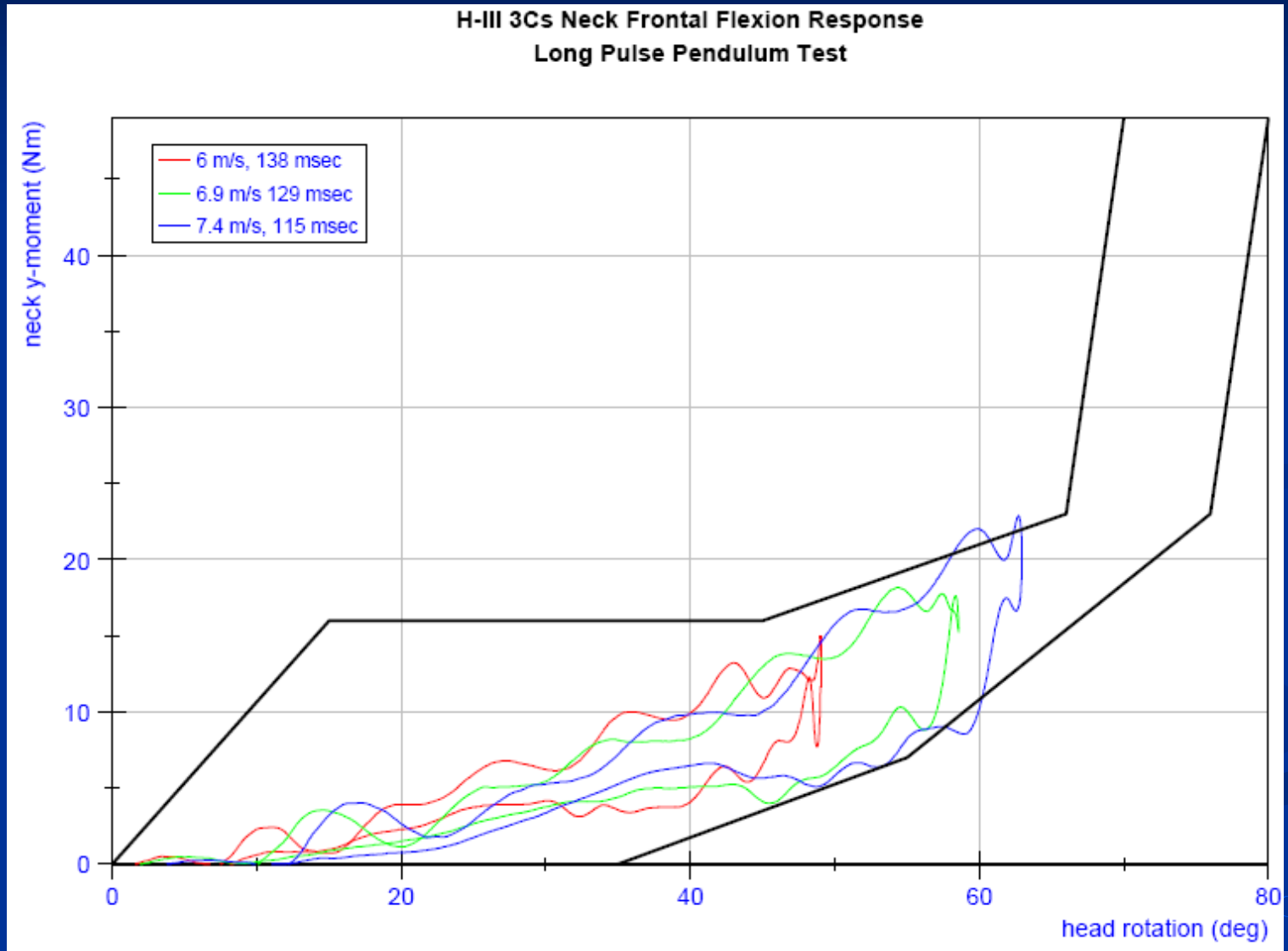
Neck Biofidelity

Q3s LONG PULSE Neck FLEXION Pendulum Results



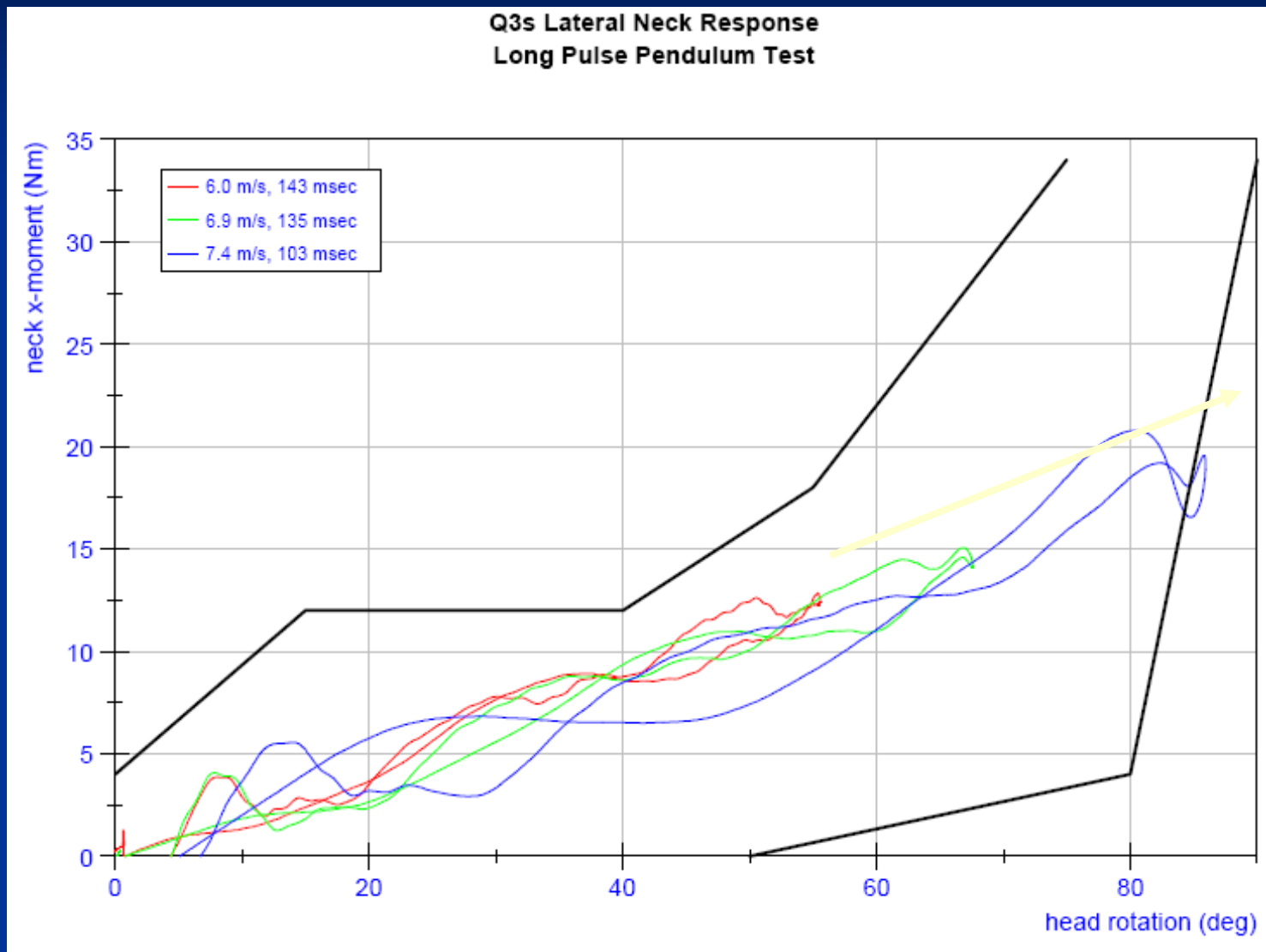
Neck Biofidelity

3Cs LONG PULSE Neck FLEXION Pendulum Results



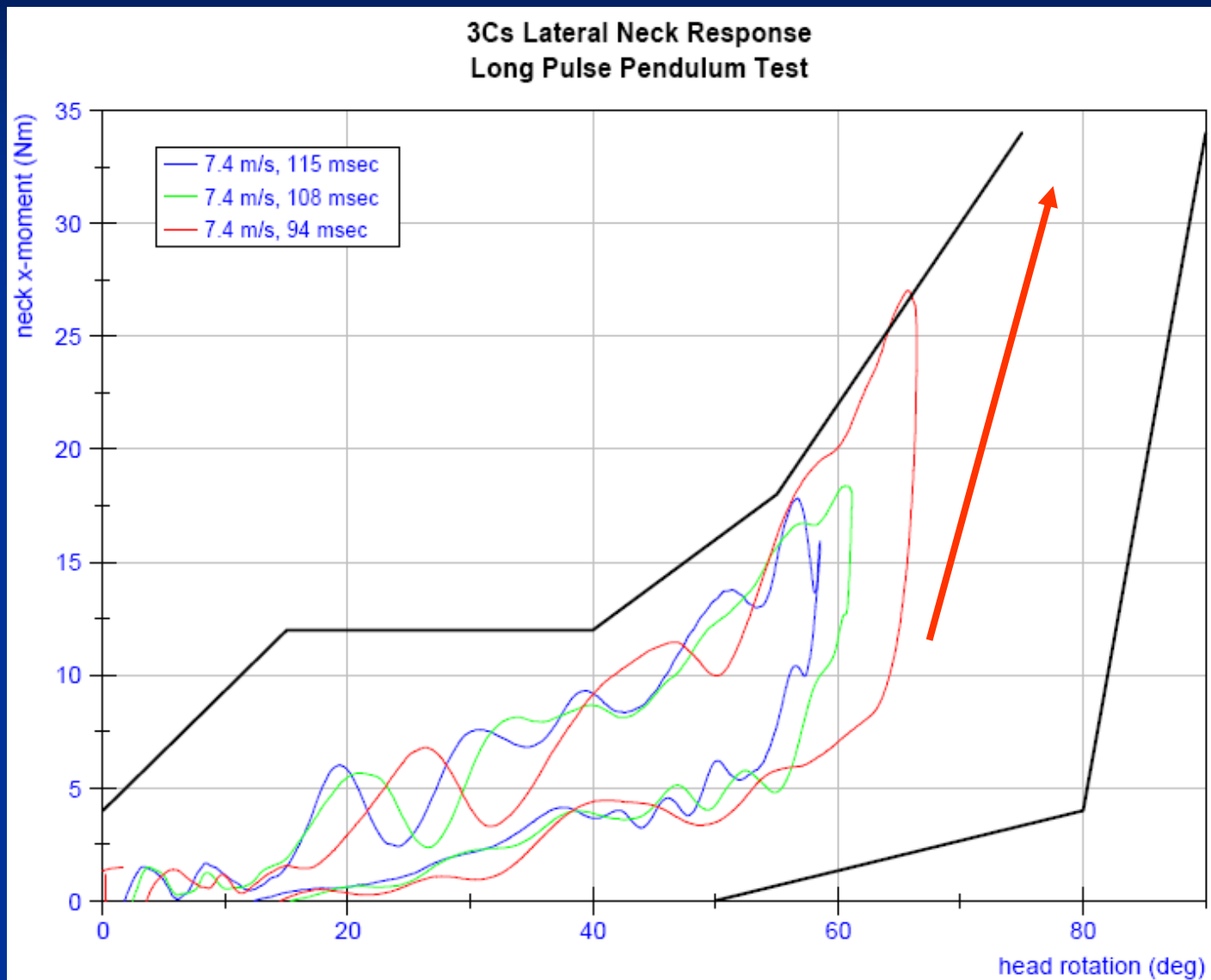
Neck Biofidelity

Q3s LONG PULSE LATERAL Neck Pendulum Results



Neck Biofidelity

3Cs LONG PULSE LATERAL Neck Pendulum Results



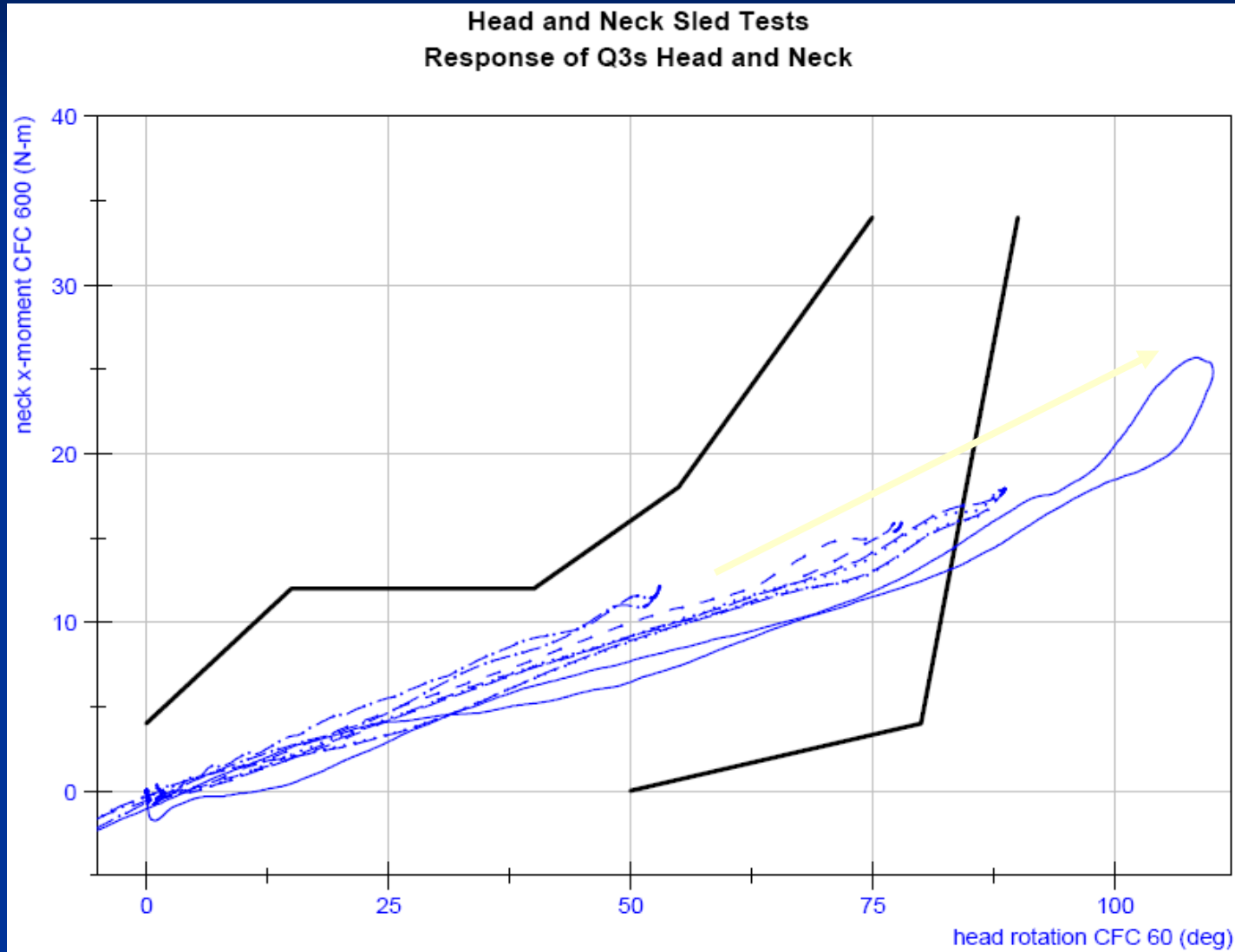
Neck Biofidelity

Results

Head/Neck Sled Tests

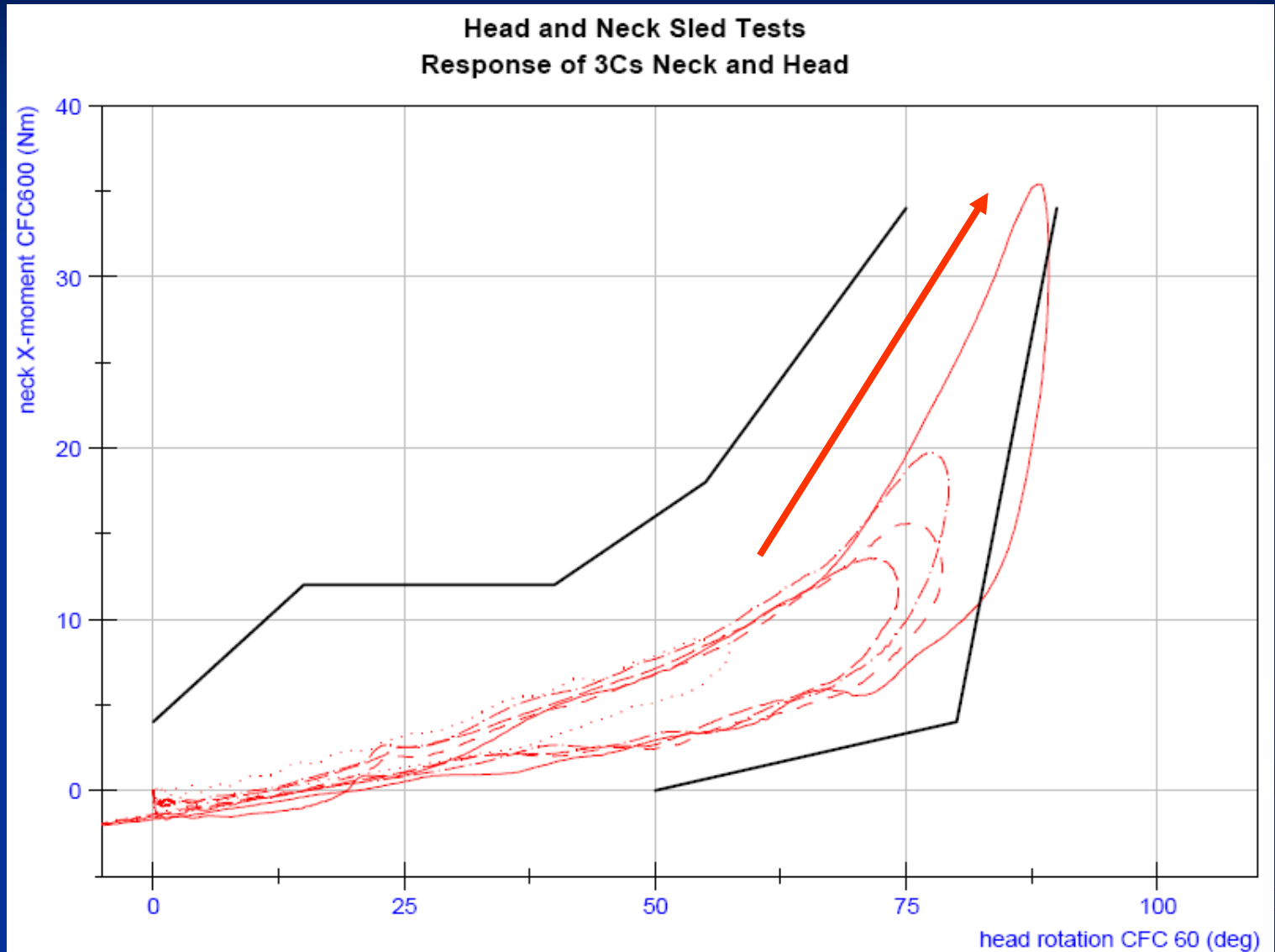
Neck Biofidelity

Q3s NECK X-MOMENT Head/Neck Sled Test Results



Neck Biofidelity

3Cs NECK X-MOMENT Head/Neck Sled Test Results



Shoulder Biofidelity

Reference #1: Irwin (Stapp 2002-22-0016)

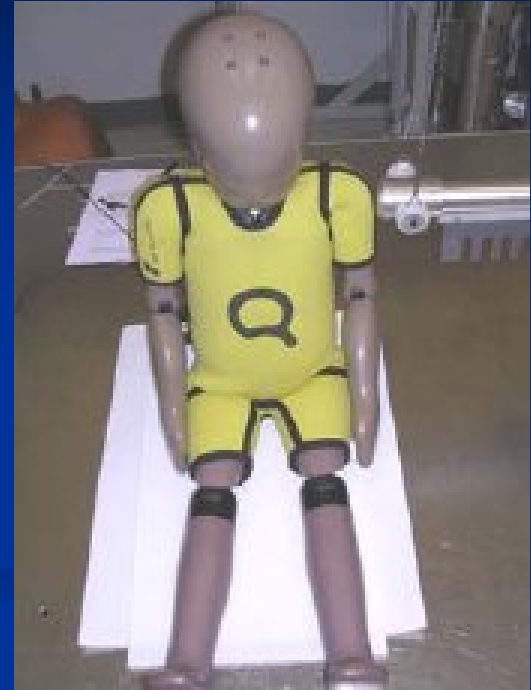
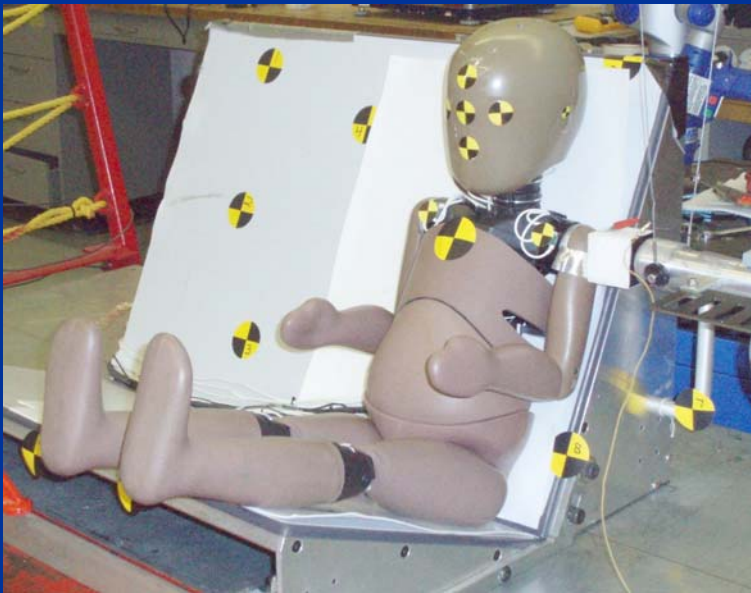
Lateral impact

1.7 kg impactor at 4.5 m/s

Reference #2: Bolte (Stapp 2003-22-0003)

Lateral & oblique padded impact

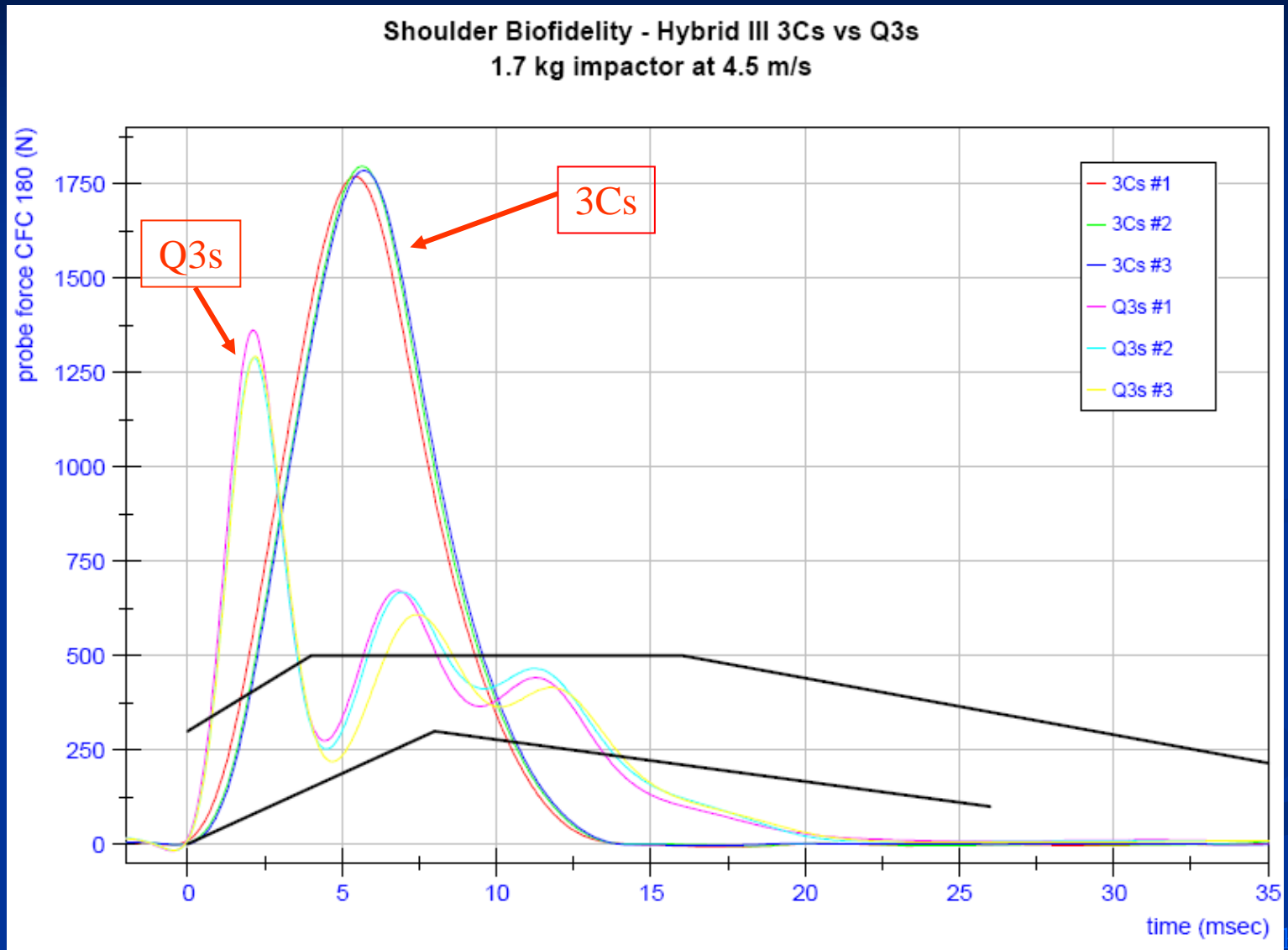
1.7 kg impactor at 4.5 m/s



Shoulder Biofidelity

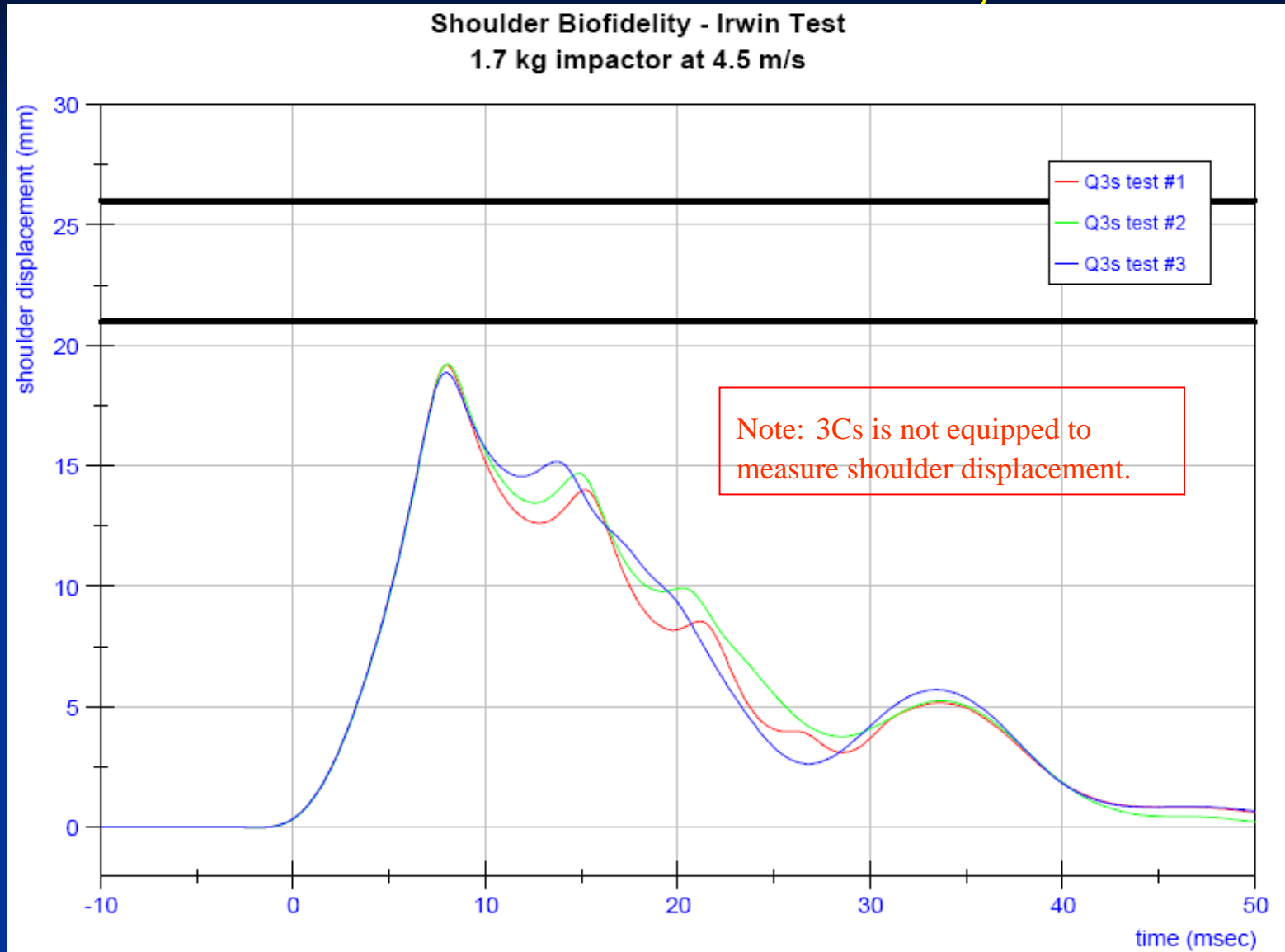
Results Irwin Impact

Shoulder Biofidelity



Irwin shoulder impact

Shoulder Biofidelity



Irwin shoulder impact

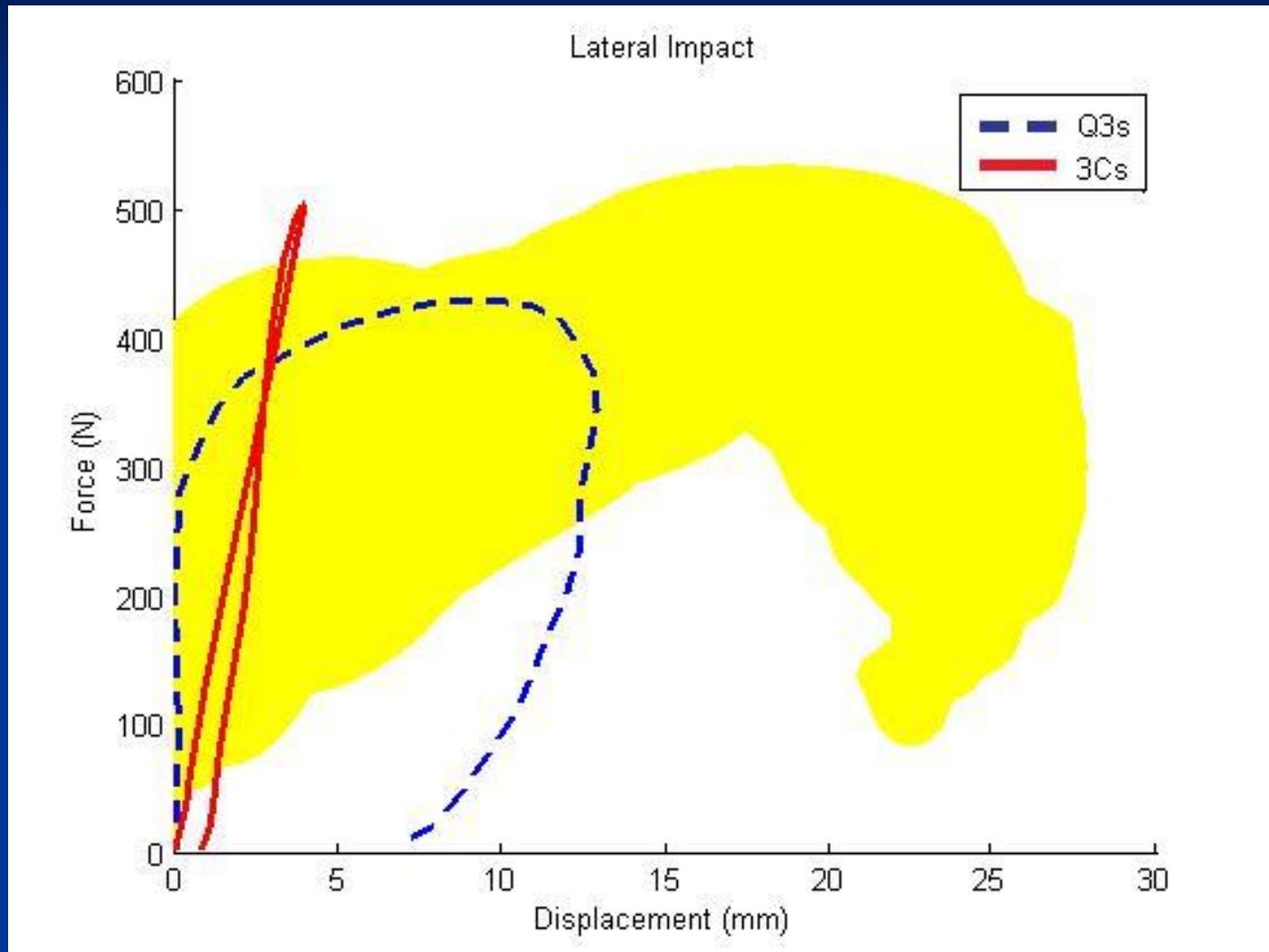
Shoulder Biofidelity

Results

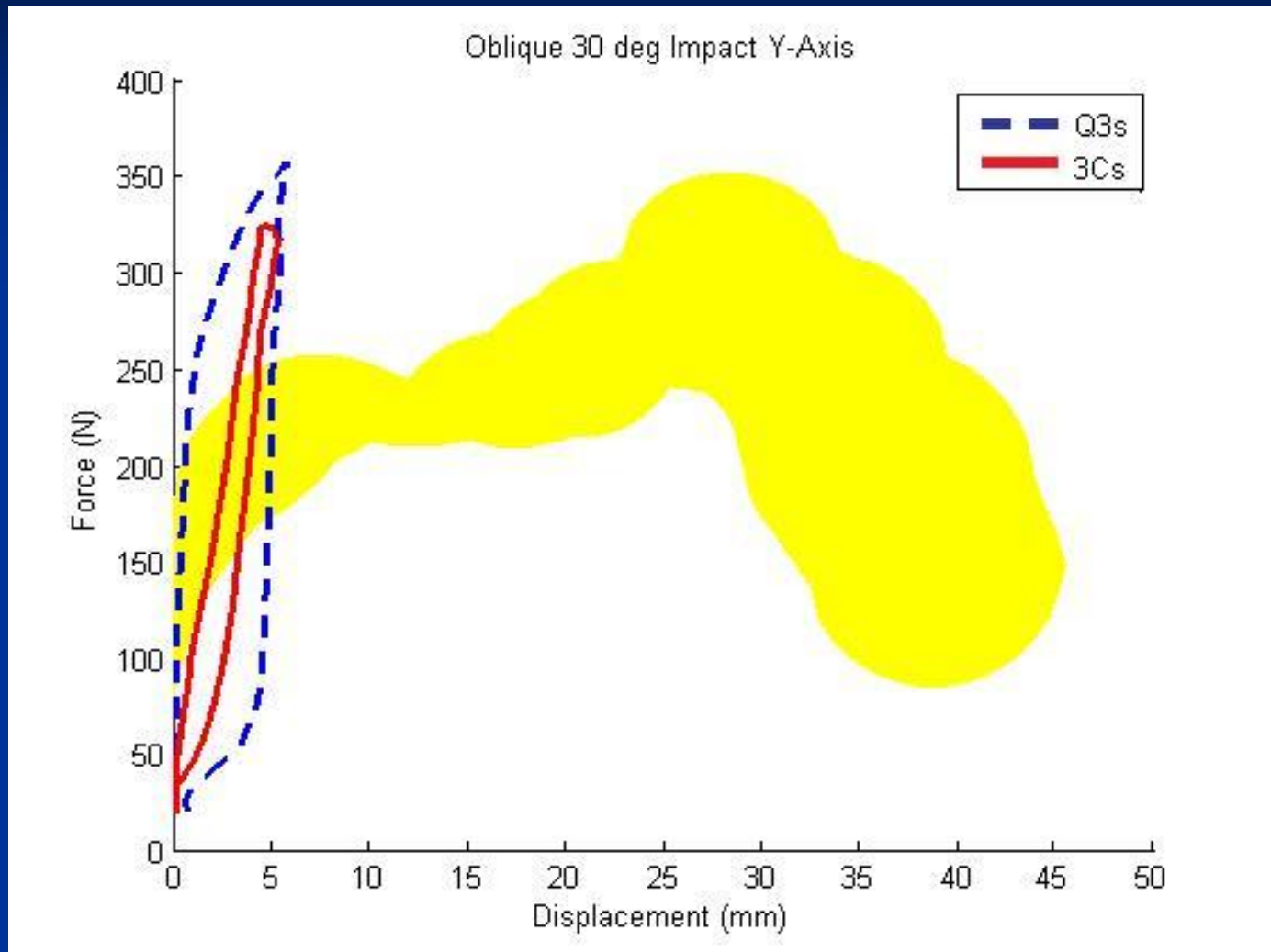
Bolte Test

Padded Shoulder Impacts

Shoulder Biofidelity



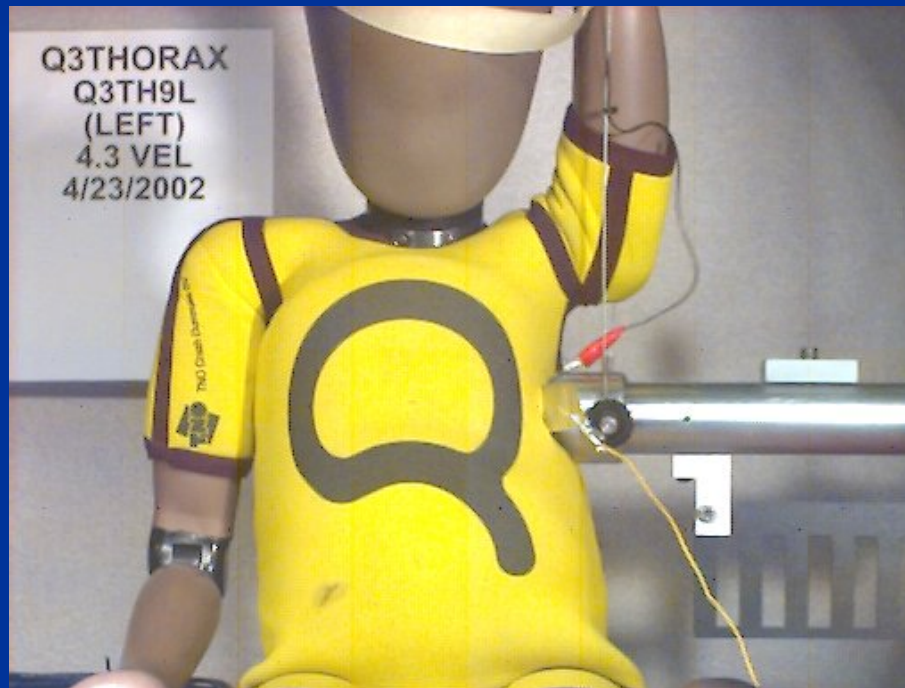
Shoulder Biofidelity



Thorax Biofidelity

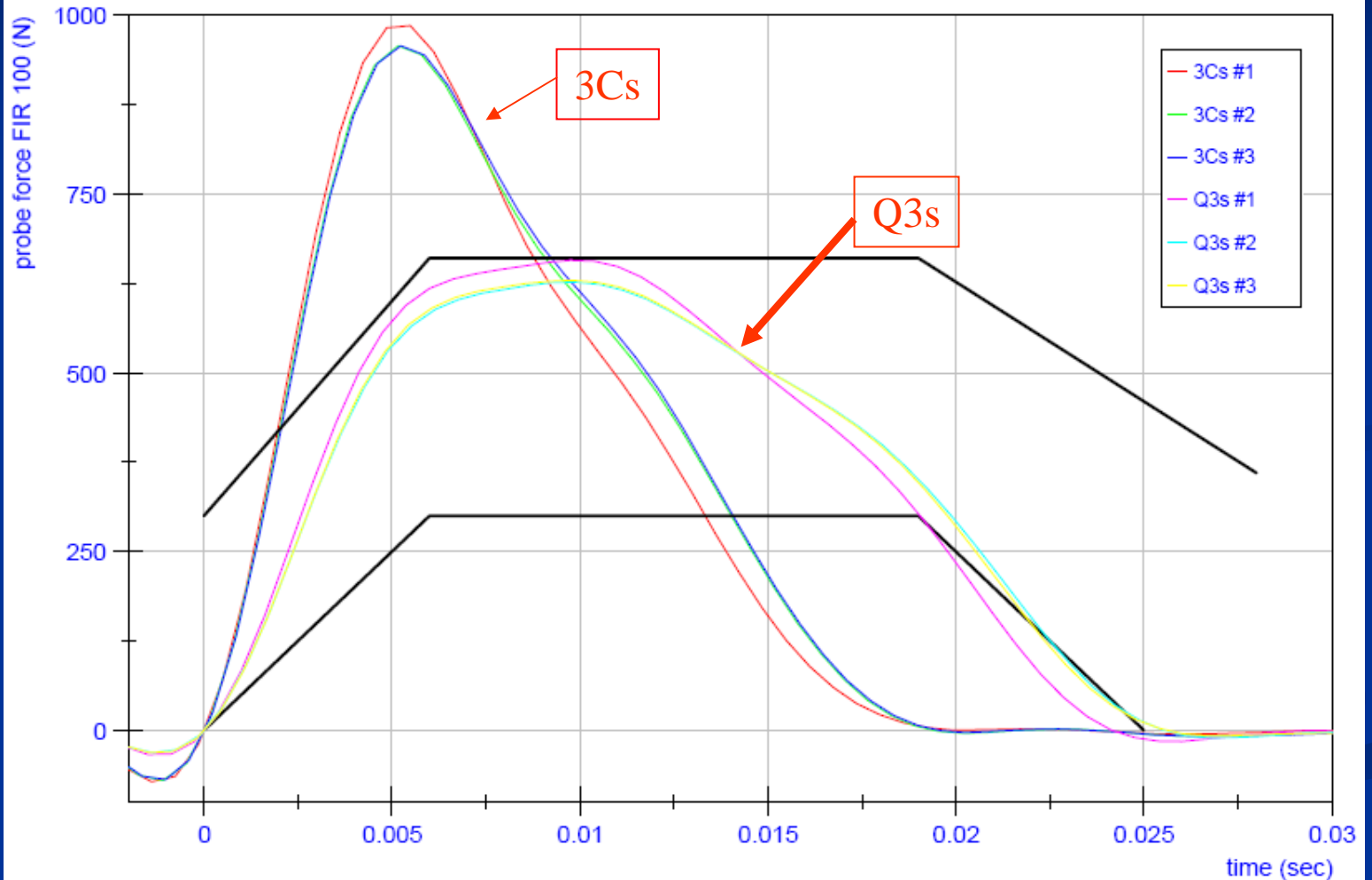
Reference: Irwin (Stapp 2002-22-0016)

Lateral impact to thorax w/ 1.7 kg impactor at 4.3 and 6.0 m/s

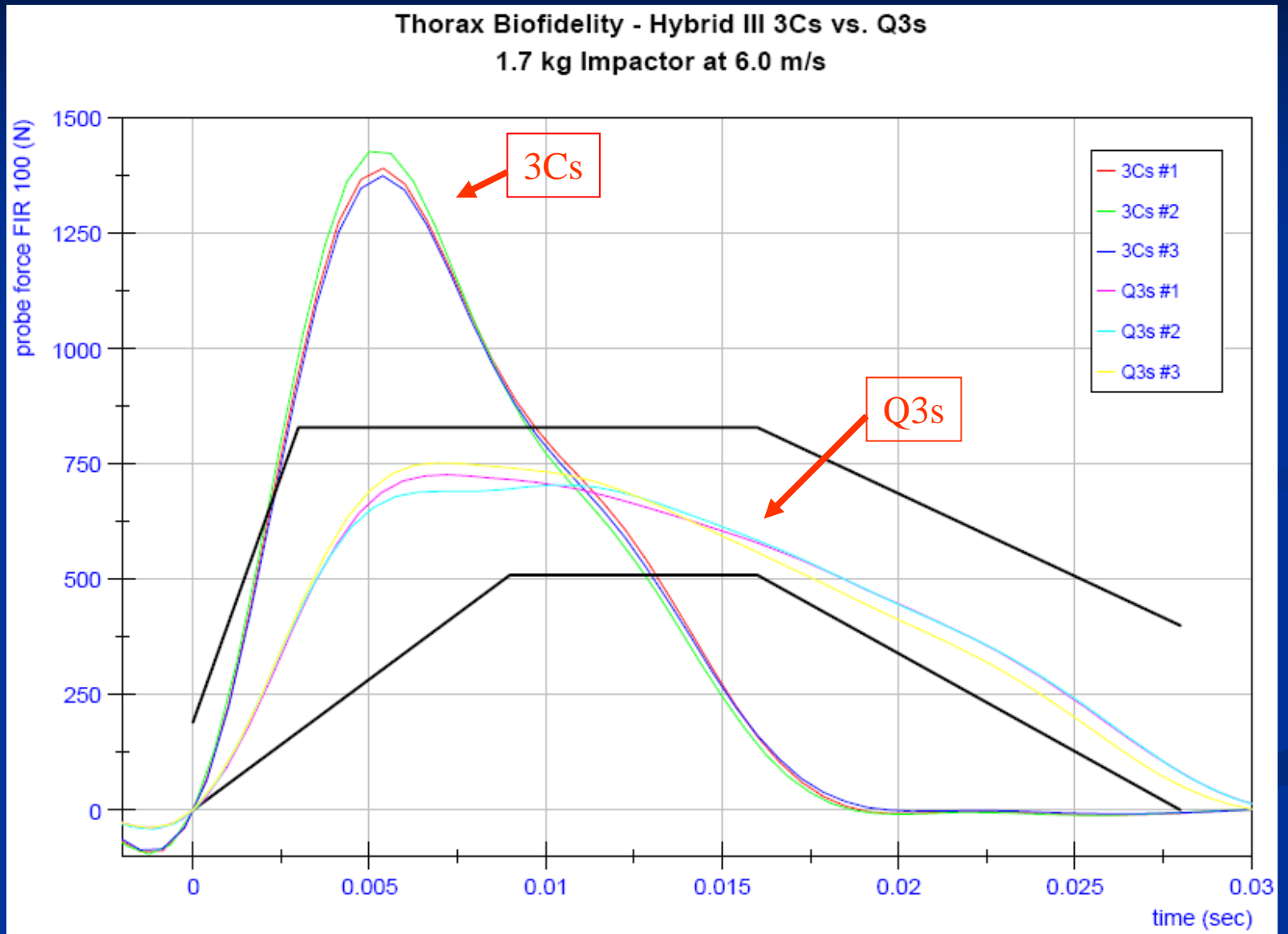


Thorax Biofidelity

Thorax Biofidelity - Hybrid III 3Cs vs Q3s
1.7 kg Impactor at 4.3 m/s



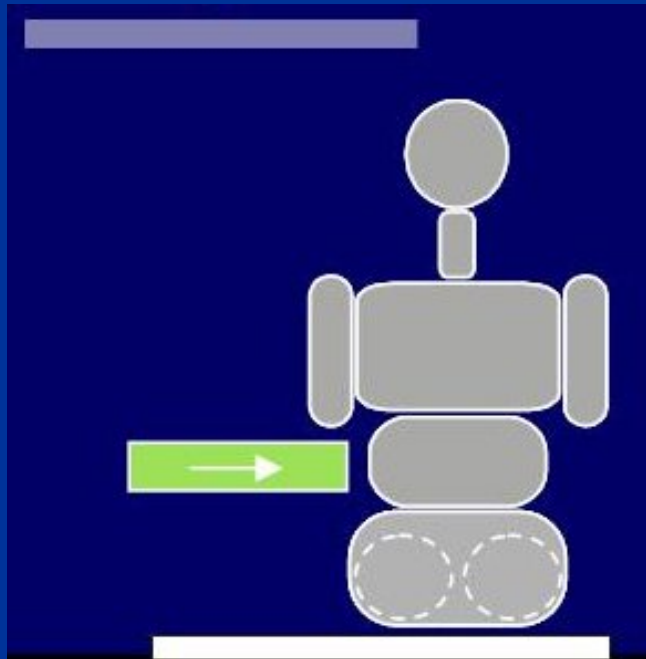
Thorax Biofidelity



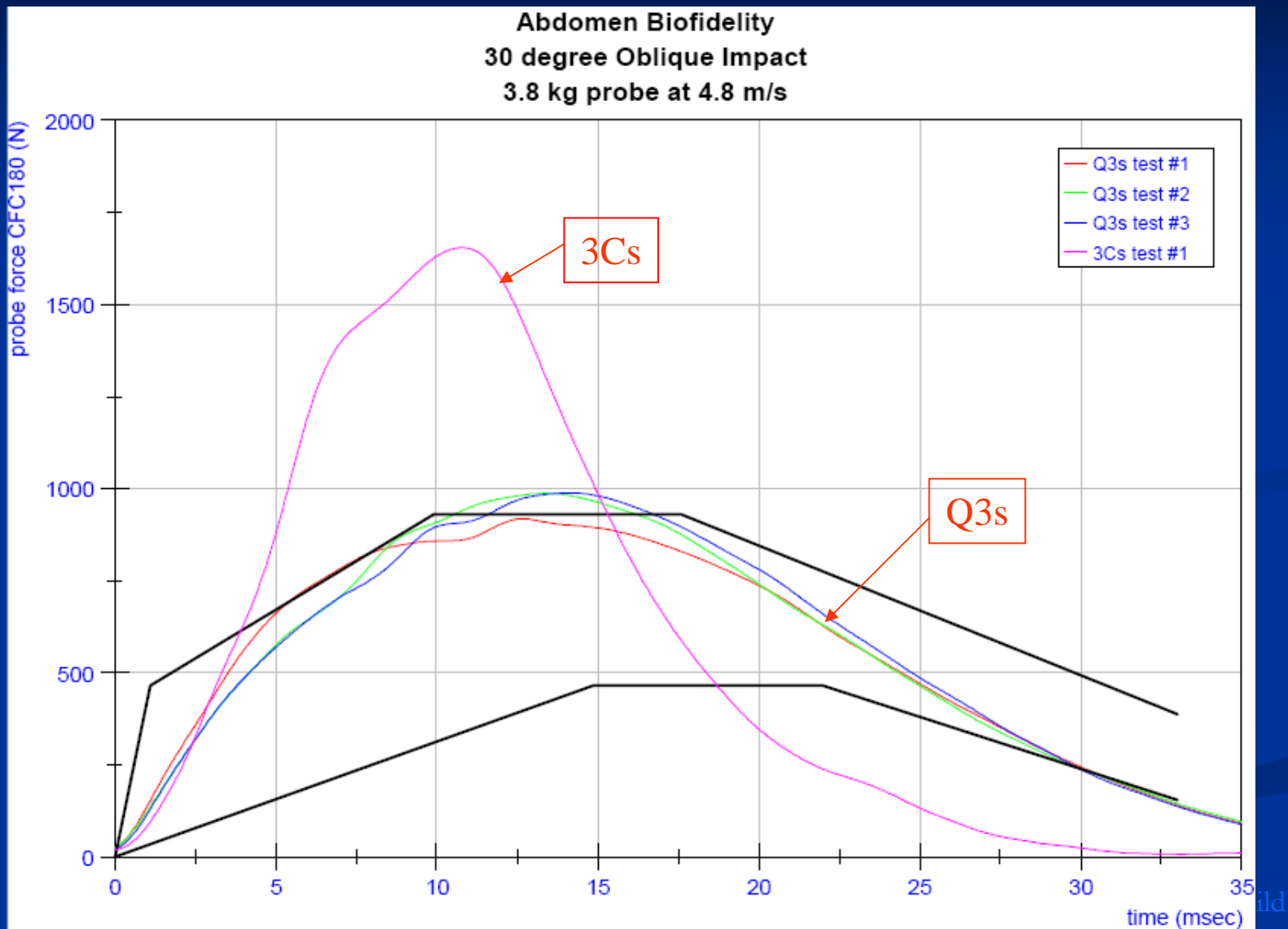
Abdomen Biofidelity

Reference: FTSS White Paper “Pendulum Response Corridors for 3 year-old Child Side Impact Dummies.” Moss and Elhagediab. 2001

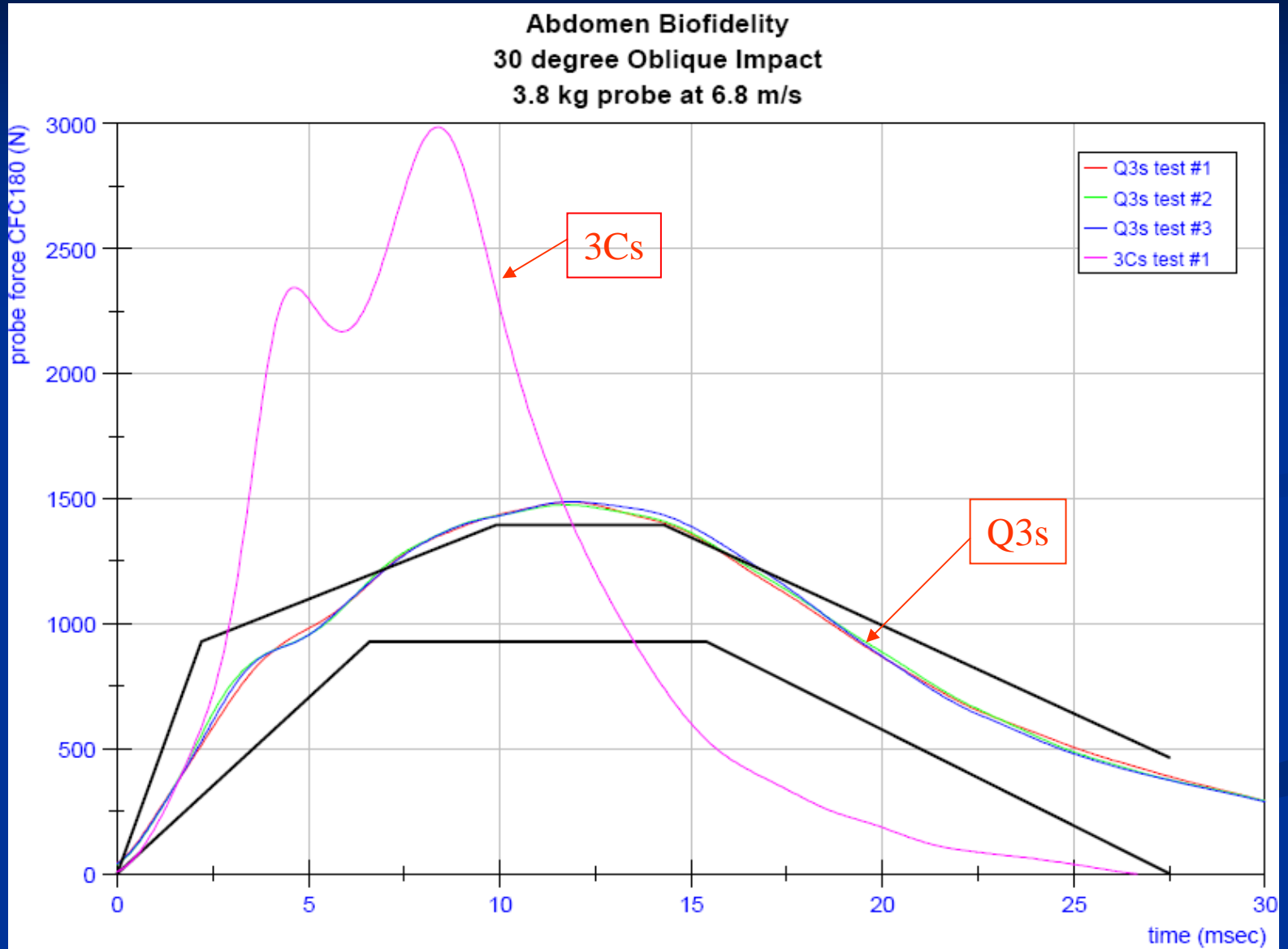
- 30° oblique impact to abdomen w/ 3.8 kg impactor at 4.8 and 6.8 m/s



Abdomen Biofidelity

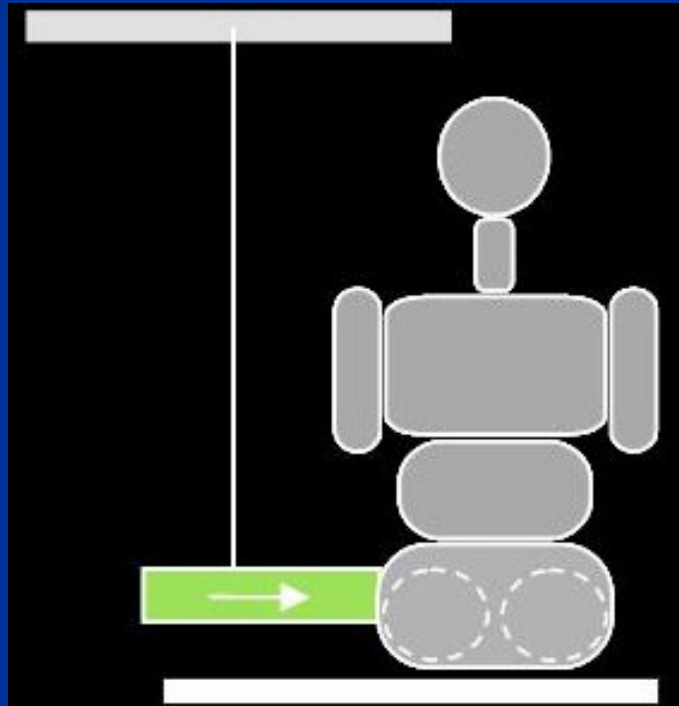


Abdomen Biofidelity

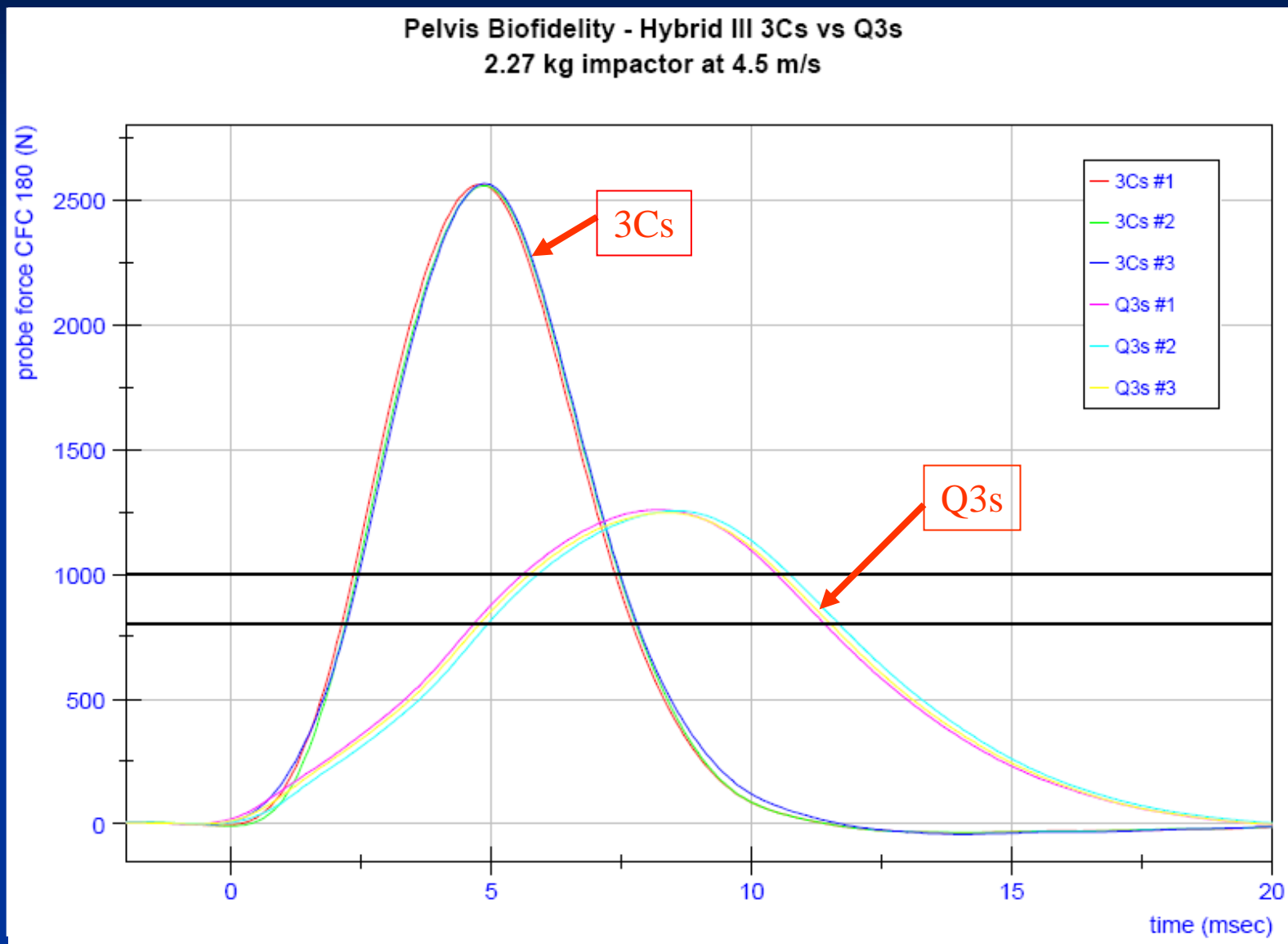


Pelvis Biofidelity

- Reference: Irwin (Stapp 2002-22-0016)
- Lateral impact to pelvis w/ 2.27 kg impactor at 4.5 m/s

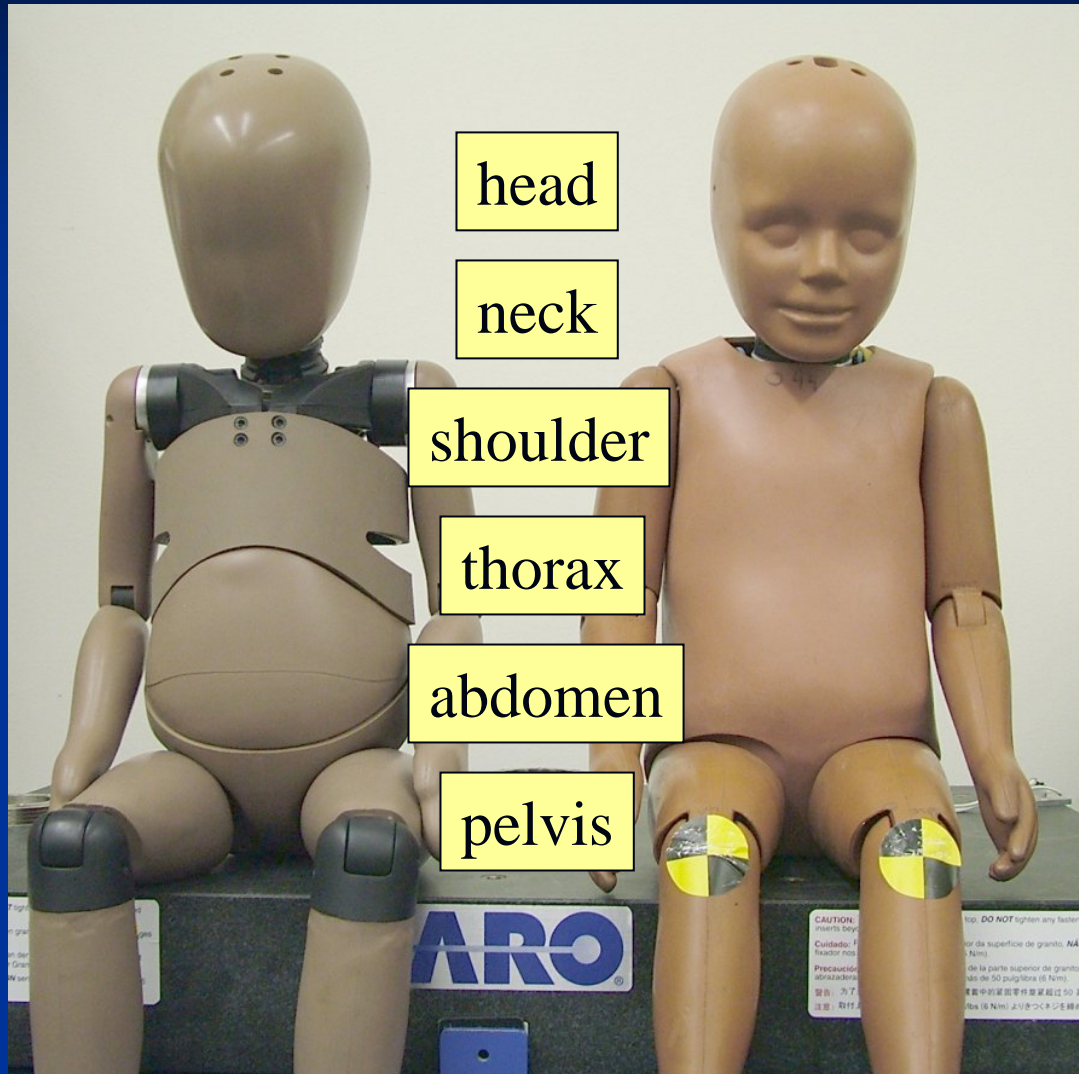


Pelvis Biofidelity



Preliminary Biofidelity Analysis

Q3s



3Cs



indicates biofidelity improvement



Informal Group on Child Restraint Systems
Brussels Oct. 7, 2008

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Certification Procedures

- Adapted procedures to use Bench Seat
- Developed a Thorax with Arm Test
- Introduced Increased Mass Impactor

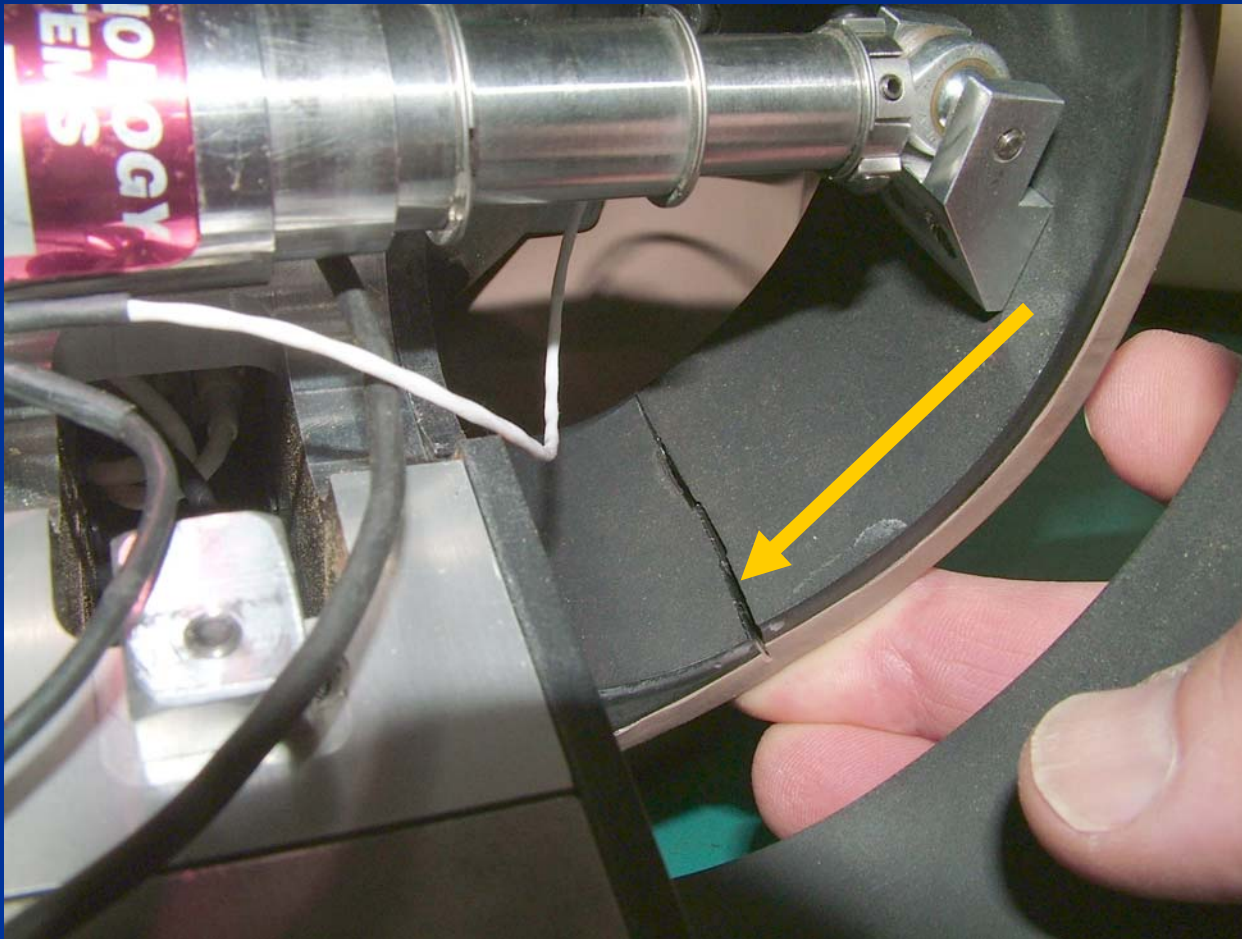


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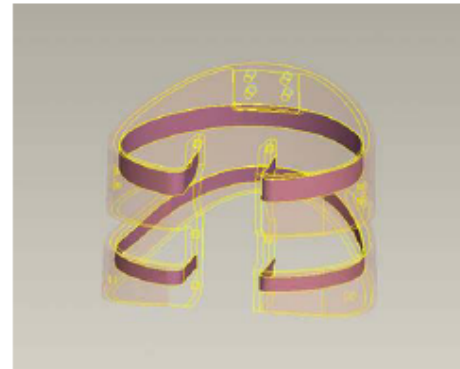
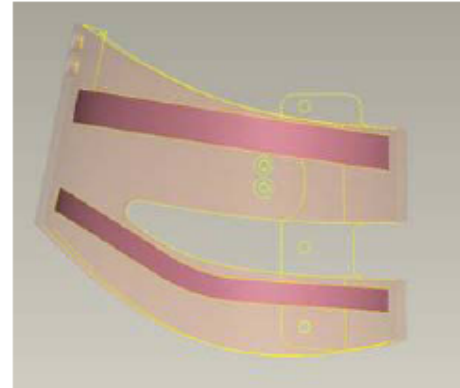
Durability Concerns

- Thorax damage observed in two different dummies



Durability Concerns

- Reinforce the rib cage with spring steel or Nitinol
- Soften the plastic material
- Reduce the strain level



8/15/2008

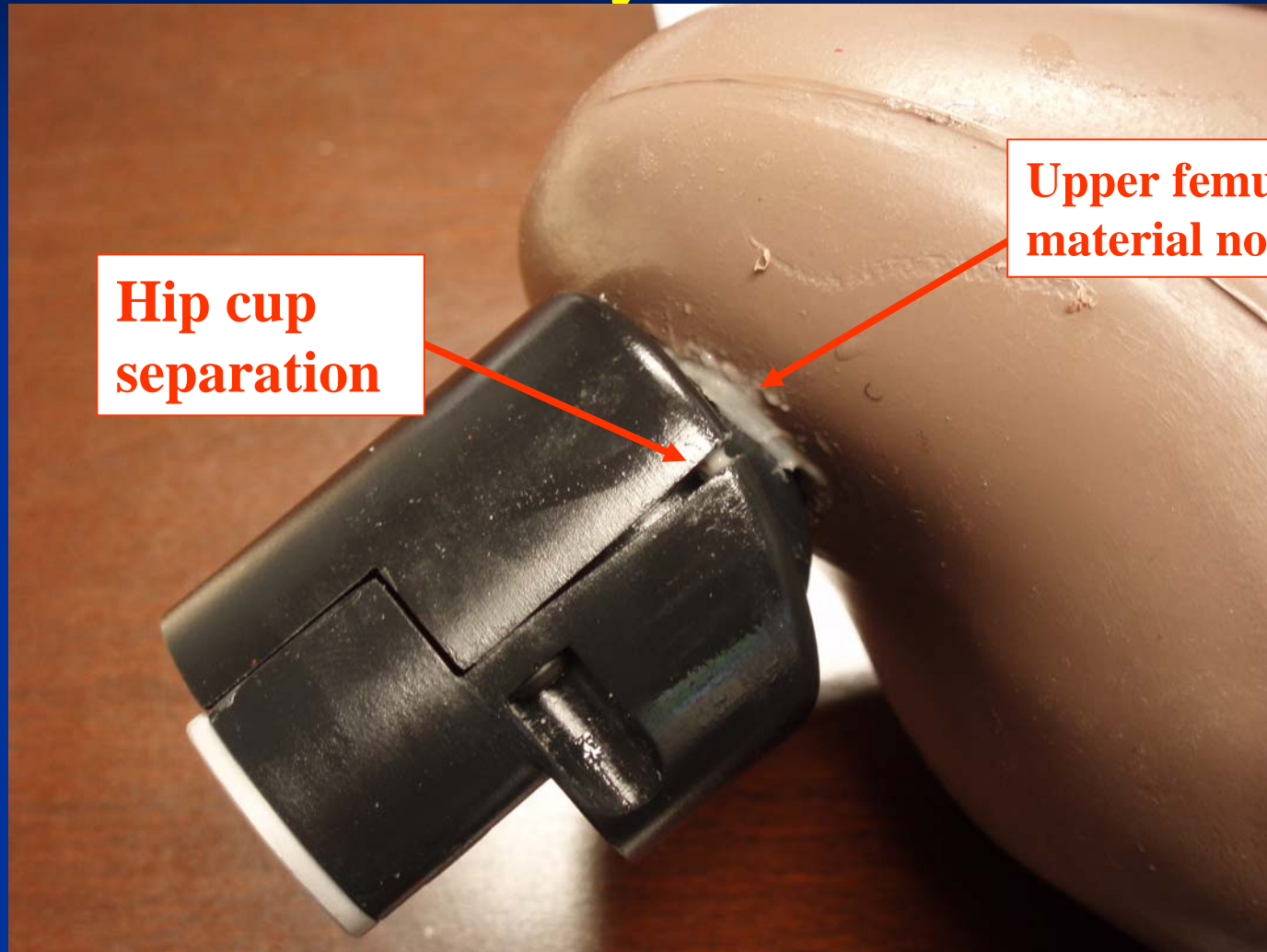
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 **First Technology**
Innovative Solutions

Durability Concerns



Durability Concerns



**Hip cup
separation**

**Upper femur filler
material not curing**

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Current Developments

- Improve Q3s thorax durability
- Improve femur issues
- Incorporate 3Cs neck design into the Q3s dummy

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Future Work

- Evaluate improvements
 - ❑ Thorax
 - ❑ Neck
 - ❑ Femur/Pelvis
- Finalize certification procedures and assess repeatability & reproducibility of responses
- Conduct sled tests for additional biofidelity assessment

Technical Contacts for this Work

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Thank You!

