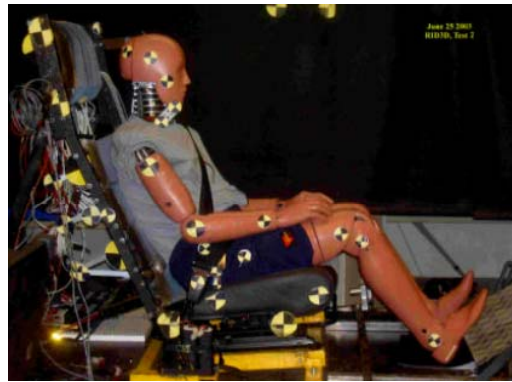

Rear Impact Dummies



Z. Jerry Wang, PhD, Chief Engineer
Eric Jacuzzi, Project Engineer

GRSP International Informal Technical Group Meeting
Washington DC
November 6, 2009

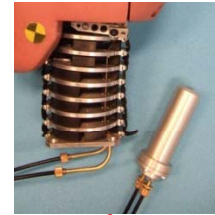
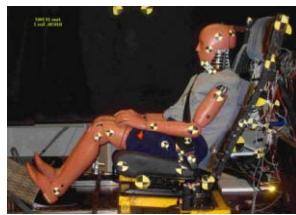
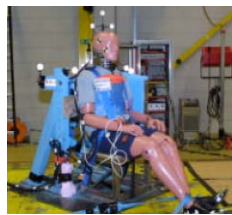
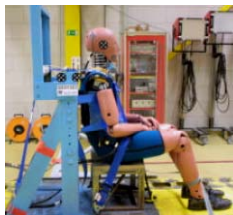
First Technology Safety Systems, Inc.

Contents

- RID3D Brief
- FTSS BioRID II+ Development

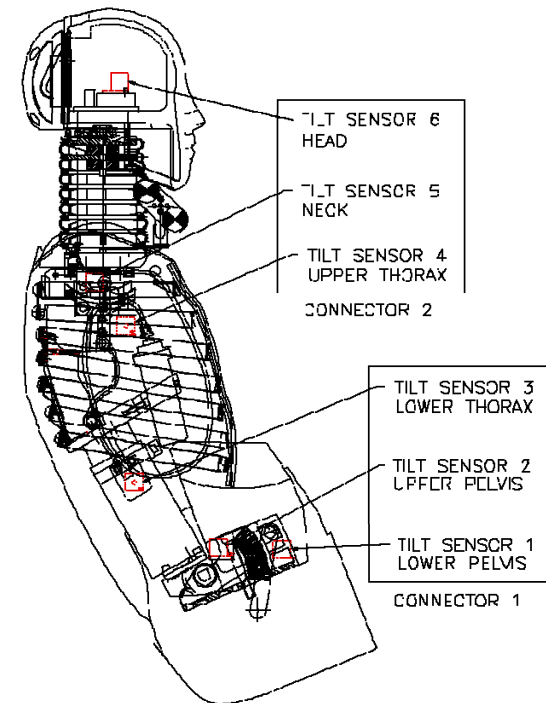
RID3D Brief

- **1998 – 2001 RID2** developed and evaluated in the EU program **Whiplash**
- **2001 – 2004 RID3D** update of RID2 in **Whiplash2**
 - Improvement of durability
 - Maintaining RID2 rear performance
 - Improvement of low severity frontal oblique impact head neck response (thus 3D)
 - Rebound from rear impact
 - Evaluation of RID3D and BIORID*
 - Equally good rear impact performance
 - RID3D wider range of application than BioRID
 - Higher severity test conditions
 - Rear impact and frontal impact
 - Off axis loading
 - Evaluation resulted in ‘Recommendations for RID3D dummy updates’
- **2006 RID3D** update according Whiplash2 recommendations
 - EEVC WG12 rear impact dummy evaluation
 - Evaluated against 5 selected rear impact biomechanical test conditions
 - RID3D, BioRID and HIII
 - Reports was summarized in EEVC report Dec 2007



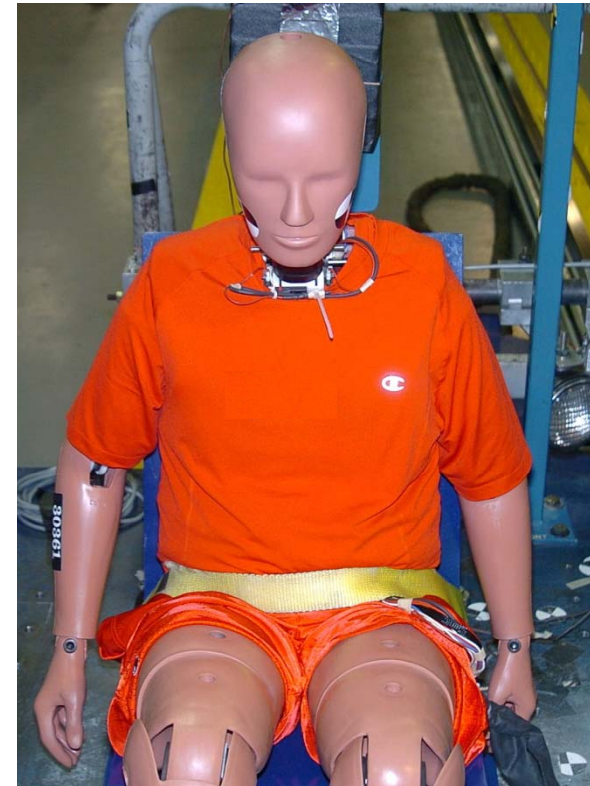
Some Unique Features Positioning

- THOR thorax design
- Adjustable lower neck joint and lumbar joint for dummy positioning
- Tilt sensors available on 6 positions to allow accurate and repeatable seating position
 - Output of rear impact dummies is highly sensitive to pre impact position



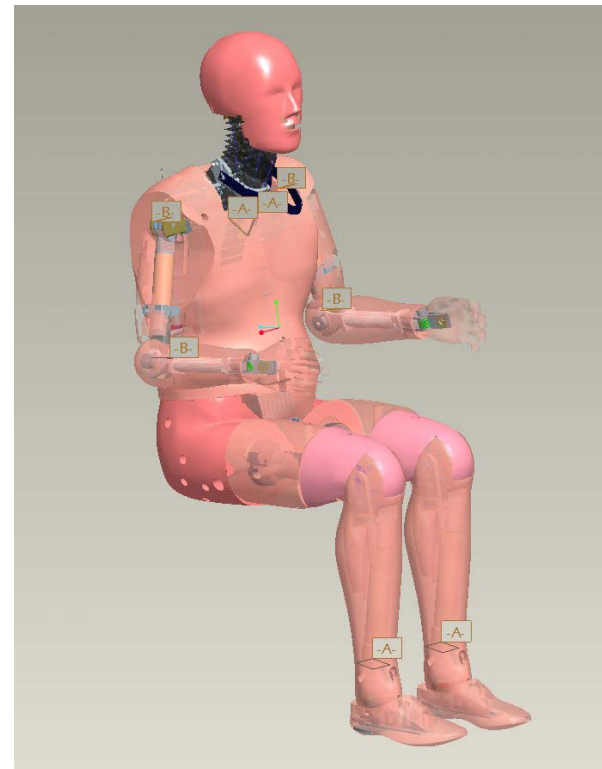
FTSS BioRID II+ Development

- Why FTSS develop the BioRID II+?
 - The customers requested FTSS to improve the BioRID II dummy
 - Enable FTSS to provide full portfolio of dummies to the safety industry
 - Goals
 - A more repeatable and reproducible dummy
 - Improved tolerance for better reproducibility
 - Improve durability
 - Improvement on dummy handling
 - Critical user notes: “Improve, but don’t make a different dummy”



BioRID II+ Development

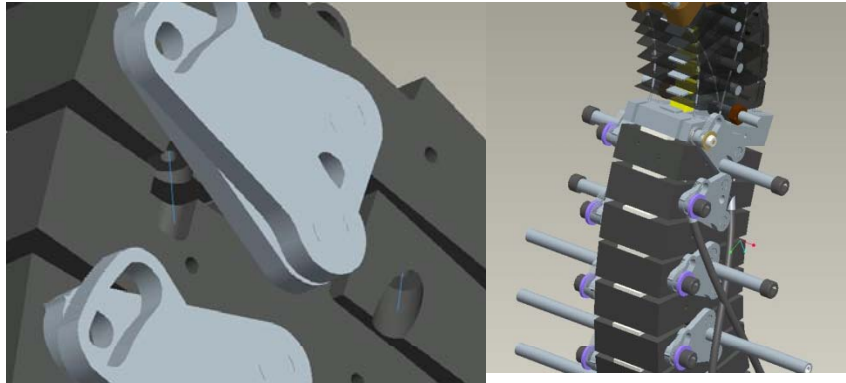
- FTSS Development and Improvements from Chalmers Design
- Calibration Fixture Development
 - Current Fixture Review
 - FTSS Calibration Fixture
- Calibration Data Summary
- Full Scale Sled Data Summary
- Durability and Repeatability Study
- FTSS Future Plan



Design Improvement Based on User's Feedback

| Task # | Description | Status |
|--------|--|---------------------------------------|
| 1 | H-point feature (combine into one, aluminum to steel) | implemented |
| 2 | Spring cable clearance to improve durability | implemented |
| 3 | Harness for lifting legs | implemented |
| 4 | Improved buffer locating feature | implemented |
| 5 | Angled buffer for durability improvement | not implemented |
| 6 | Move jacket split line away from the center | implemented |
| 7 | Femur joint friction adjustment redesign | no satisfactory solution yet |
| 8 | Head cable exit from side | design completed, not implemented yet |
| 9 | Remove T1 load cell without disassembling the spine | implemented |
| 10 | EuroNCAP T1 and L5 indicator improvement | implemented |
| 11 | Calibration fixture improvement | under development |
| 12 | ARS sensor to replace the rotary pot | implemented |
| 13 | Head redesign to improve access to cable tension adjustment nuts | under development |

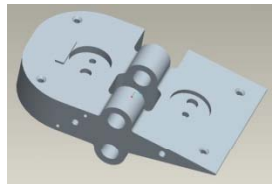
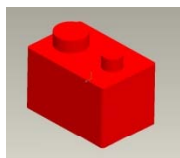
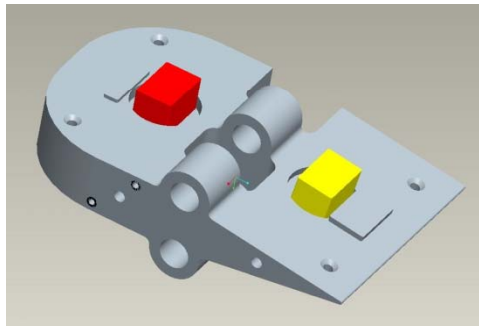
Design Improvements



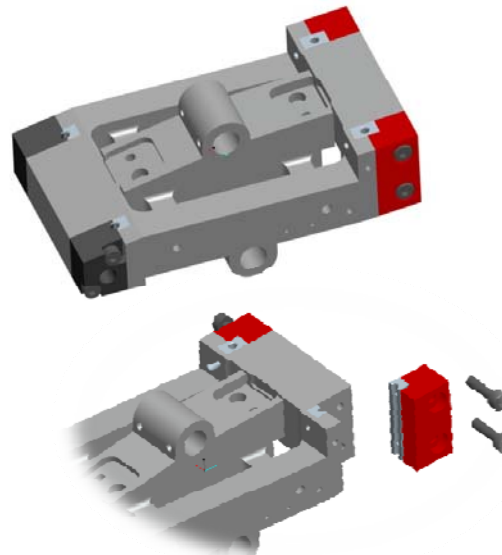
muscle substitution cable sheath clearance.



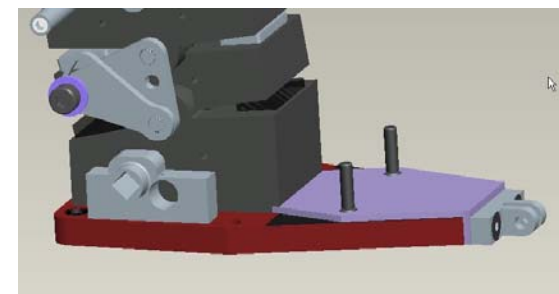
Jacket with side flap.



Vertebra bumper locating feature.



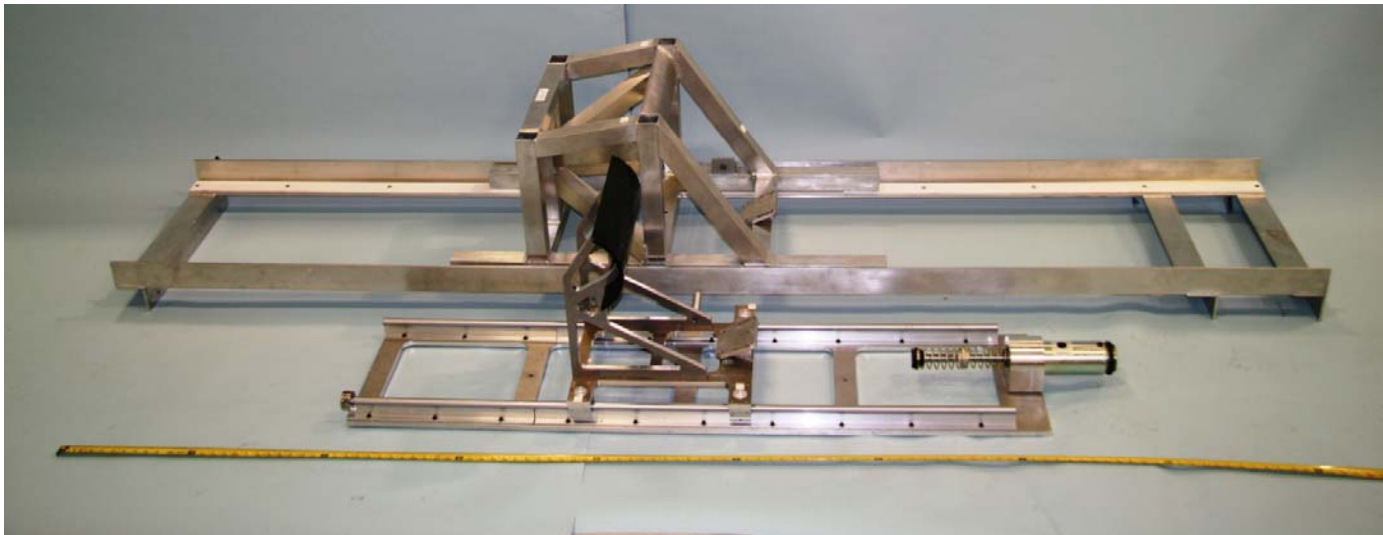
Improved T1 design



Improved H-point locator design

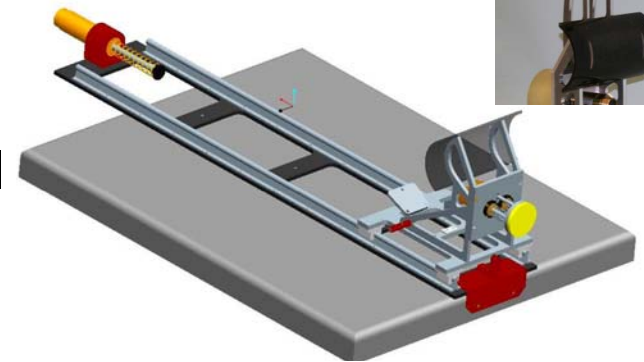
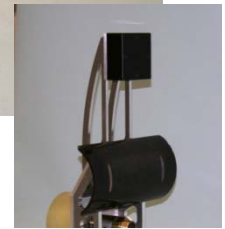
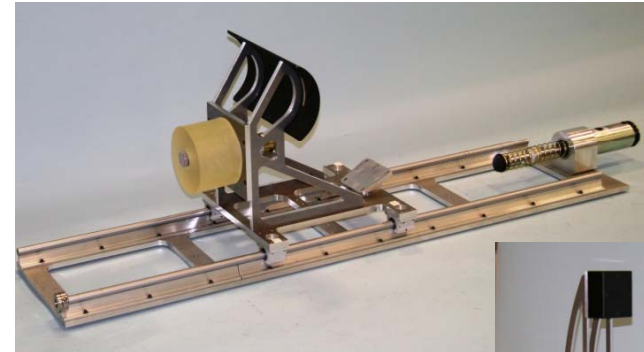
Calibration Fixtures

- Current Calibration Fixture Review
 - Too long for most labs to use on dummy tables
 - Not enough constraint and allow lateral and vertical movement
 - High friction with Teflon sheets



FTSS Calibration Fixture

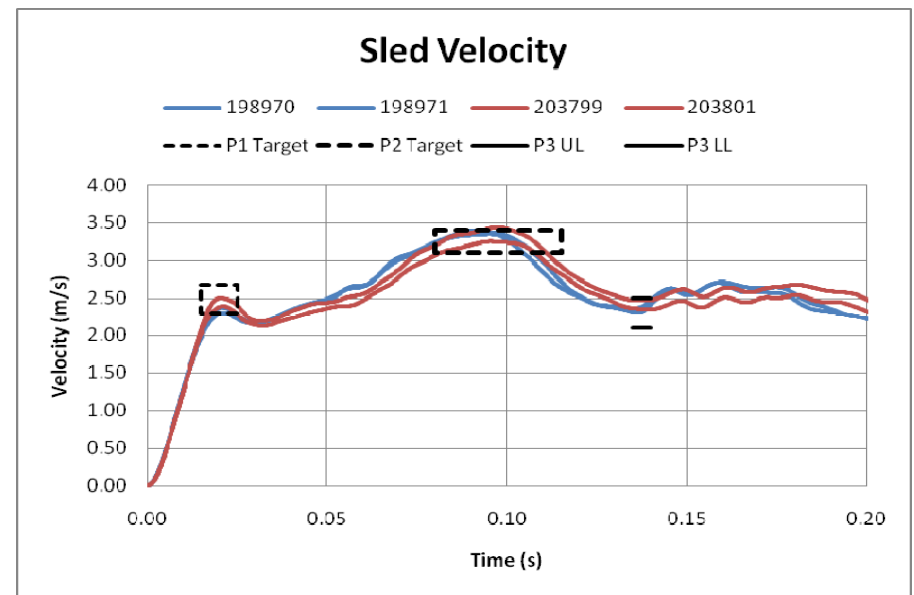
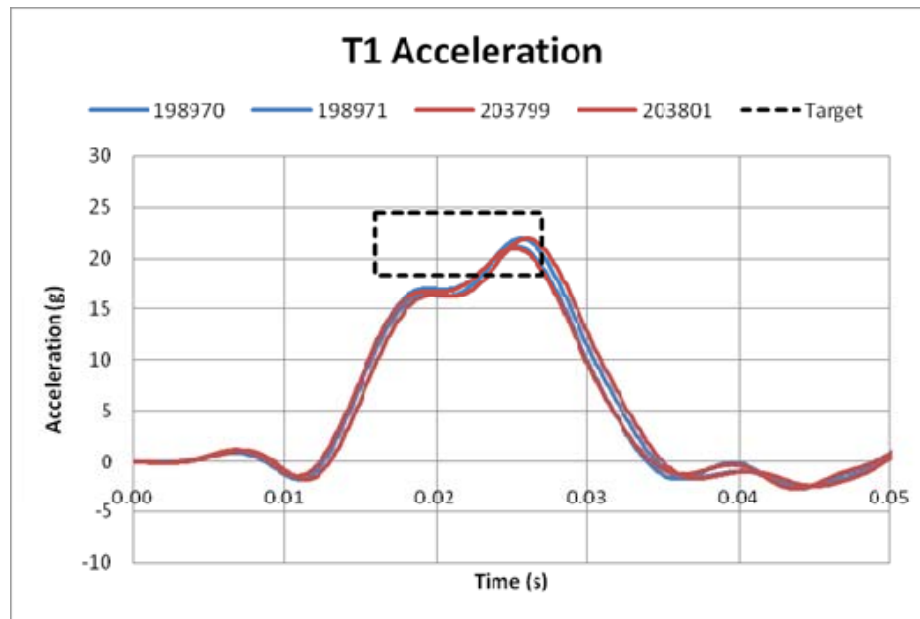
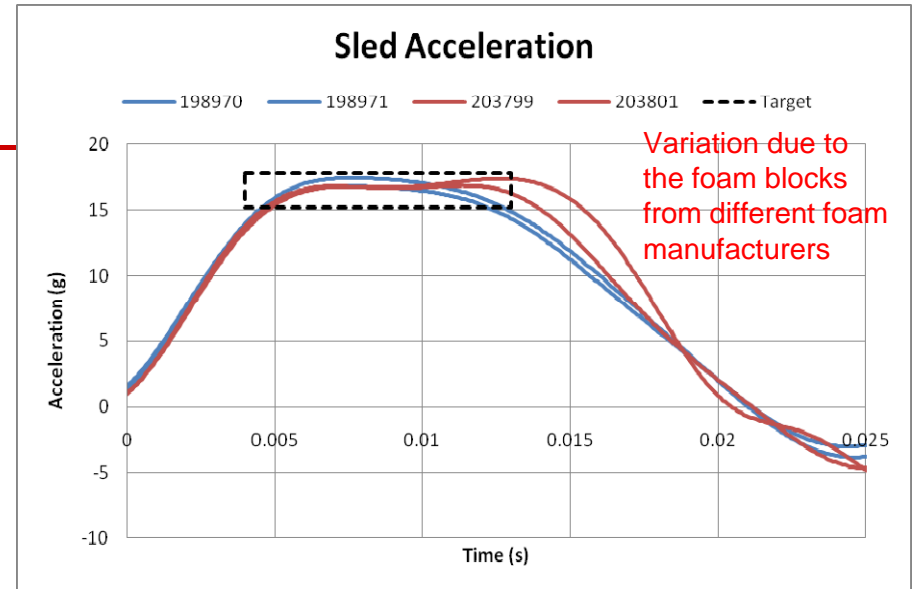
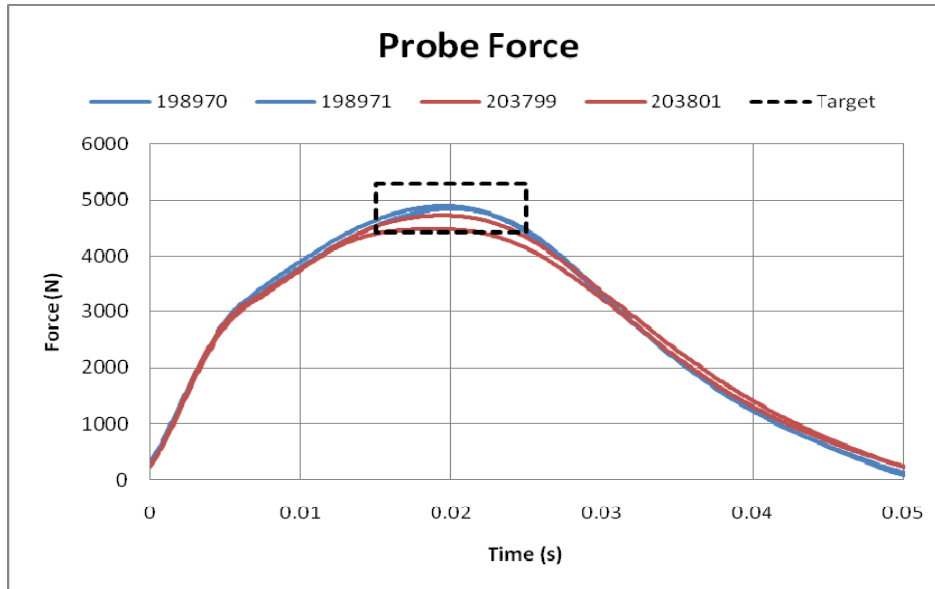
- Matches weight of original sled with smaller package
- Track length reduced based on test duration
- Fits on a standard table and clamps
- Uses precision linear rails and ball bearings, reducing friction and constraining all motion to longitudinal axis only
- Tunable damper systems replaces the consumable foam
- Headrest ready



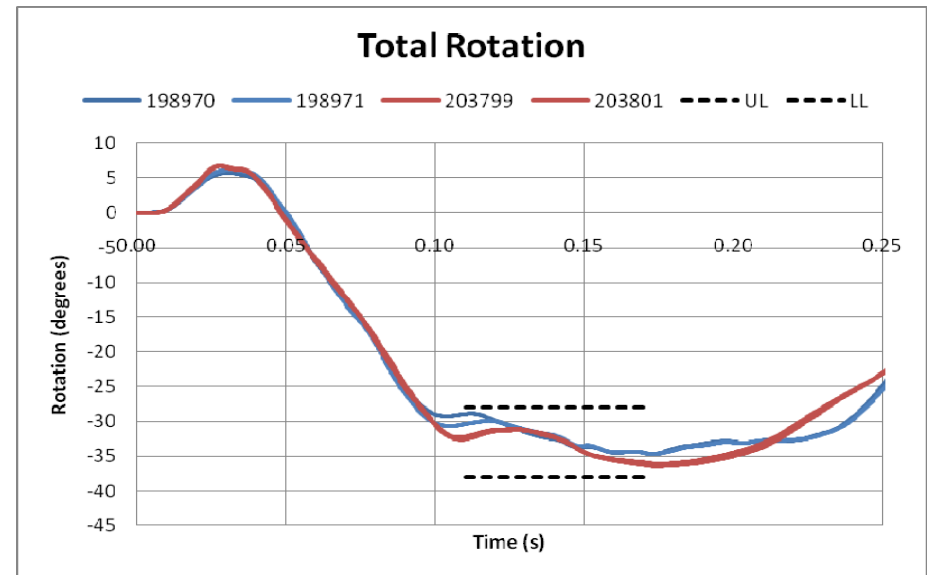
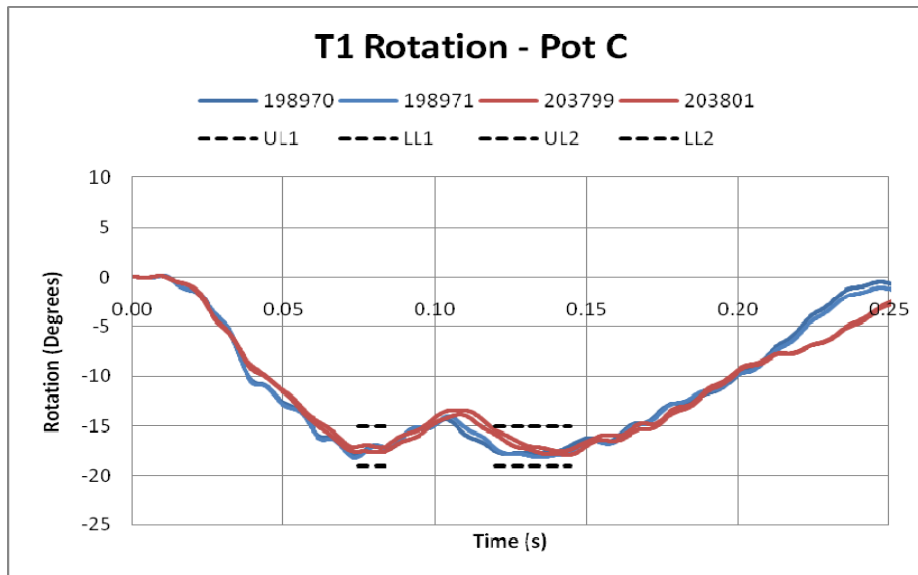
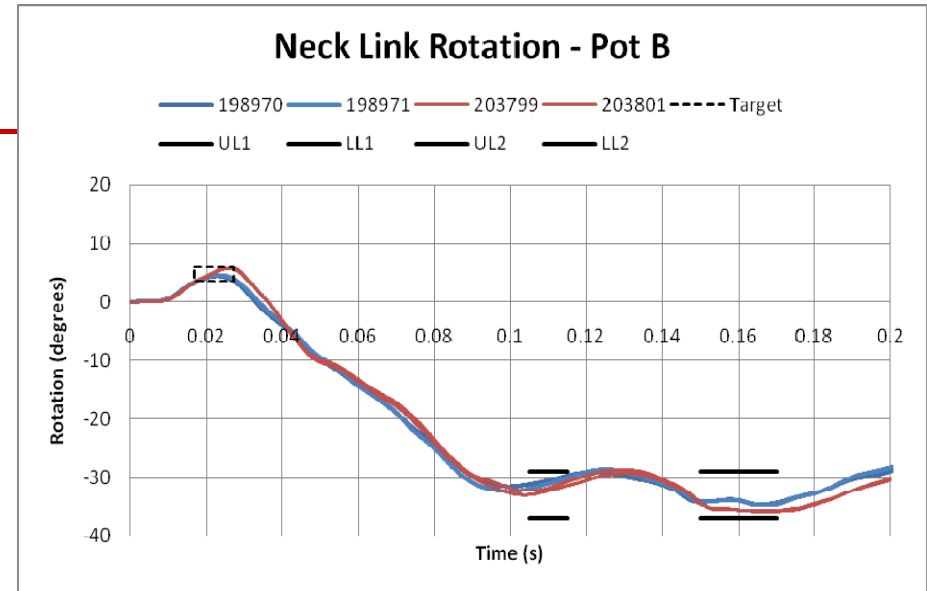
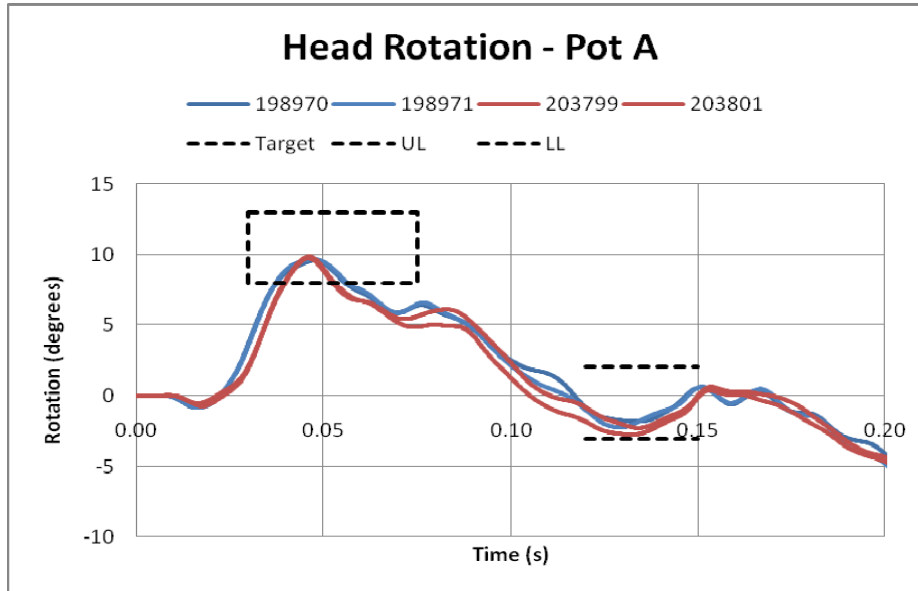
First Article Test Experience

- FTSS conducted over 250 tests on the first BioRID II+ since June 2009
- The dummy was calibrated on monthly basis
- No replacement parts are needed after 250+ tests
 - The cervical, thoracic, and lumbar bumpers and stops were never replaced. The original bumpers are still functioning properly.
 - The dummy was completely disassembled 5 times, with load cells substituted etc.

Calibration Data Comparison

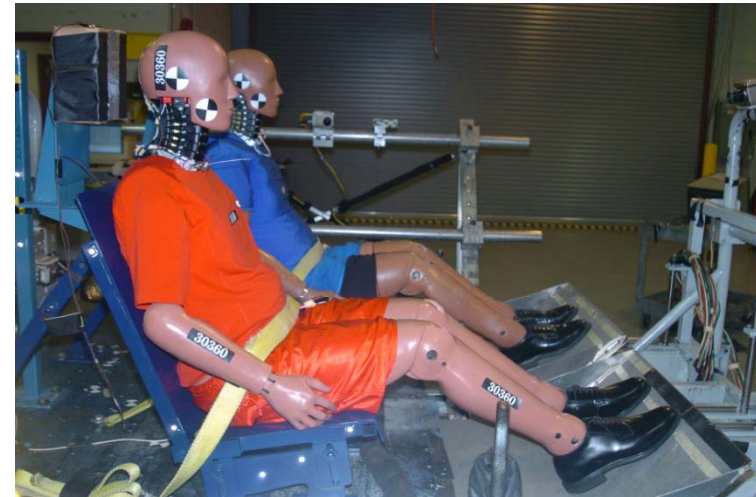


Calibration (cont'd)

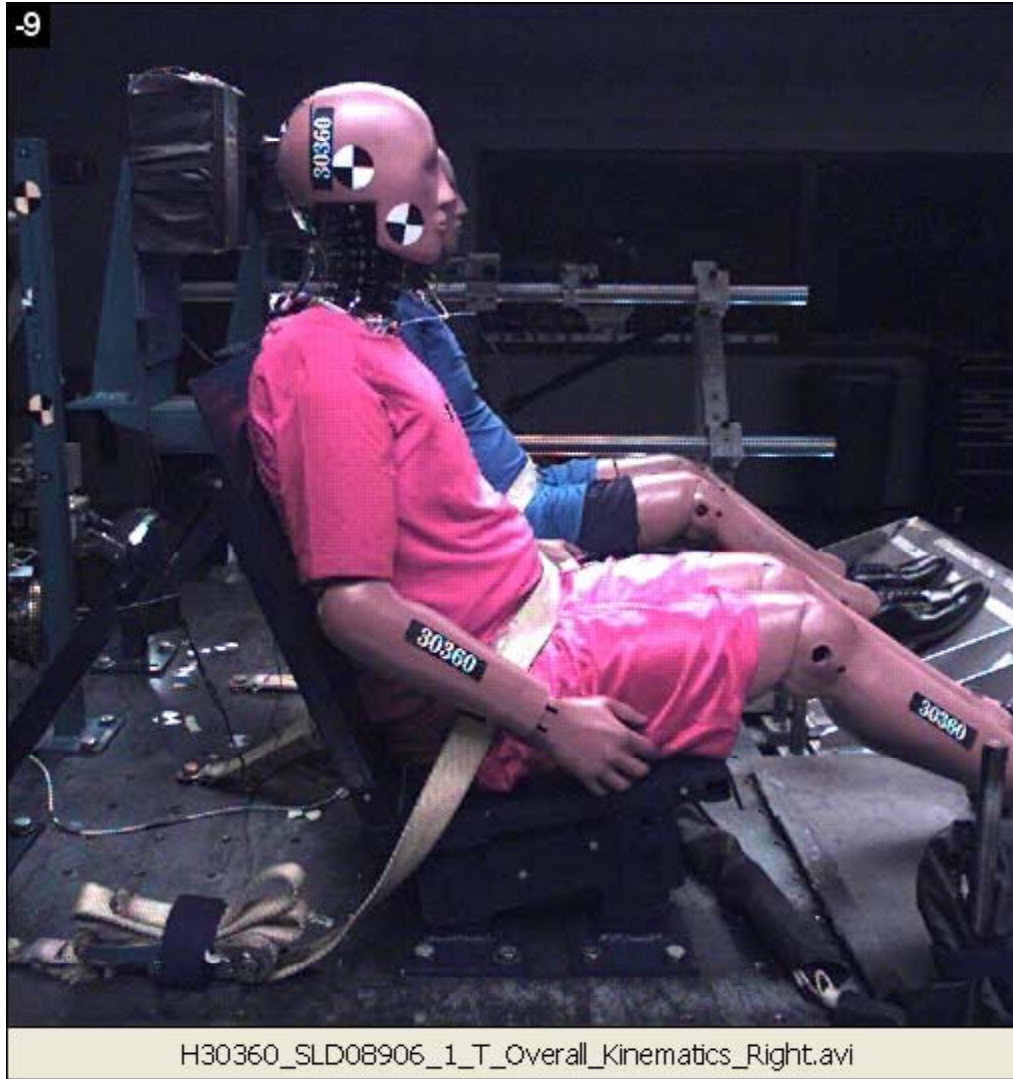


Validation and Comparison Tests

- Dual bucket rigid seat sled test
 - FTSS dummy and Denton dummy for comparison
 - IIHS procedure was used with some exceptions due to the rigid seat
 - Data channels
 - EuroNCAP
 - IIHS
 - Additional
 - Preliminary data review
- Planned tests in the coming months
 - IIHS test protocol
 - EuroNCAP test protocol
 - Dummy reproducibility study



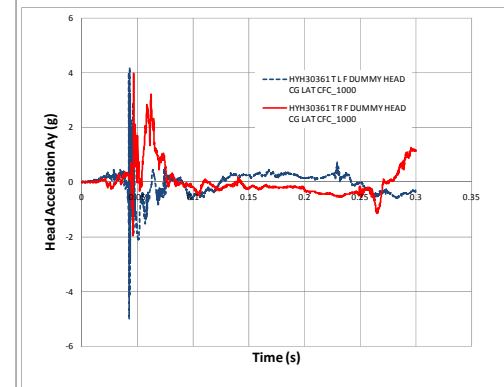
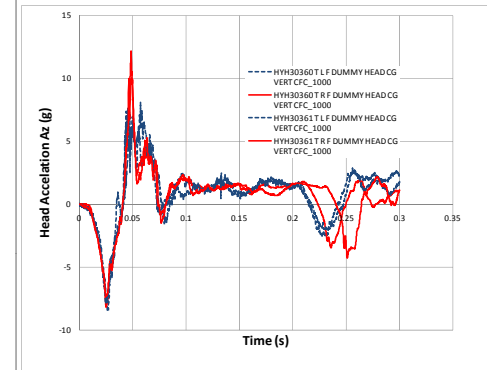
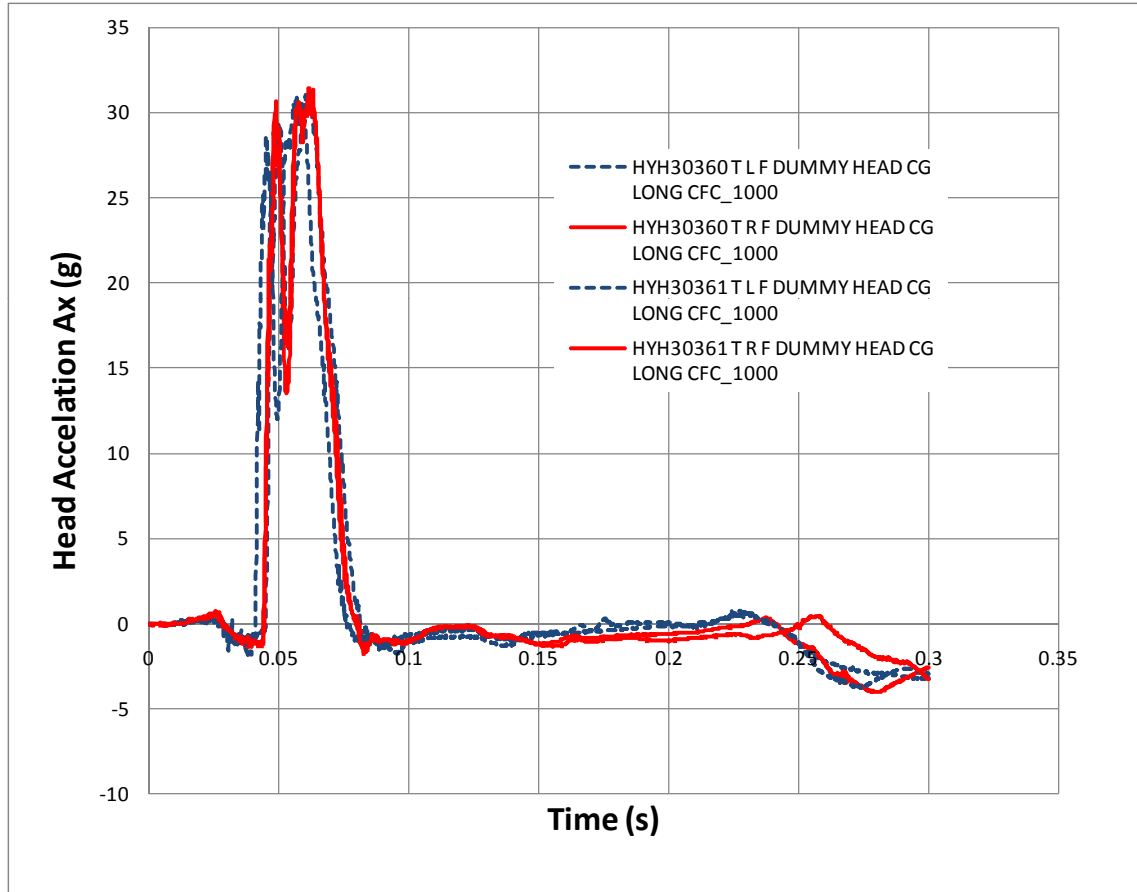
Sled Test



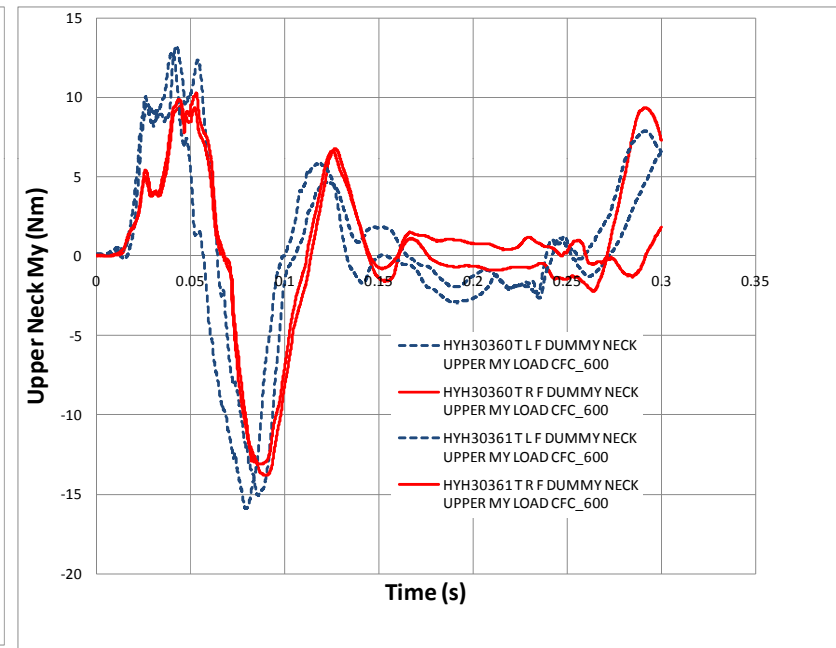
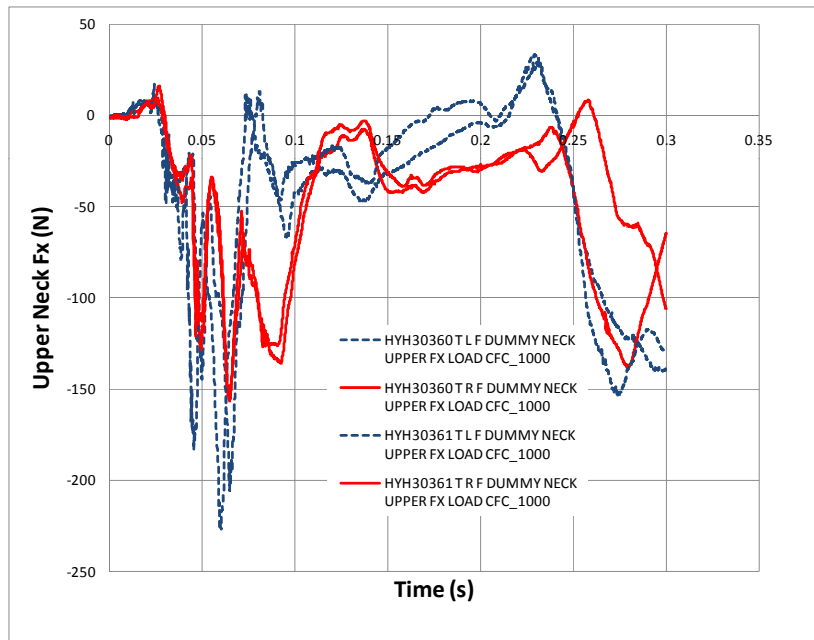
Sled Test Data

- Two tests overlay
- **Red solid lines** – FTSS dummy
- **Blue dotted lines** – Denton dummy

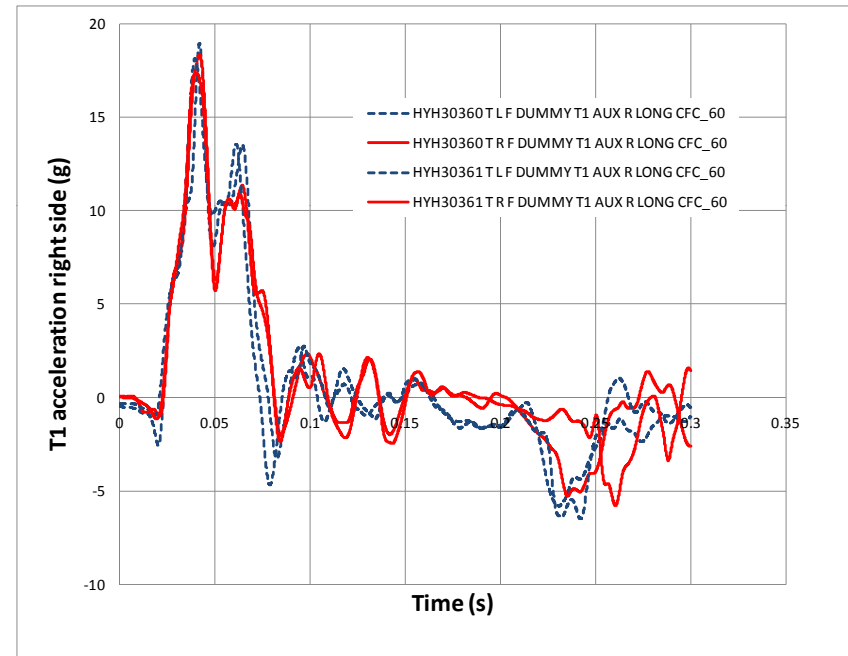
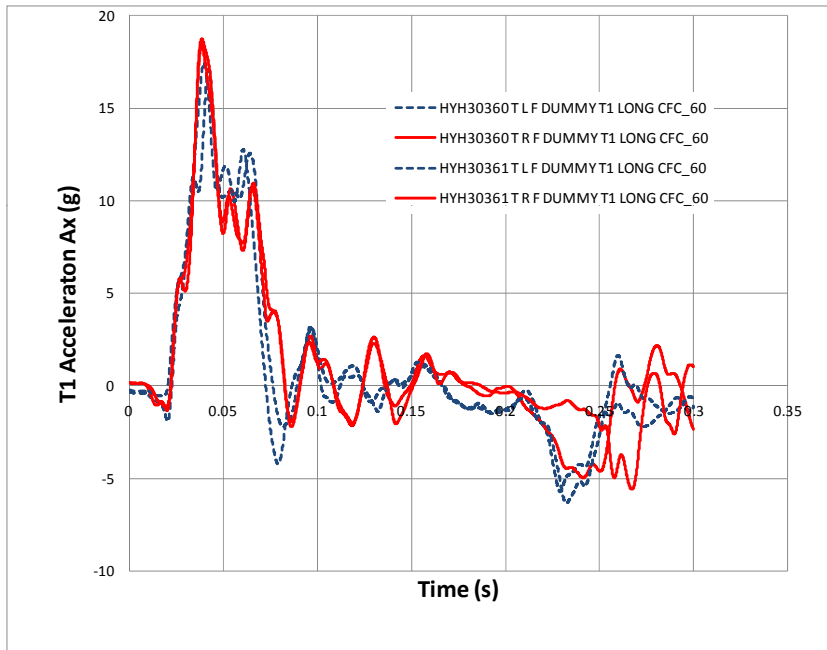
Head Acceleration



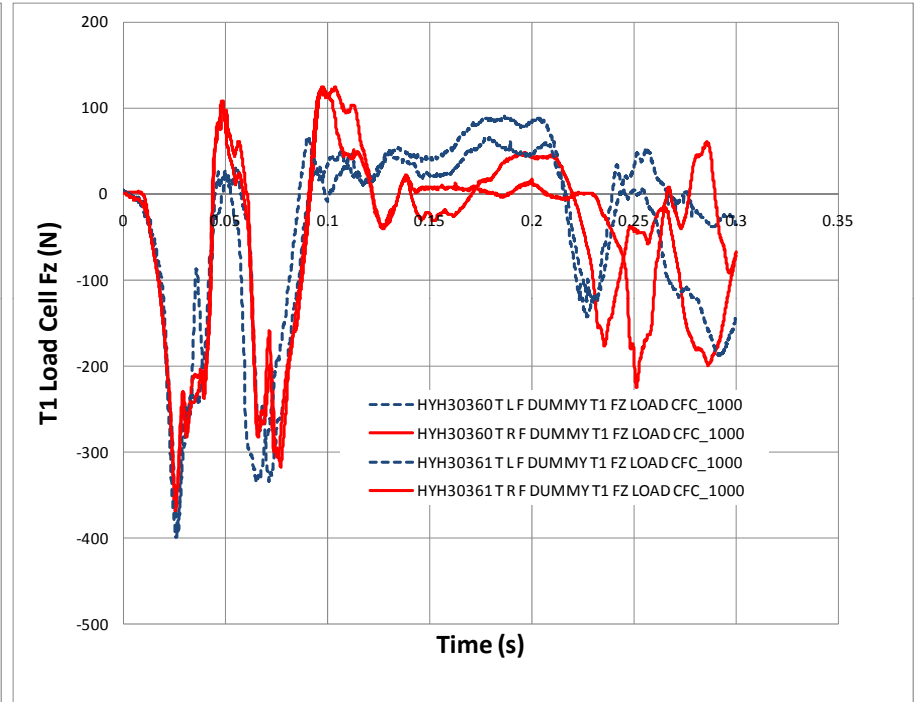
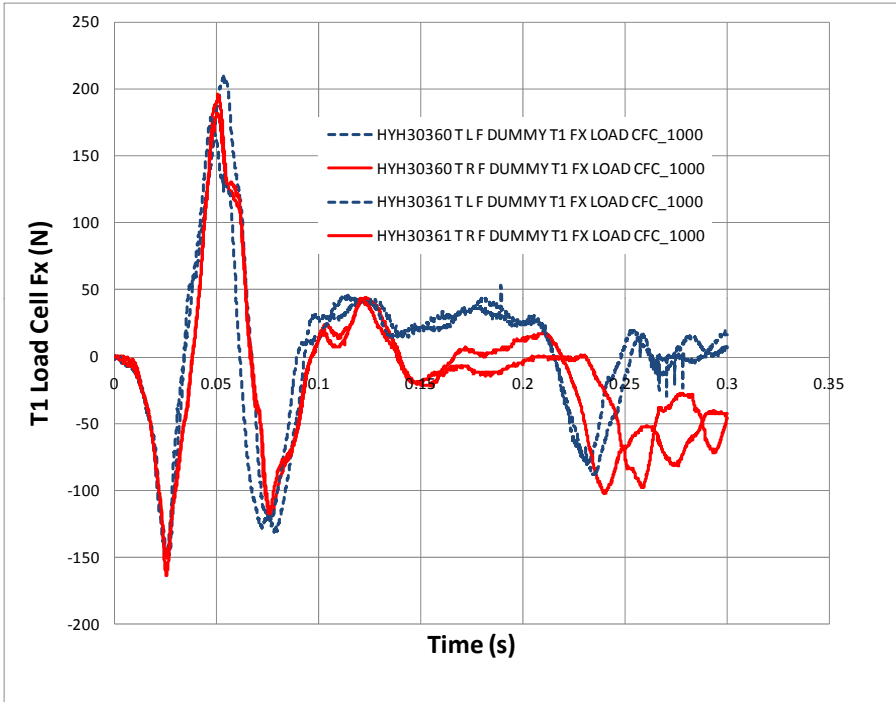
Upper Neck Data



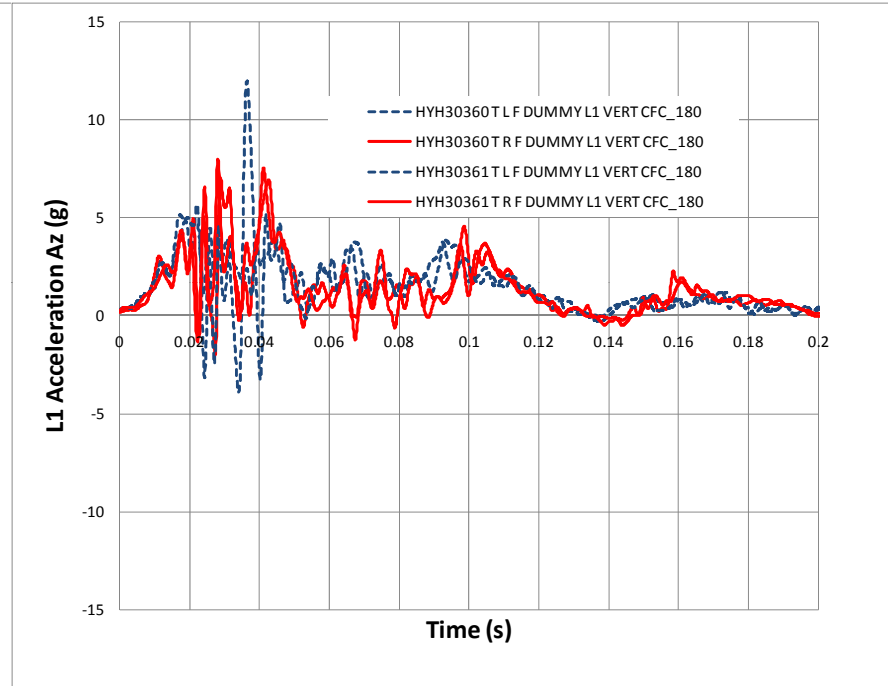
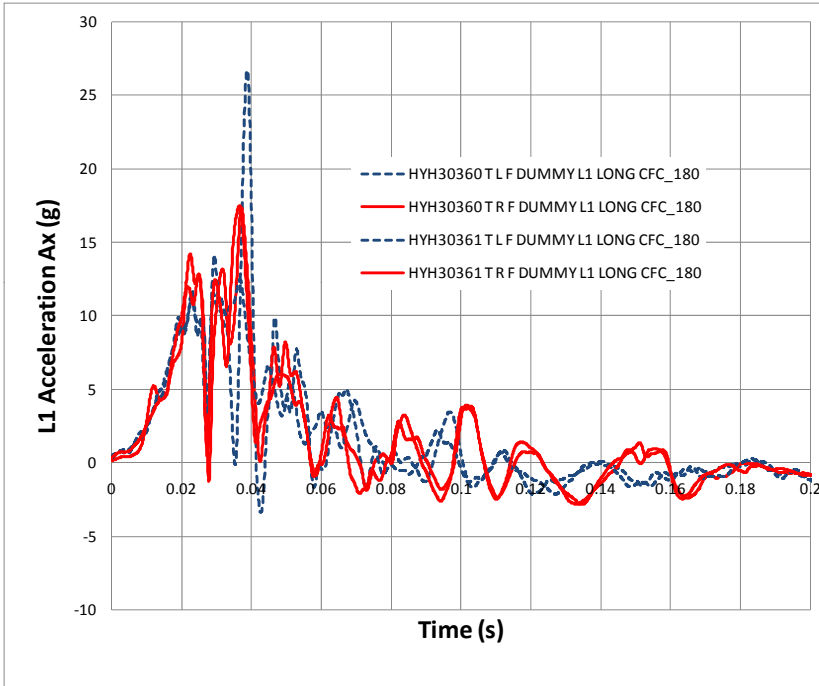
T1 Acceleration



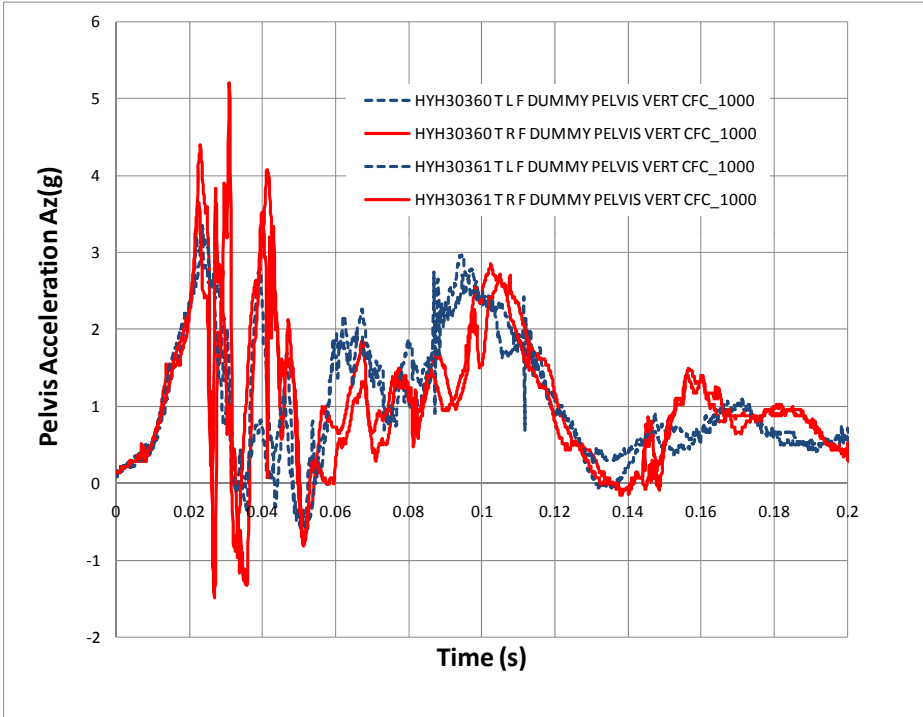
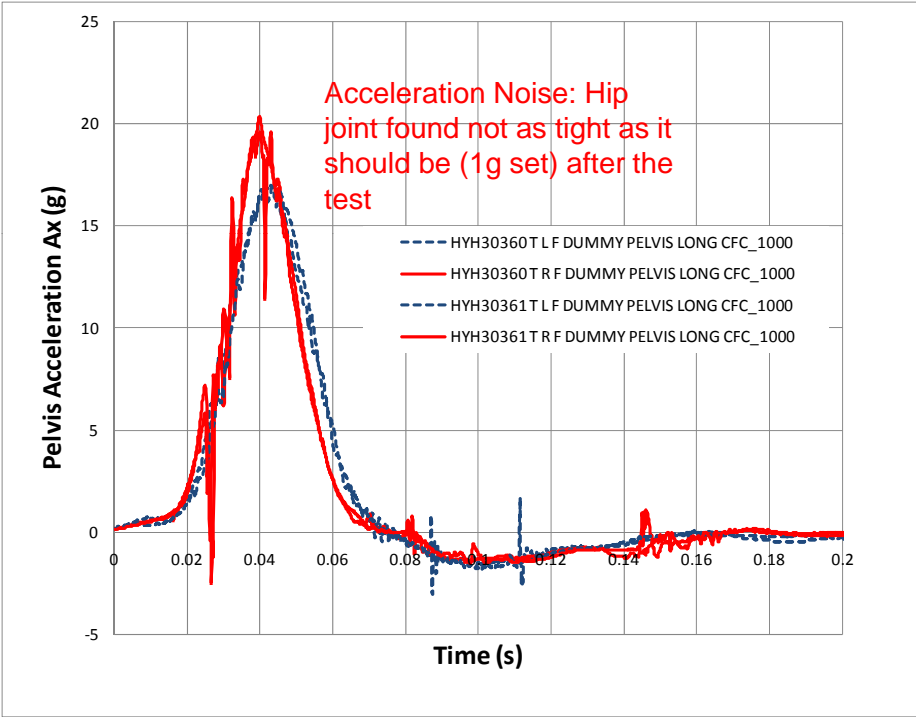
T1 Load Cell



L1 Acceleration



Pelvis Acceleration



Summary

- All design improvements are based on users' experience and comments
- Calibration and sled testing were conducted
 - Good durability and repeatability in calibration test and sled test
 - Good comparison to Denton dummy performance in sled test
- Mini-sled design show good handling and will continue the development and refinement work

Status and Future Work

- 2nd and 3rd dummy are ready for testing in December 2009
- Dummies for customer orders are in process
- Participation of Global BioRID Users' Group Meeting (GBUM) and GRSP whiplash group to support the activities toward rear impact regulation and harmonization
- Further improvements
 - Friction reduction in muscle substitution system to improve the repeatability in testing
 - Further refinement of tunable damper system for mini-sled
 - Improve the accessibility to the head cavity for the cable tension adjustment



Manufacturing Clarification

- FTSS is committed to manufacture both RID3D and BioRID⁺ II and continue to provide support to the industry.

