

UPDATE ON CERTIFICATION TEST DEVELOPMENT

9/10/2013

prepared by: Paul Depinet, John Below, John Stephens,
Dennis Moeller, John Arthur, Gus Serrano

Agenda

- Goal
- Current Tests
- Test under development
- Test Recommendations
 - Certification tests to use
 - Certification tests to stop testing
 - Inspection tests to use



Goal

- Develop certification tests which can control dummy reproducibility
 - Must control setup of neck muscle substitutes and damper
 - Must detect critical differences between dummies found in vehicle seat R&R work
 - ▶ Spine bumper stiffness
 - ▶ Jacket stiffness
 - ▶ Pelvis stiffness



Current Tests

- Spine quasi-static setup *(have corridors)*
 - Set springs and thorax/lumbar shape adjustment
- Mini-sled without head restraint *(have corridors)*
 - Set damper, verify correct spring & shape adjustments
- Mini-sled WITH head restraint *(presently no corridors)*
- Jacket only impact *(presently no corridors)*
- Pelvis only impact, back & bottom *(presently no corridors)*



Tests under Development

- Full dummy
 - Mini-sled WITH head restraint
 - Mini-sled with seat back & head restraint
- Spine stiffness
 - Spine quasi-static bending (flexion & extension)
 - Bumper compression on spine
- Jacket
 - Jacket impact
 - Jacket quasi-static compression check
- Pelvis
 - Pelvis impacts (back & bottom)
 - Pelvis shape check
 - Pelvis quasi-static compression check



Tests Under Development

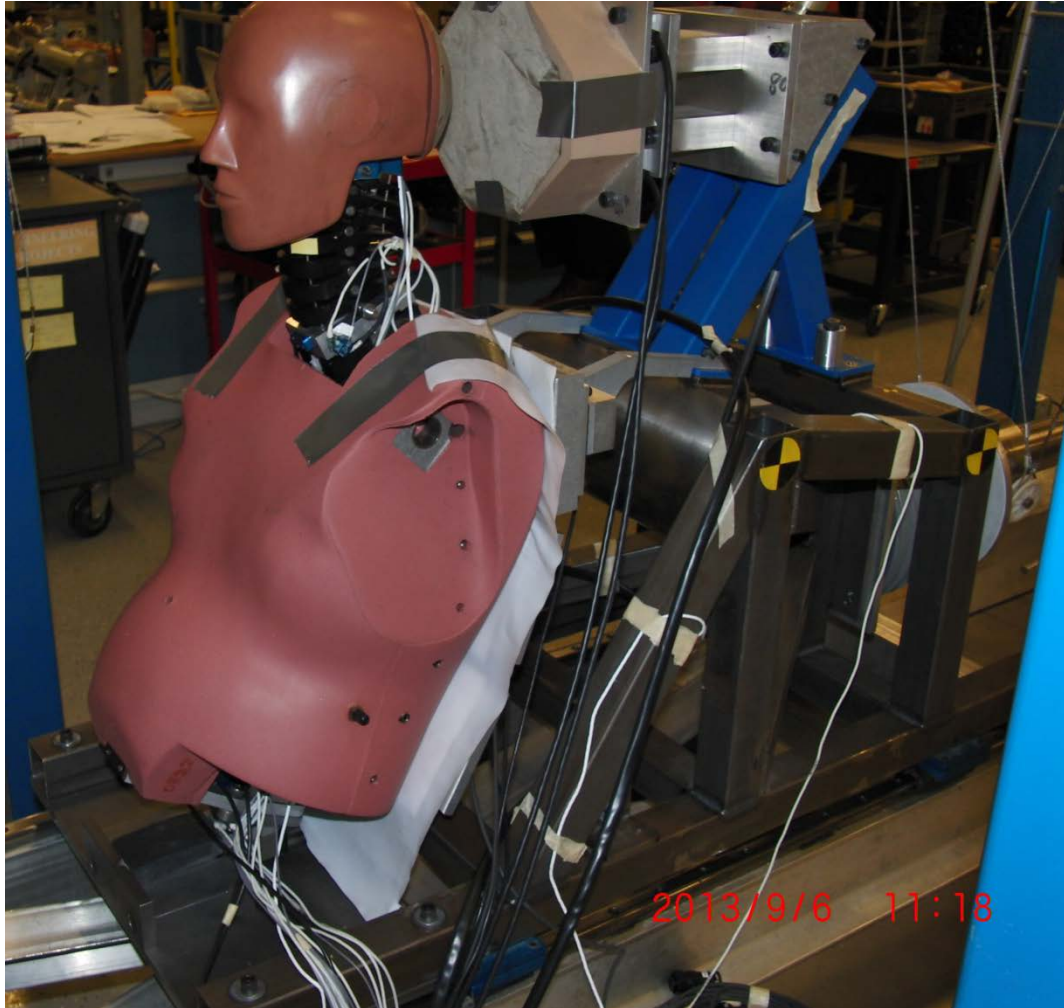
- For all tests
 - Determine if they predict an important performance parameter shown to affect seat performance
 - ▶ Jacket, bumpers, pelvis
 - Are they repeatable & reproducible?
 - Establish corridors that adequately control dummy performance
 - Determine which tests are needed, and what parameters are necessary & sufficient



Tests Under Development

**Mini-sled with
seat back & head restraint**

Mini-sled with seat back & head restraint



Mini-sled with seat back & head restraint

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



Mini-sled with seat back & head restraint

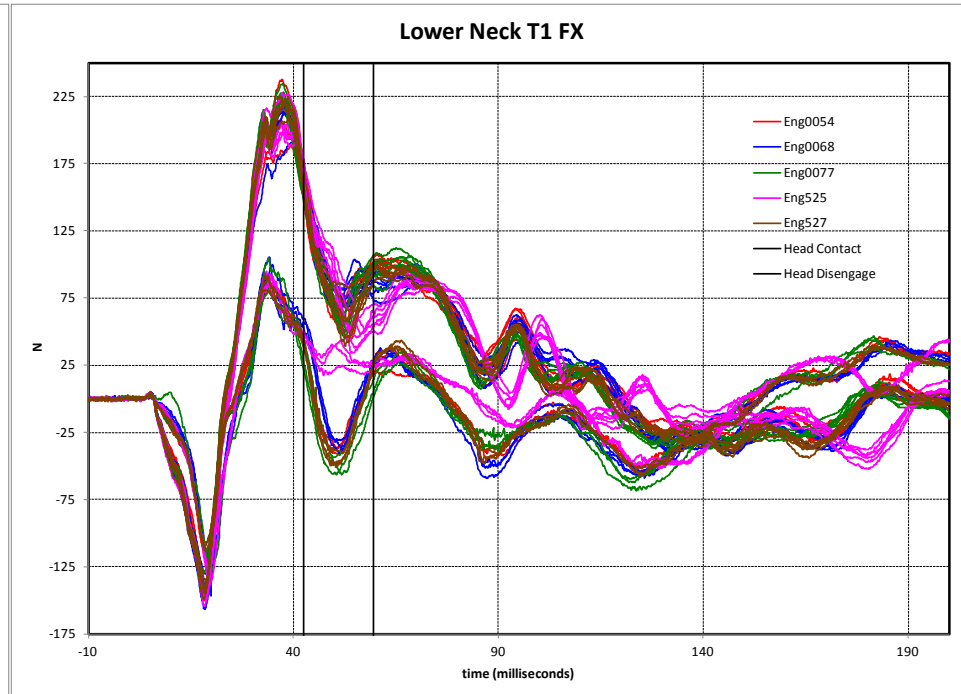
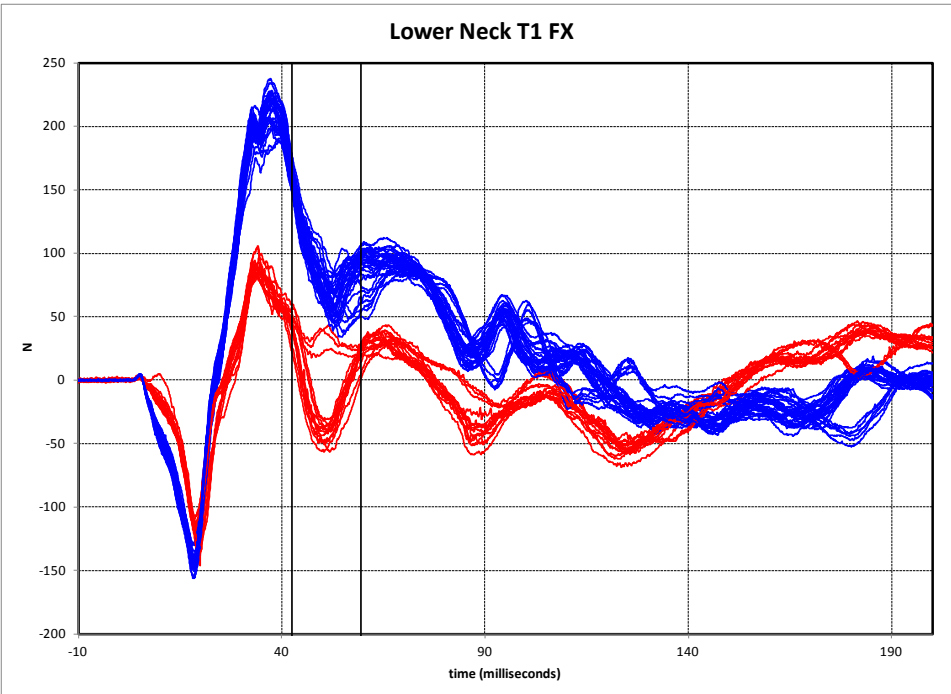


Mini-sled with seat back & head restraint

- Can clearly distinguish stiff vs normal bumpers on some channels
 - Should be possible to set corridors!
- Jacket and bumper interact on other channels
 - Set corridors to exclude jacket/bumper deviations
 - Still need jacket only to control just the jacket



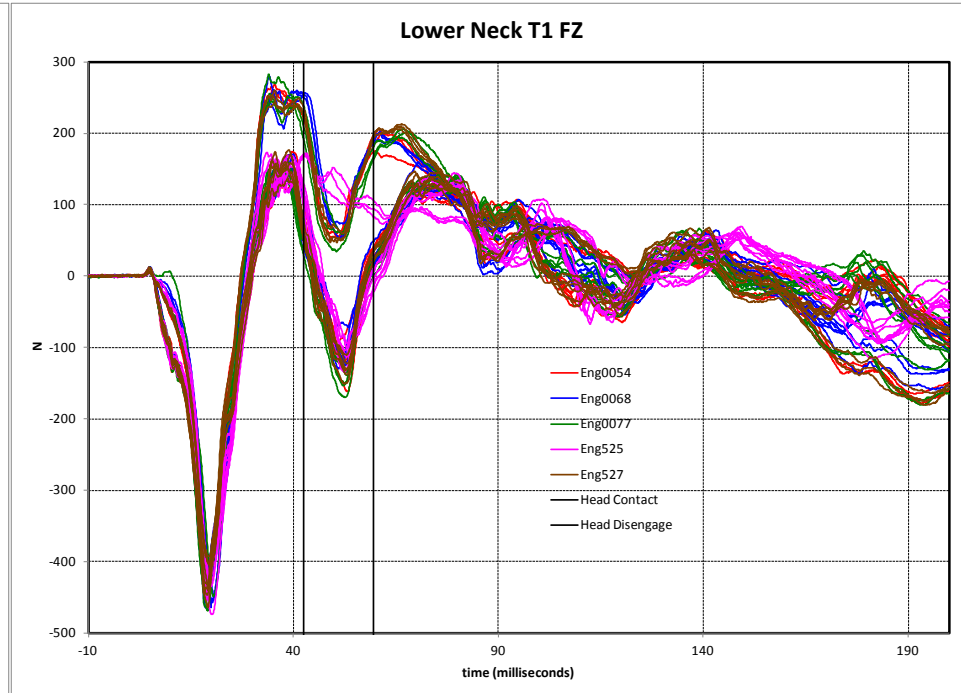
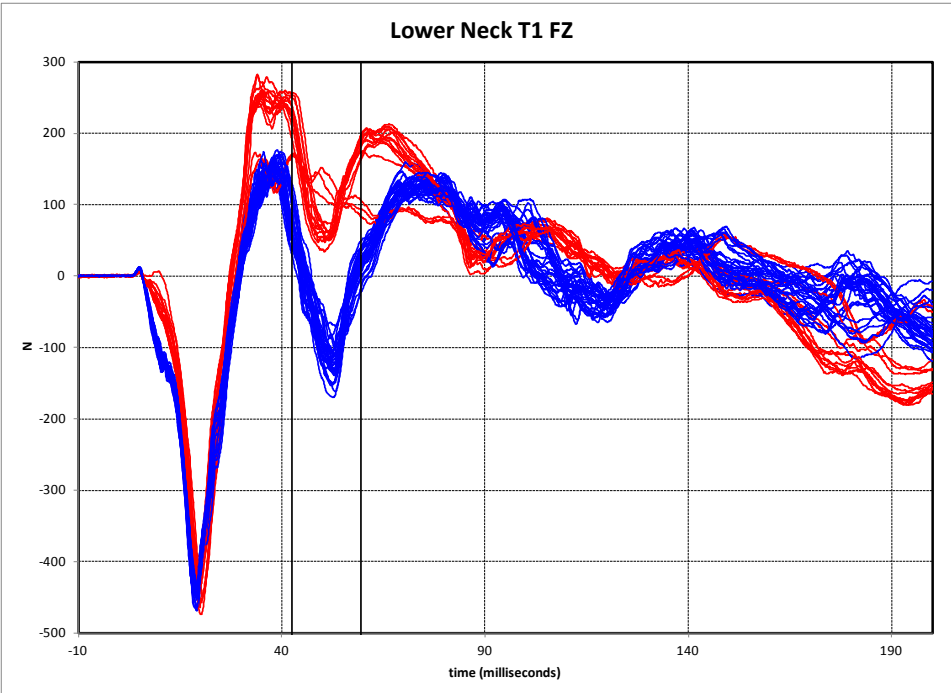
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



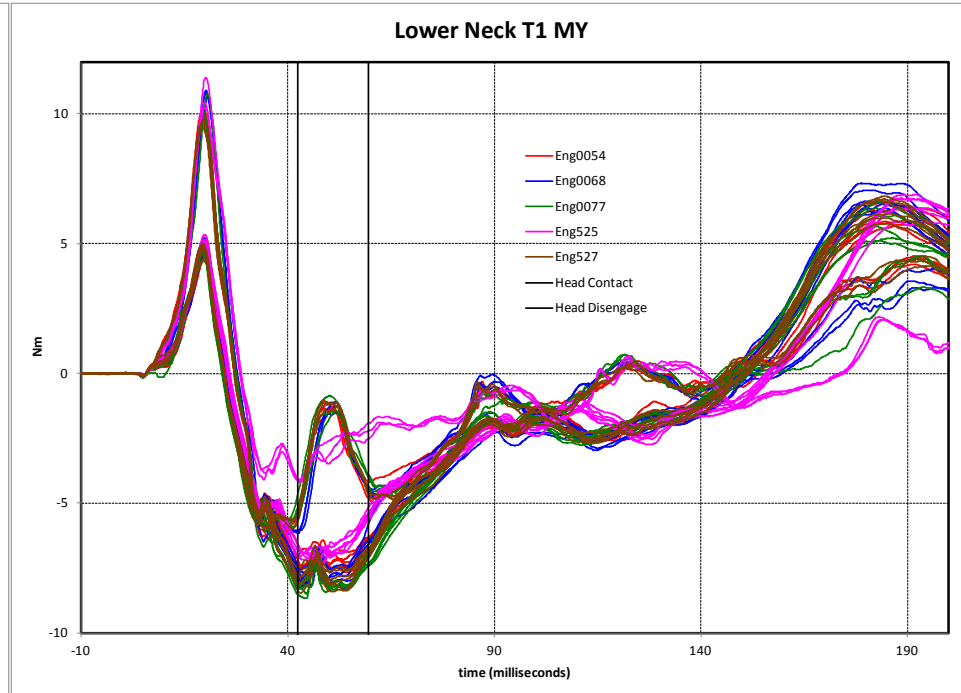
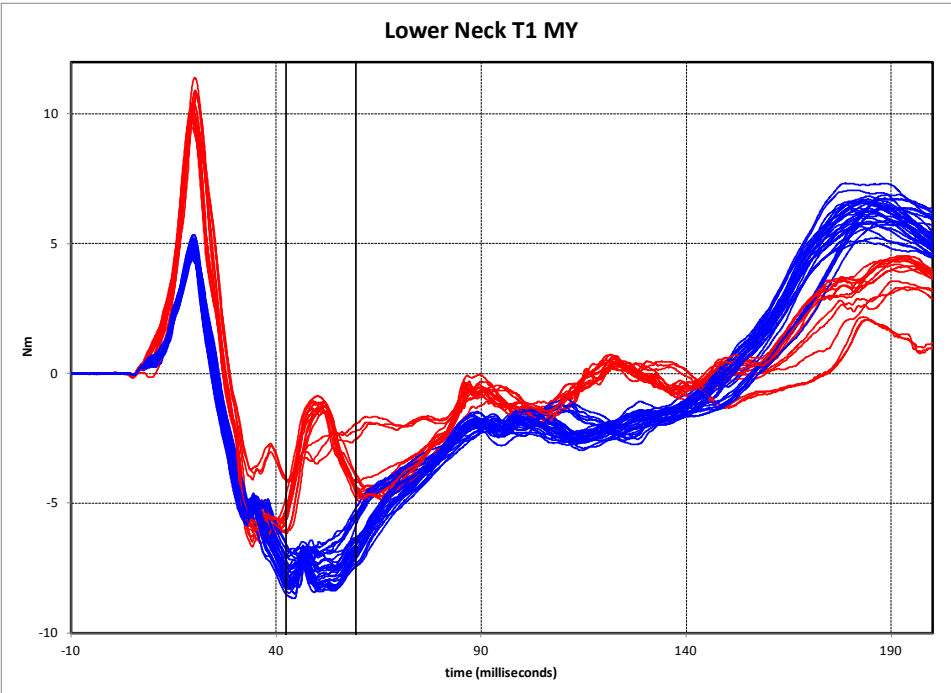
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



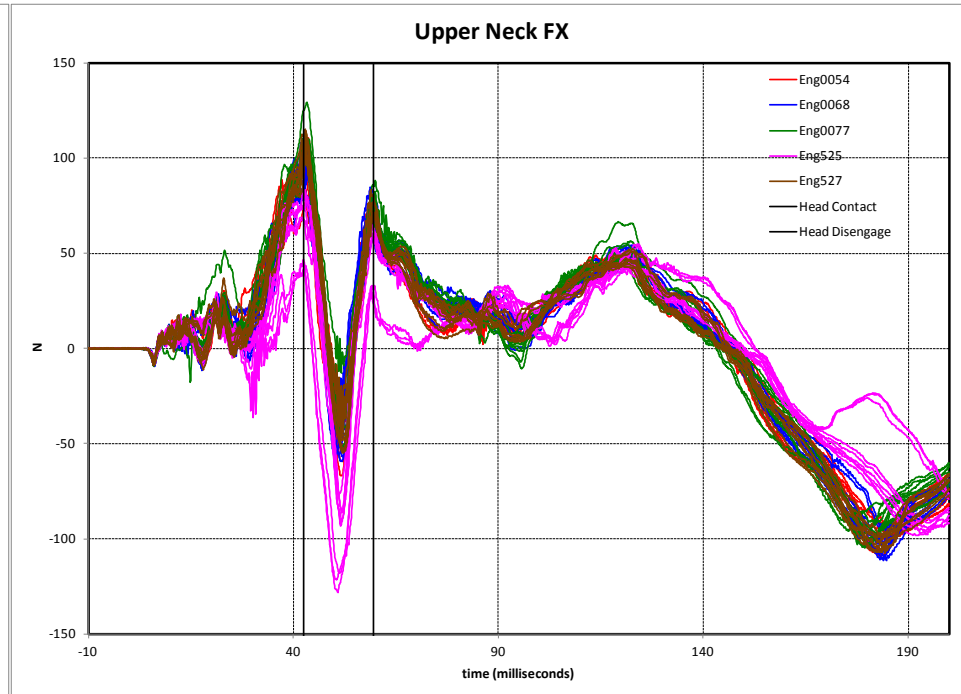
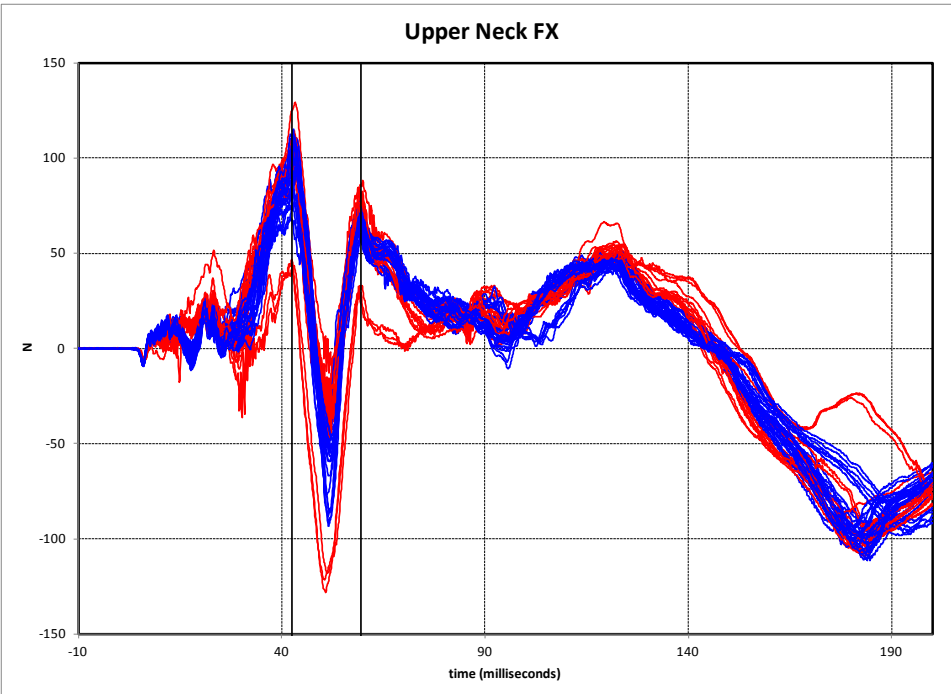
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



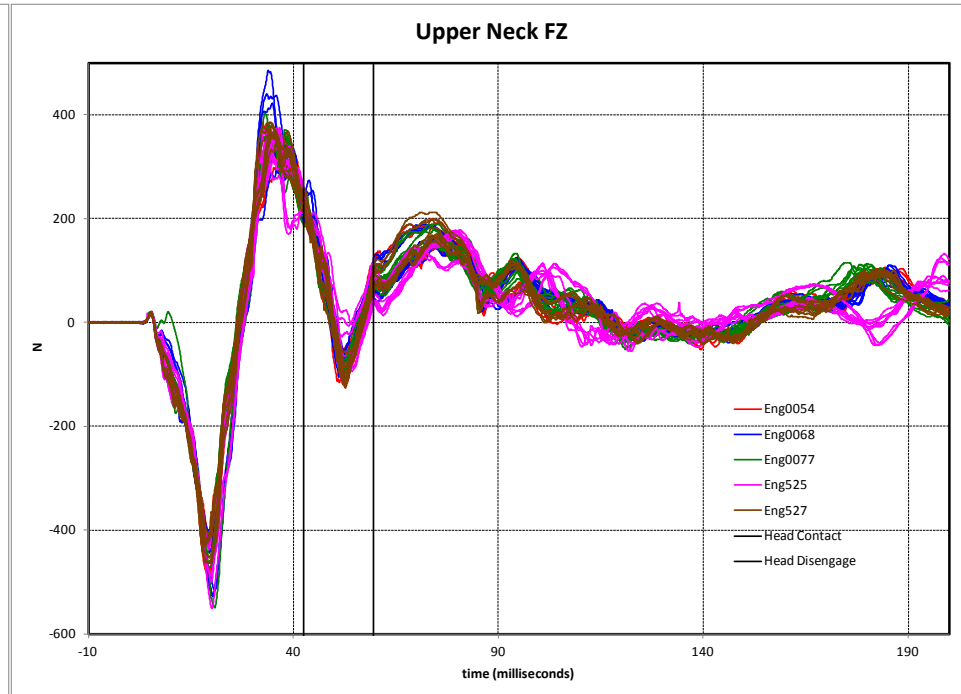
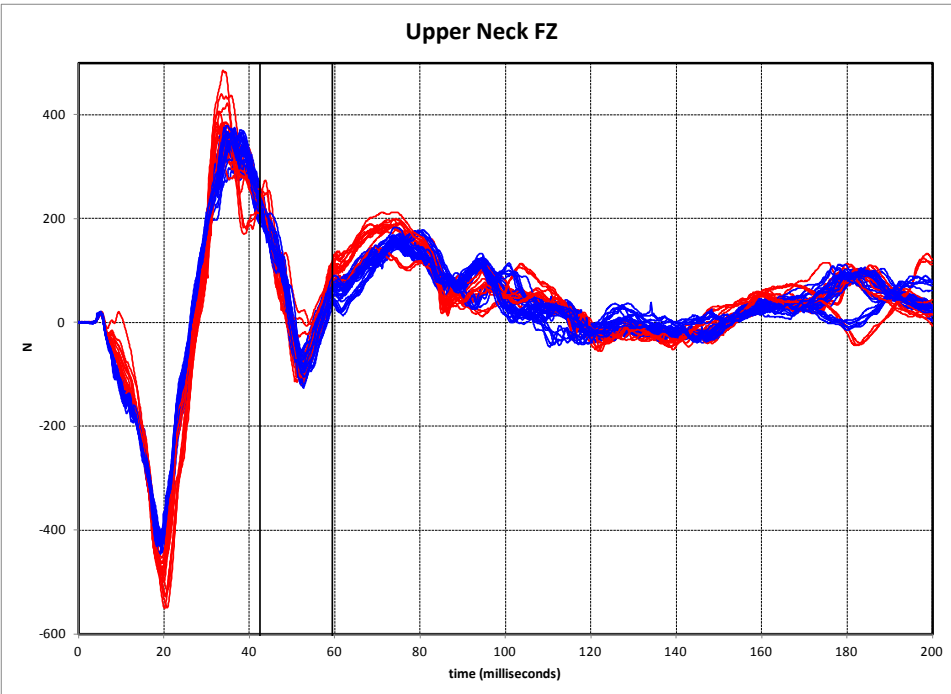
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



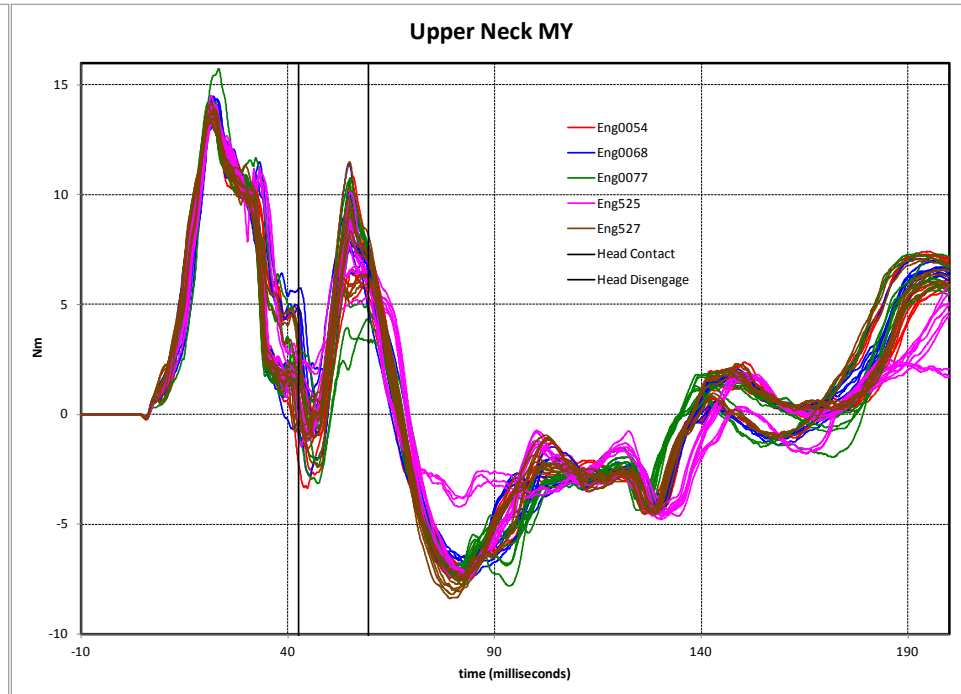
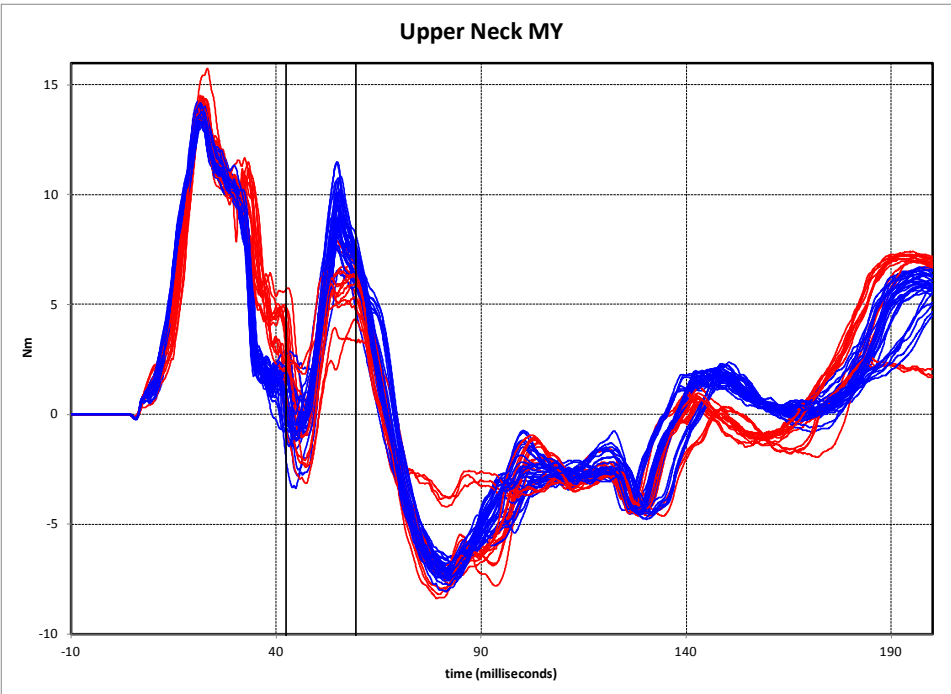
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



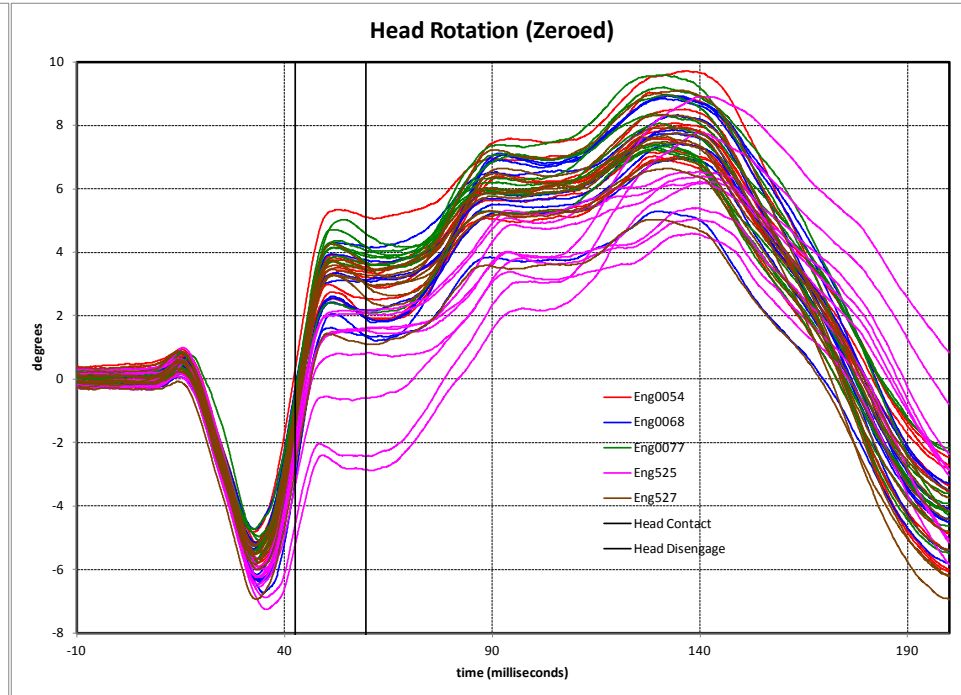
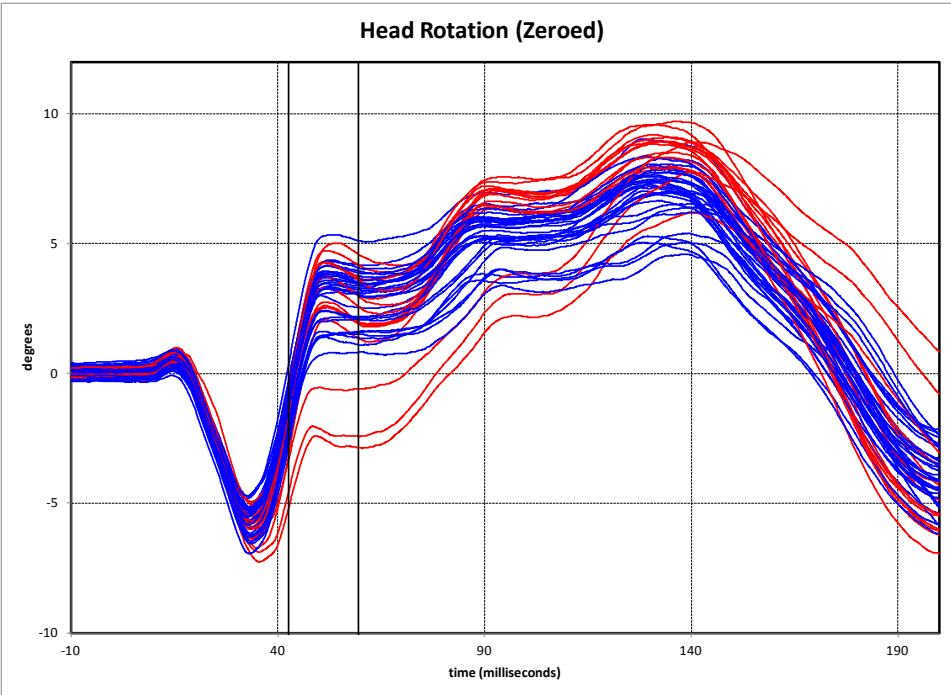
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



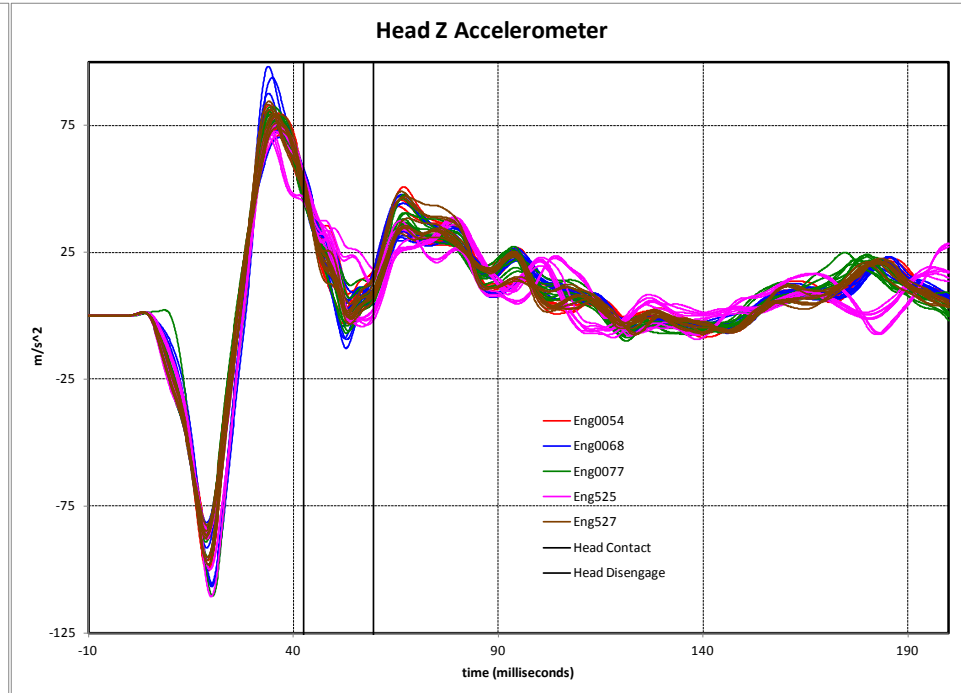
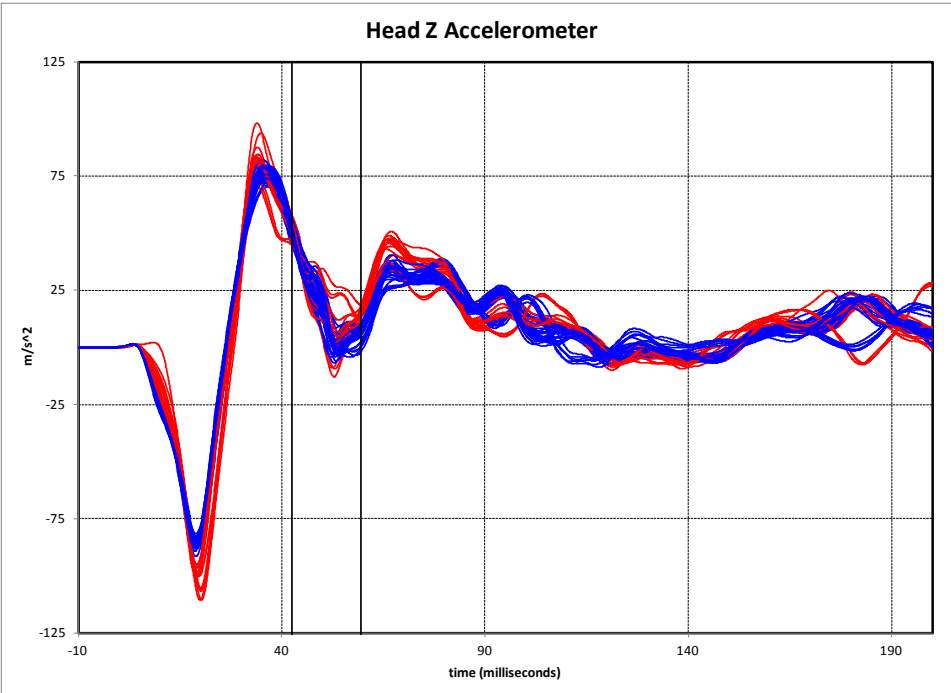
Mini-sled with seat back & head restraint



Red = Stiff; Blue = Normal bumpers



Mini-sled with seat back & head restraint

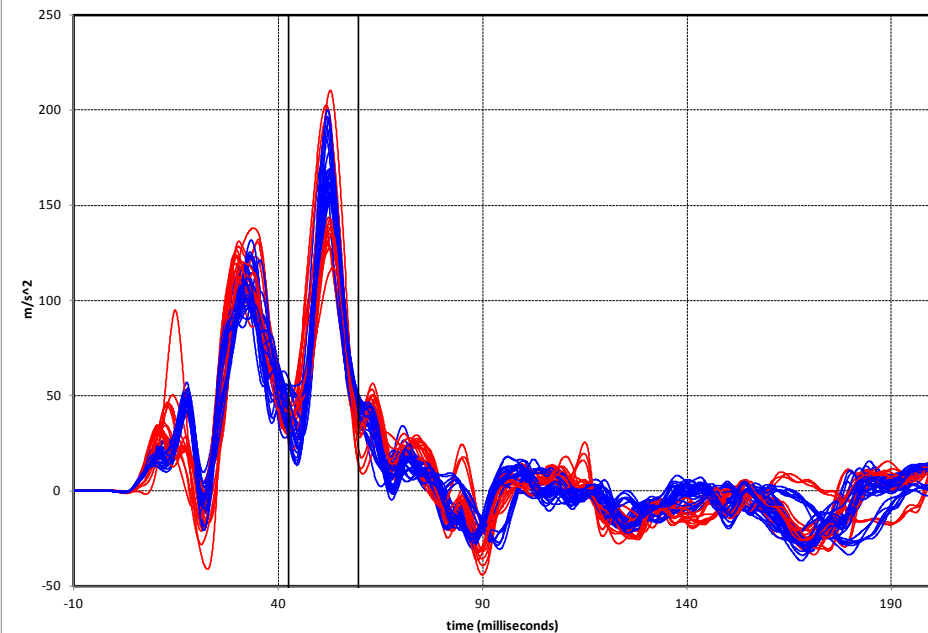


Red = Stiff; Blue = Normal bumpers

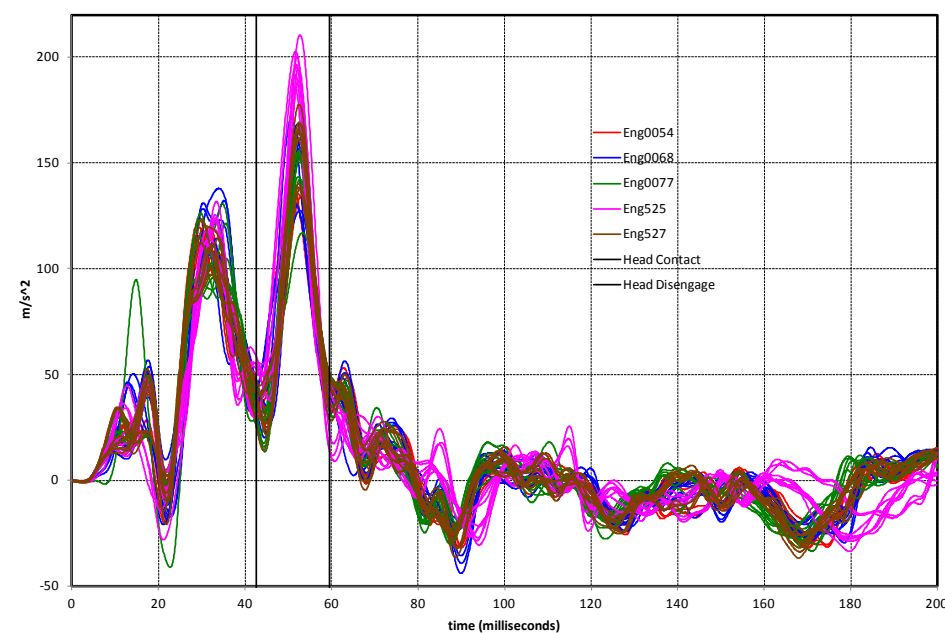


Mini-sled with seat back & head restraint

C4 Thorax X Accelerometer



C4 Thorax X Accelerometer

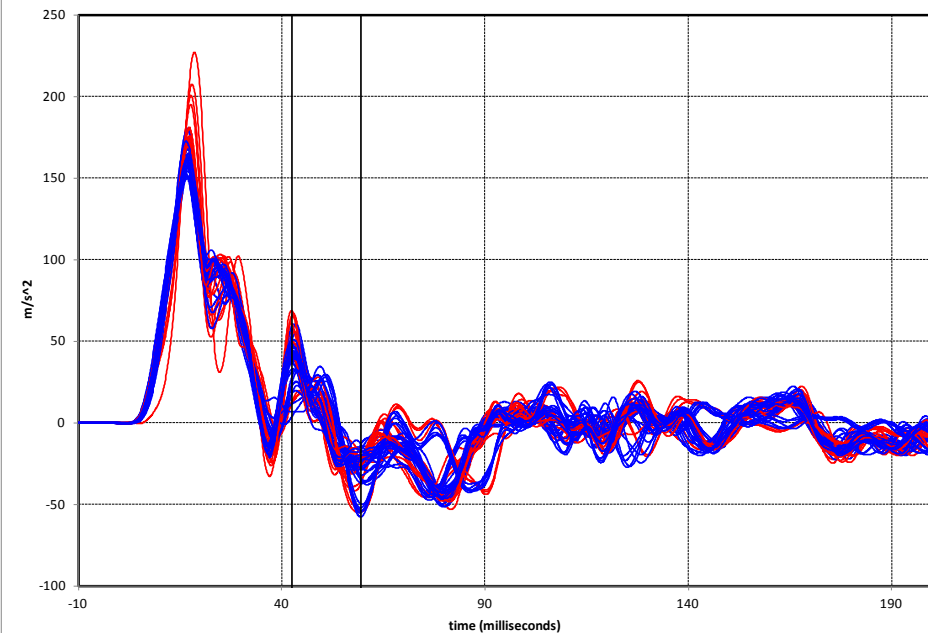


Red = Stiff; Blue = Normal bumpers

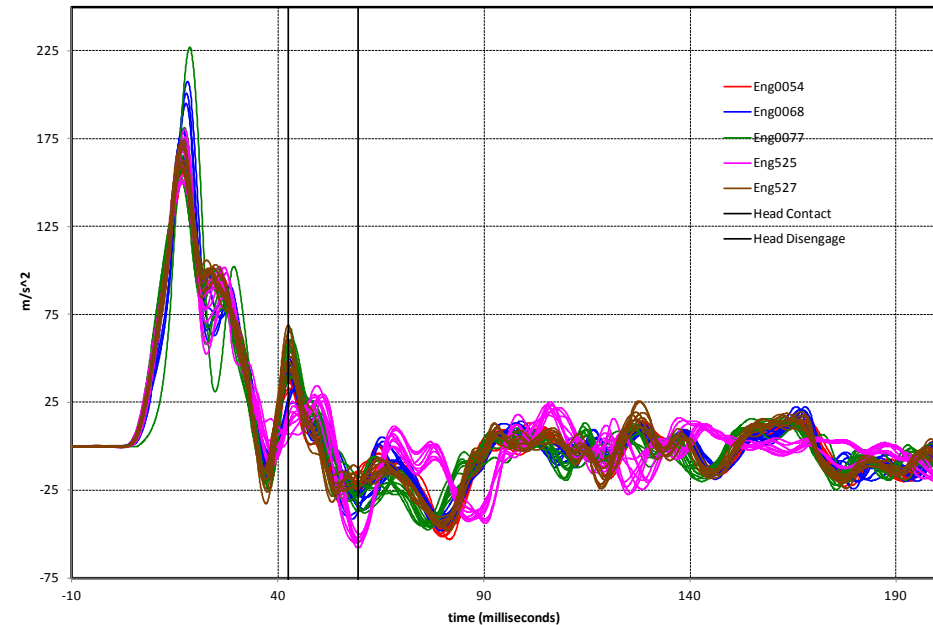


Mini-sled with seat back & head restraint

L1 Lumbar X Accelerometer



L1 Lumbar X Accelerometer



Red = Stiff; Blue = Normal bumpers



Mini-sled with seat back & head restraint

- Next steps
 - Write up test procedure
 - Do further testing
 - ▶ Do statistical analysis of effects/interactions
- Immediate improvements
 - Add wait time between tests
 - ▶ None was done to speed process
 - ▶ We know wait time is needed for jacket & bumpers
- Improve positioning procedure



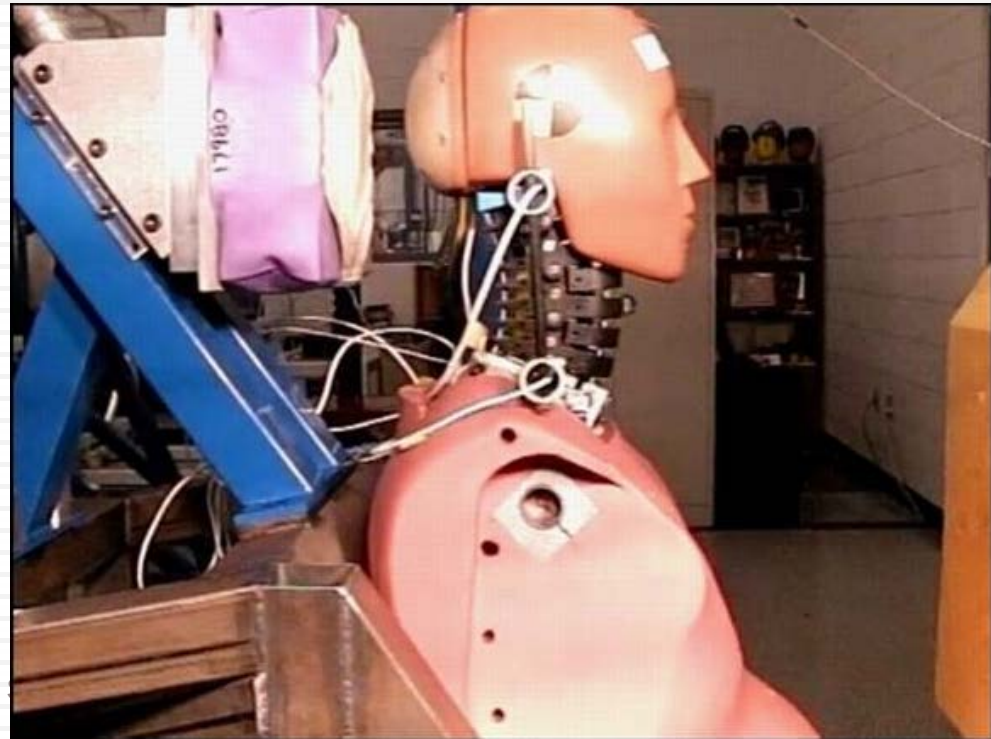
Mini-sled with seat back & head restraint

- *Need to make sure this effect can be replicated!*
- Future testing needed
 - Dummies 0068, 0100, 0054, 0077 from study
 - Repeat bumpers of varying stiffnesses with two jacket stiffnesses over jacket corridor
 - Swap bumpers in regions on 1 or more spines
- Create corridors based on dummies in R&R study
- Check on R&R in lab and between labs



Tests Under Development

Mini-sled WITH Head Restraint



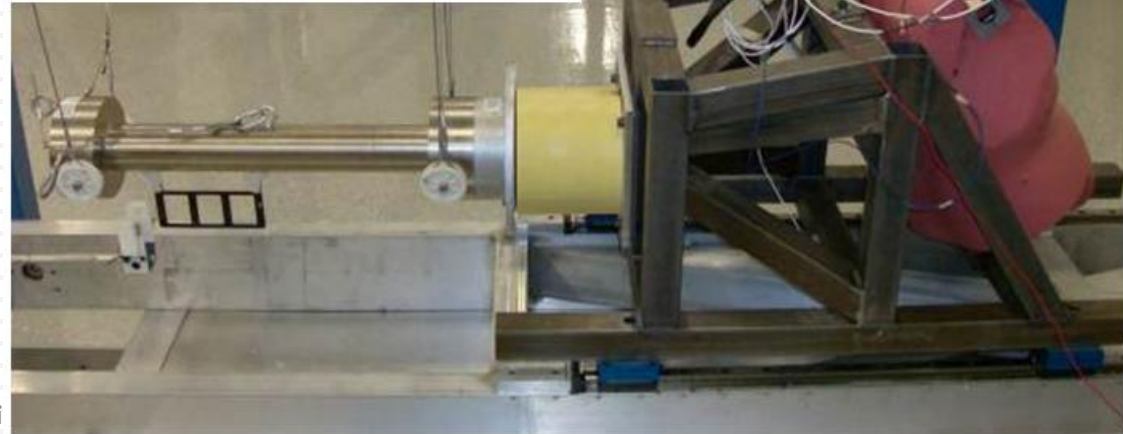
Mini-sled WITH Head Restraint

- Didn't clearly distinguish dummies before and after rebuild
- Probably not useful if the new back support mini-sled can clearly distinguish dummies
 - Recommend dropping this test if these results are confirmed



Tests Under Development

Mini-sled without head restraint



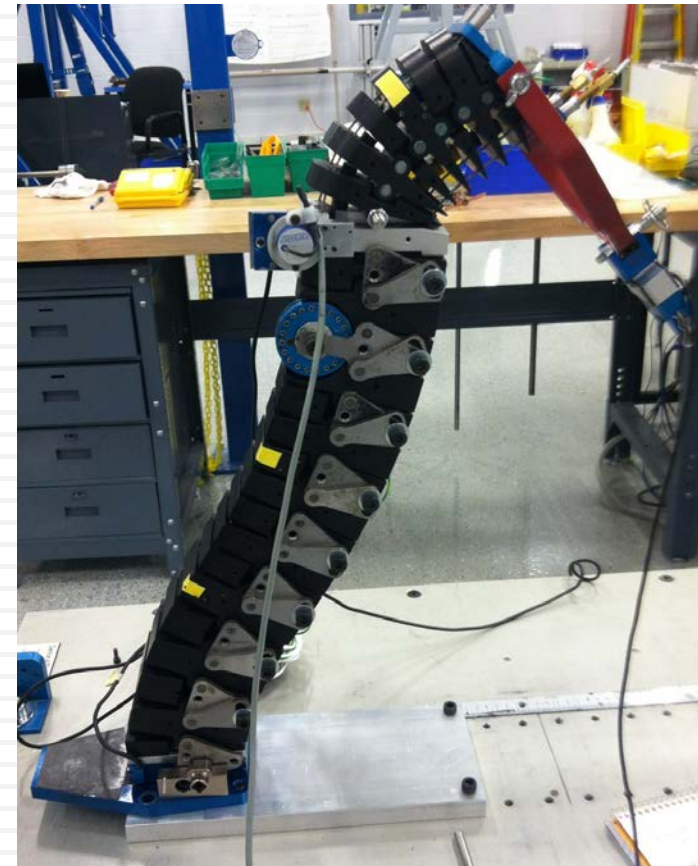
Mini-sled without head restraint

- Current certification used to setup dummies
 - Verifies spine and muscle substitute adjustment
 - Allows adjust of damper
 - Verifies neck bumper function
 - This test needs to be maintained for these purposes
- Limitations
 - Does not clearly detect thorax/lumbar bumper differences
 - Indicates jacket differences, but corridors to control jacket not possible as differences are small
- Possible improvements
 - Verify lab to lab reproducibility
 - Adjust corridors based on 4 R&R dummies?



Tests Under Development

Spine quasi-static bending (flexion & extension)



Spine quasi-static bending

- Shows very poor repeatability and reproducibility
- Does not clearly show bumper differences between R&R dummy spines pre & post rebuild
- ***Recommend no further work on this test!***



Tests Under Development

Bumper Compression On Spine



Bumper Compression On Spine

- Probably
 - An absolutely necessary test for maintaining dummy
 - Can be an inspection test to be done as part of maintenance rather than a certification test
 - ▶ As long as mini-sled with back support proves to detect dummy differences adequately
- Currently doing R&R testing to verify procedure works properly
- Further work
 - Confirm R&R (within 1 lab and between labs)
 - Finish building parts for all vertebra locations
 - Collect test data
 - ▶ Dummies 0054, 0068, 0077, 0100 from
 - ▶ Various bumper stiffnesses going into mini-sled with back support work
 - Establish corridors on R&R dummies (and/or similar bumpers)



Tests Under Development

Jacket Only Impact

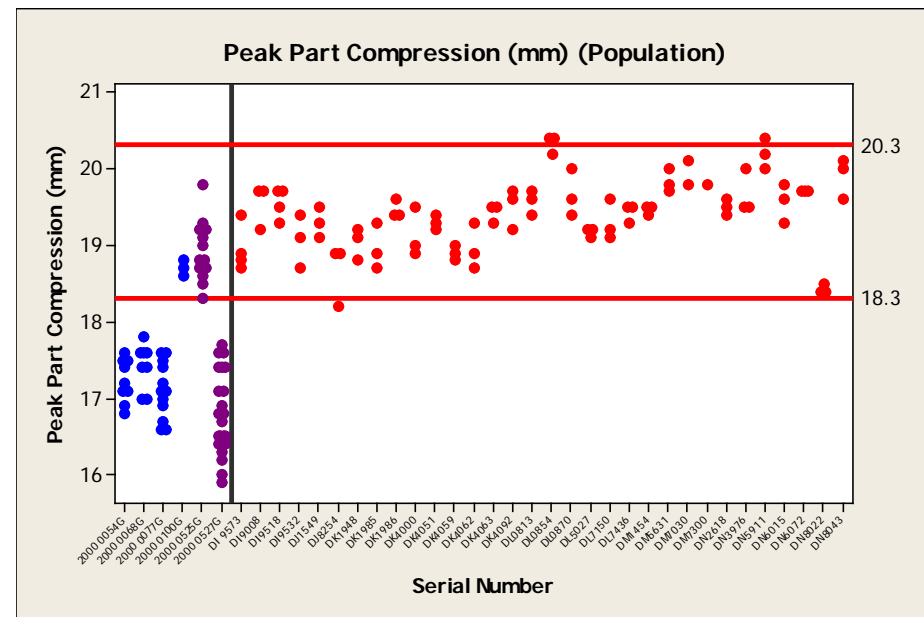
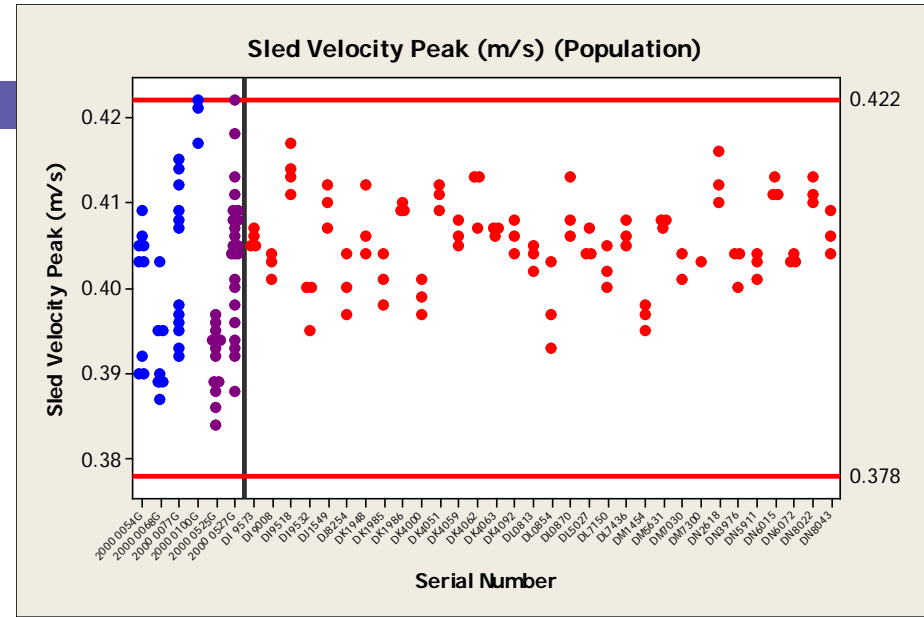
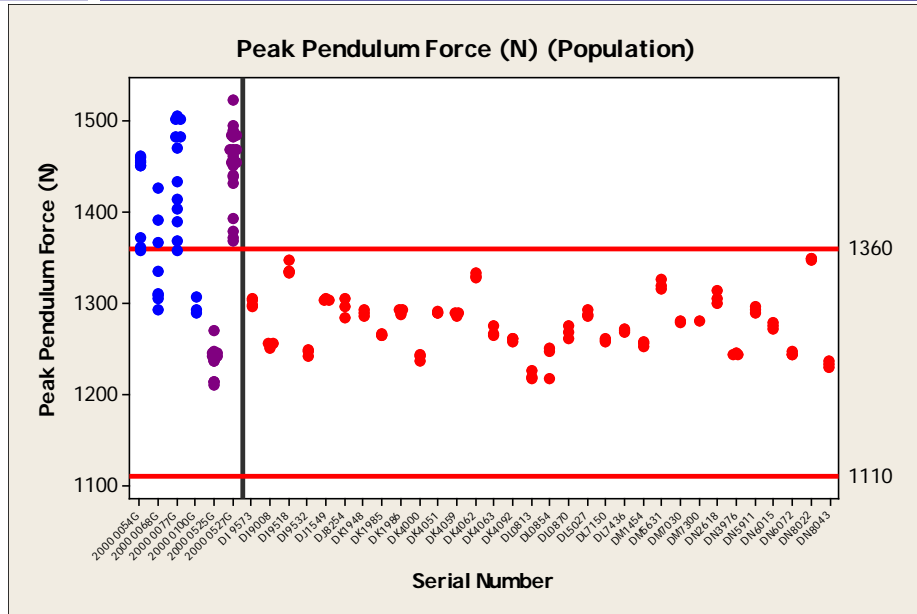


Jacket Only Impact

- Detailed study done on
 - 4 R&R jackets
 - Excluding original R&R jackets that gave differences
 - Lab to lab variation testing R&R jackets
 - Checking practicality of production to corridors
 - Some possible sources of test variation
- Conclusions reached and recommendations made for parameters, corridors and test improvements



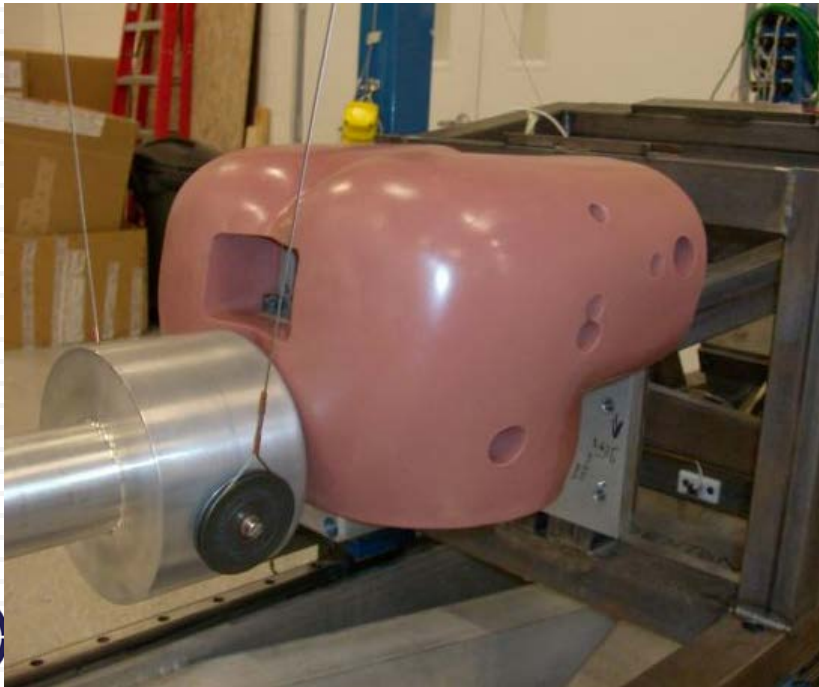
Jacket Only Impact



- New jacket corridors proposed
 - Pendulum impact: 1110N - 1360N (+/- 10%)
 - Peak sled velocity: 0.378m/s – 0.422m/s (+/-6%)
 - Peak part compression: 18.3mm – 20.3mm (+/-5%)

Tests Under Development

Pelvis Impact (back & bottom)

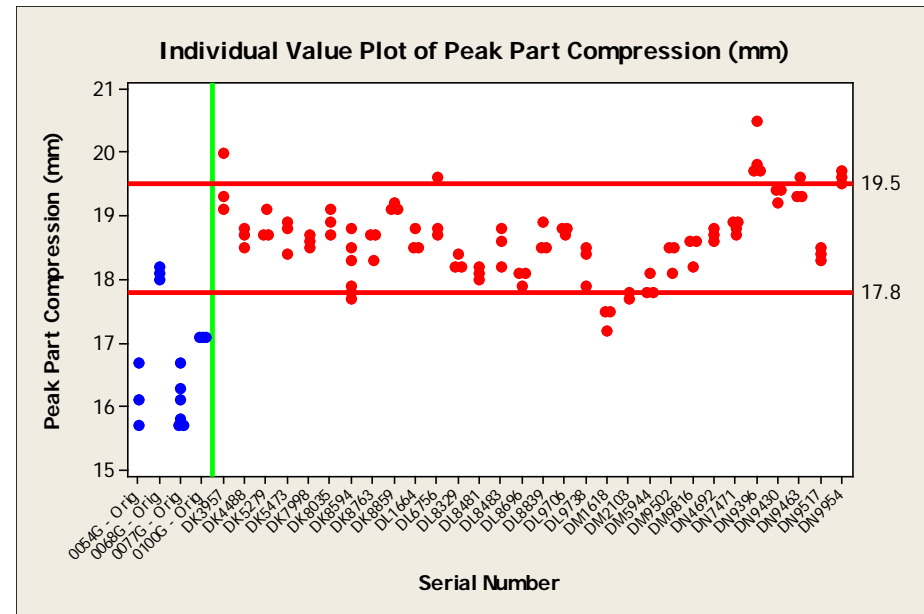
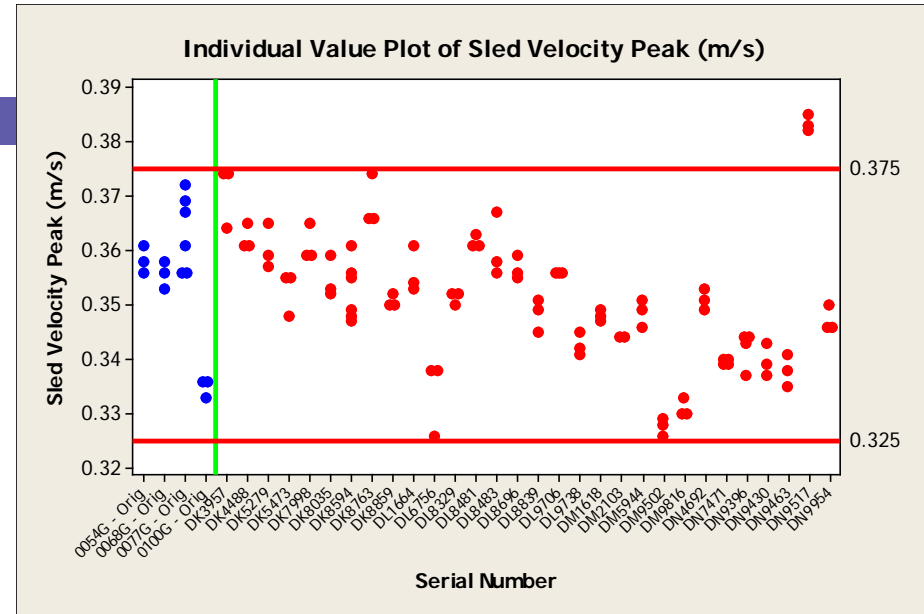
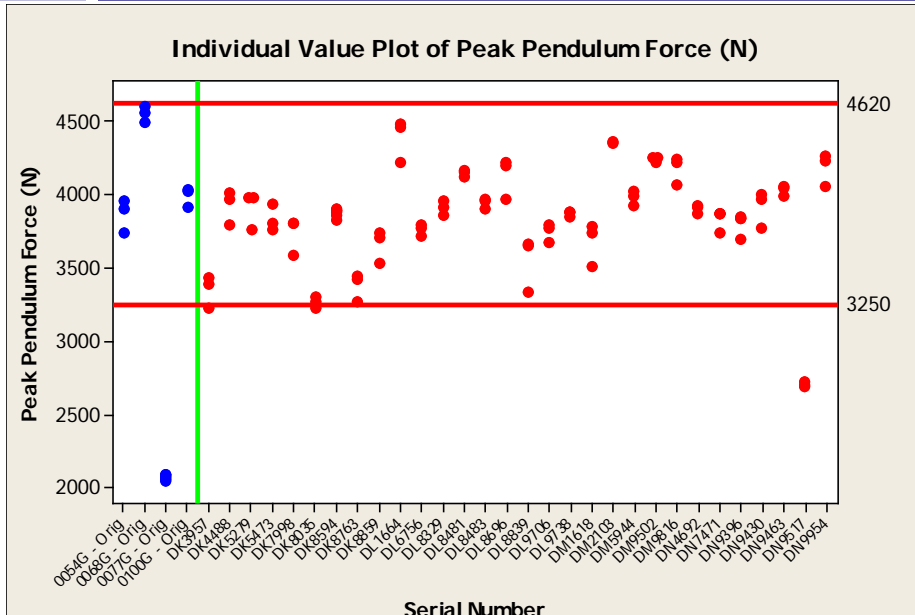


Pelvis Impact (back & bottom)

- Detailed study done on
 - 4 R&R pelvises, back and bottom
 - Excluding original R&R pelvises that gave differences
 - Lab to lab variation testing R&R pelvises
 - Checking practicality of production to corridors
 - Some possible sources of test variation
- Conclusions reached and recommendations made for test to use, parameters, corridors and test improvements
 - Only bottom of pelvis test needed



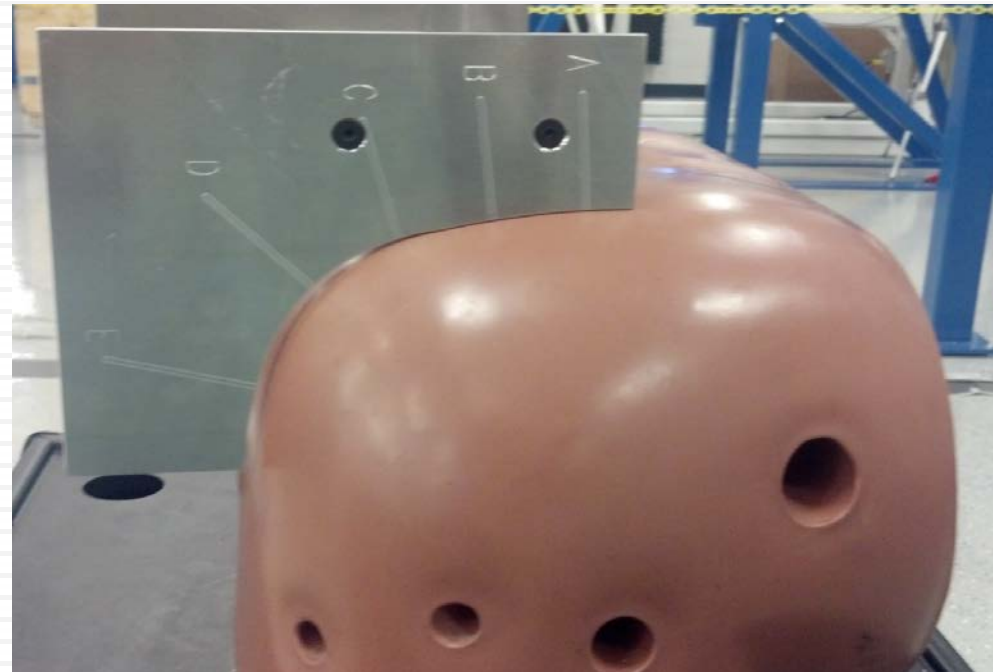
Pelvis Bottom Impact



- Pelvis bottom corridors proposed
 - Pendulum impact: 3250 N – 4620 N (+/- 17%)
 - Peak sled velocity: 0.375 m/s – 0.325 m/s (+/-7%)
 - Peak part compression: 17.8 mm – 19.5 mm (+/-5%)

Tests Under Development

Pelvis Shape Check



Pelvis Shape Check

- Inspection test to make sure pelvis has not shrunk too much
 - Plate with 5 locations for each side
 - Measure pelvis offset with a steel ruler
 - ▶ Rough check to catch gross deformations
 - ▶ If we can eventually set limits, a go/no go gage could be used
- Just starting to work with this
 - Need to test multiple old pelvises
 - Verify R&R is sufficient
 - Set corridors



Tests Under Development

Pelvis Quasi-static Compression



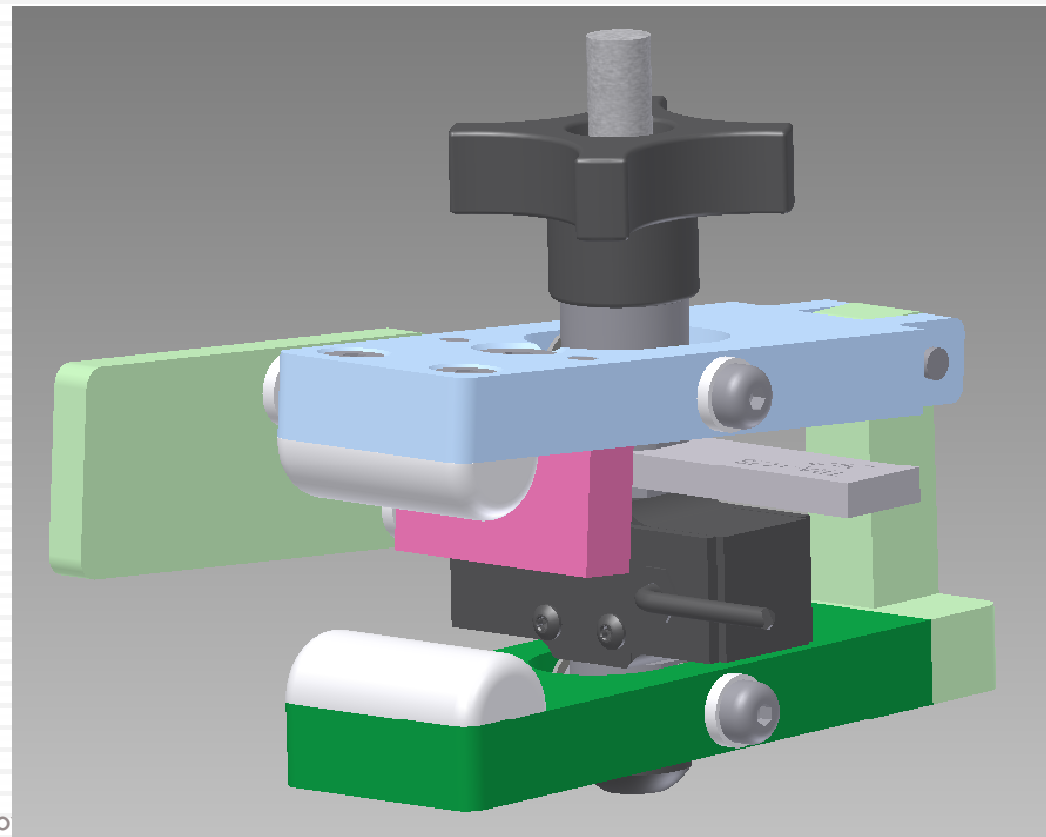
Pelvis Quasi-static Compression

- Inspection test to make verify dynamic impact failure is due to stiffness of flesh
- Just starting to work with this
 - Need to test multiple old pelvises
 - Verify R&R is sufficient
 - Set corridors



Tests Under Development

Jacket Quasi-static Compression



Jacket Quasi-static Compression

- Inspection test to make verify dynamic impact failure is due to stiffness of flesh
- Not yet started to work with this
 - Need to manufacture tool
 - Need to test multiple old jackets
 - Verify R&R is sufficient
 - Set corridors



Test Recommendations

Recommended Certification Tests

- Spine quasi-static setup
- Mini-sled without head restraint
- Mini-sled with seat back & head restraint
- Jacket only impact
- Pelvis only impact (bottom only)



Recommend Stopping Testing

- Mini-sled WITH head restraint
- Pelvis impact (back)
- Spine quasi-static bending



Recommended Inspection Tests

- Spine bumper stiffness
- Pelvis shape check
- Would be helpful but not essential for regulation
 - Pelvis quasi-static compression check
 - Jacket quasi-static compression check



Questions?