

Performance of head restraints as a function of seat back strength in rear impact sled tests

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Background

- NHTSA recently proposed an upgrade to the dynamic test option in FMVSS 202.
- The head rotation with respect to torso should not exceed 12 degrees for a 50th percentile male HIII dummy and 20 degrees for a 95th percentile male HIII dummy in a 17.5 km/h rear impact sled test.



FMVSS 202 Sled Tests

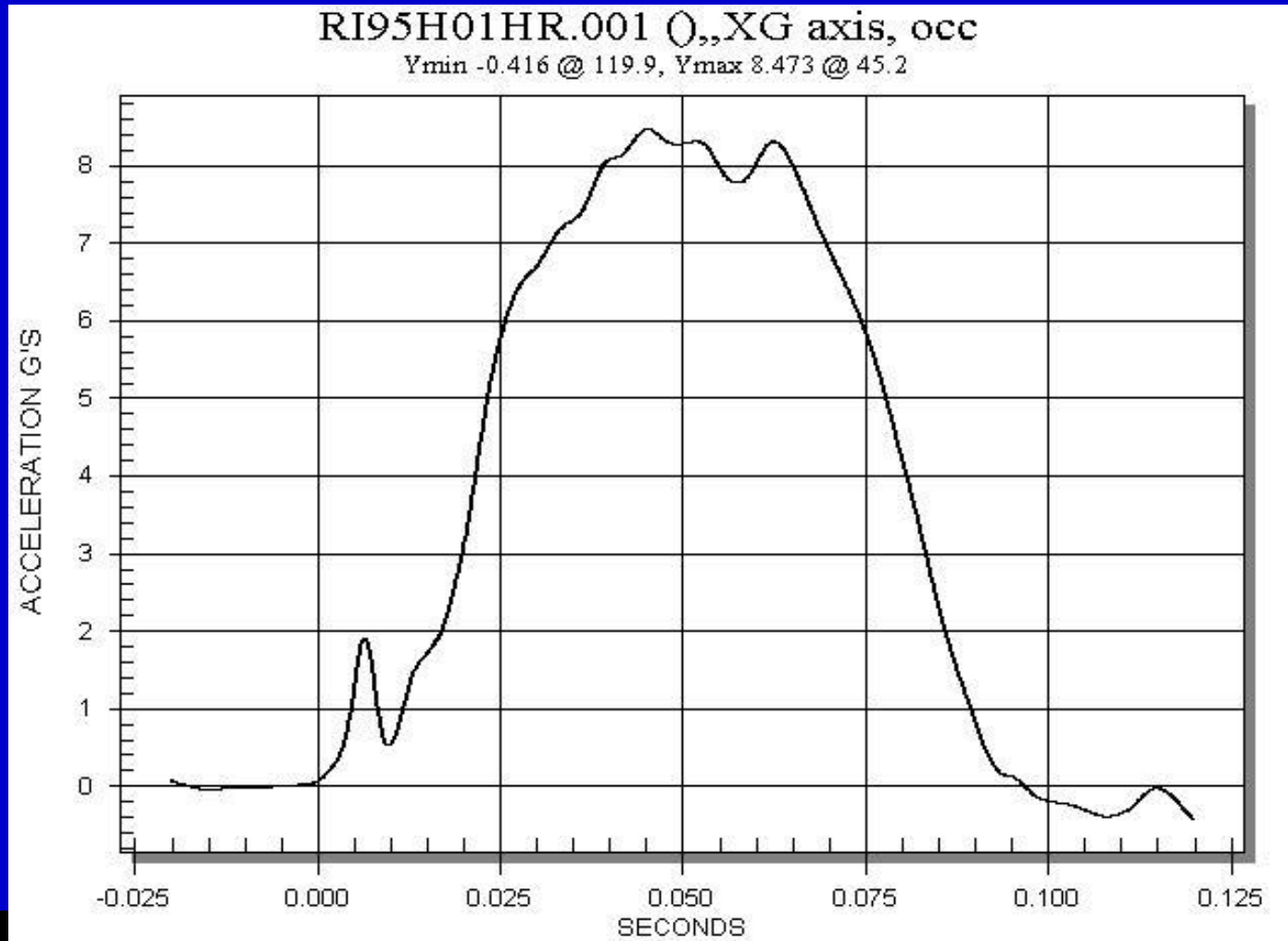
- To examine the performance of current seats with respect to the upgraded dynamic test:
- $\Delta V = 17.5$ km/h sled tests with OEM seats

Dummy	Head Restraint Height (mm)	OEM Seats
50% HIII	750	Taurus
50% HIII	800	Taurus, Volvo, Camry, Easi
95% HIII	800	Saab, Deville

Backset=50 mm in all tests



Typical Sled Pulse



Test with 50th % HIII male dummy in Taurus seat with 750 mm head restraint height



Seat rotation
=18 deg

Head rotation
= 42 deg.

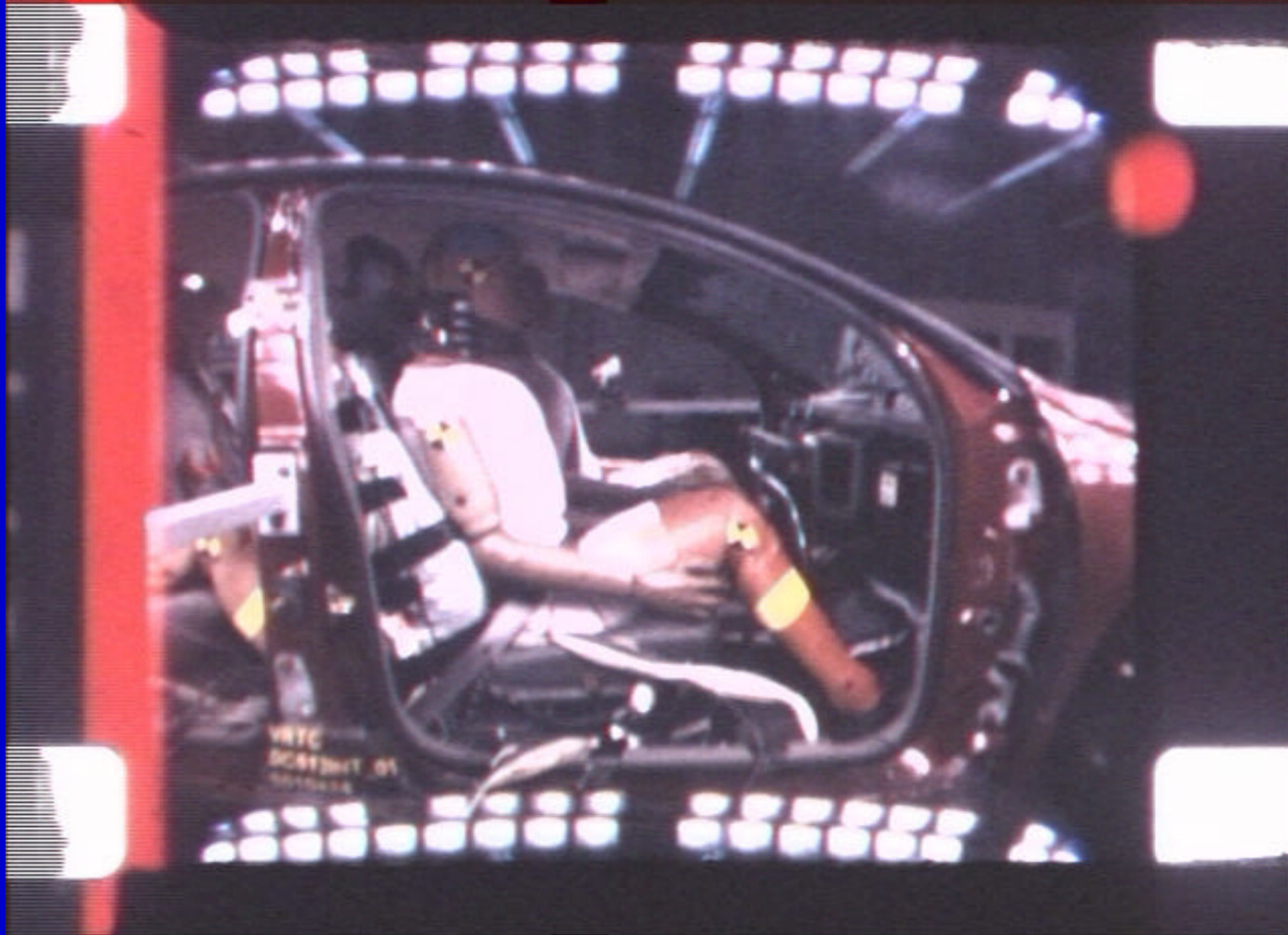
Nij (upper)=0.2

HIC15=23



Test with 50th % HIII male dummy in Volvo seat with 800 mm head restraint height

Frame Number : -0030



Seat rotation
=8.4 deg

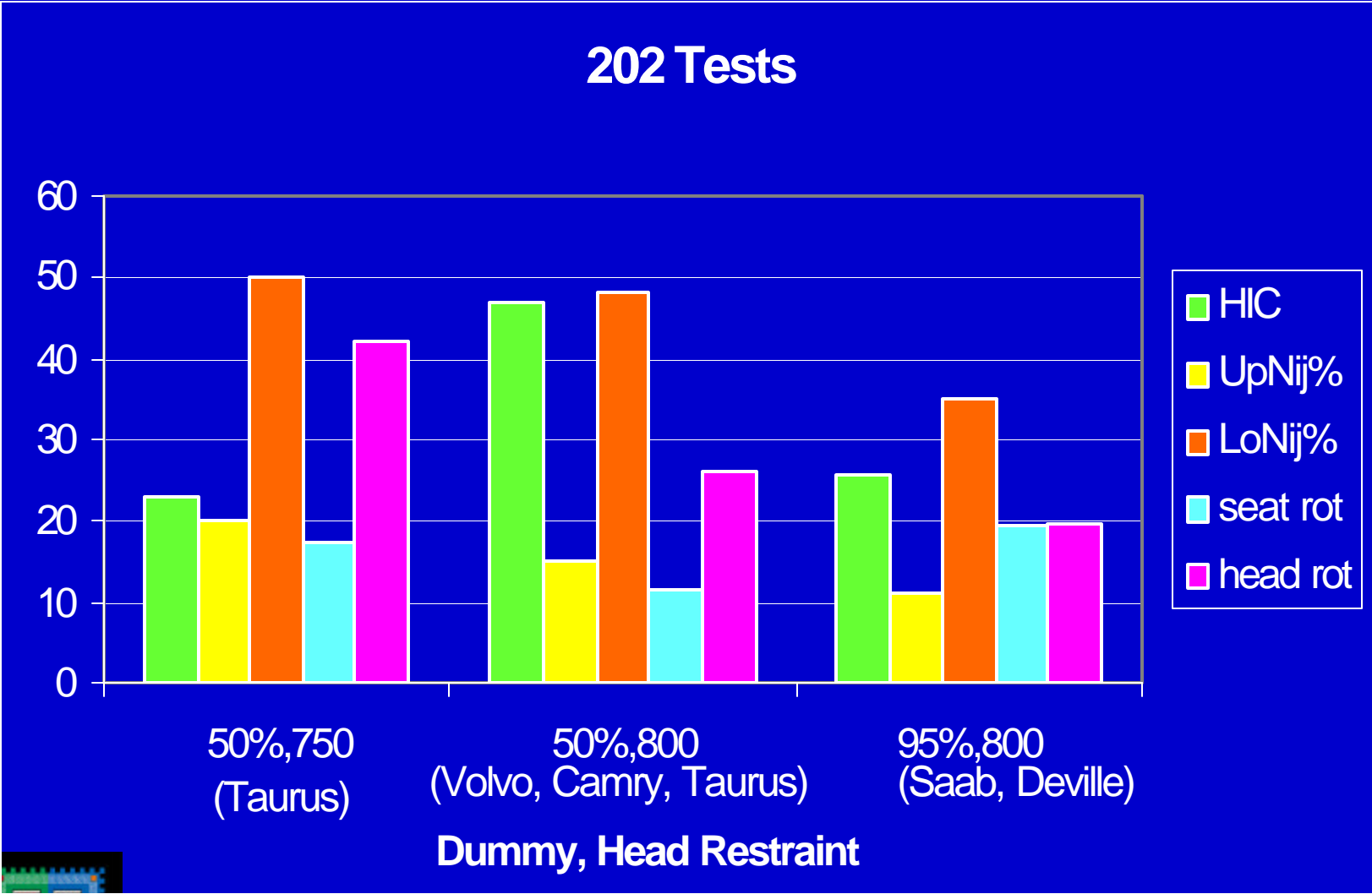
Head rotation
= 22 deg.

Nij (upper)=0.1

HIC15=35



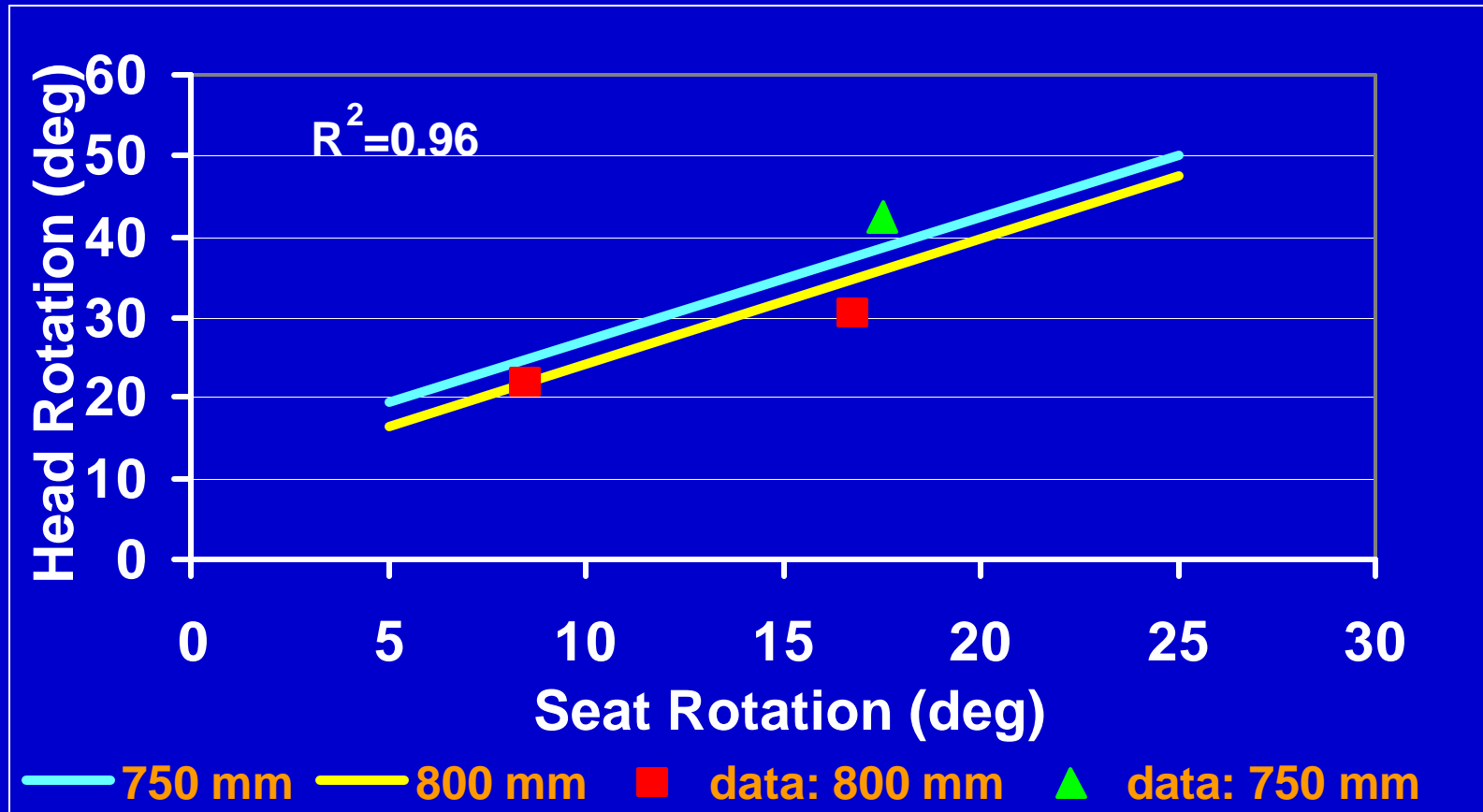
Summary of 202 Tests



Dummy, Head Restraint



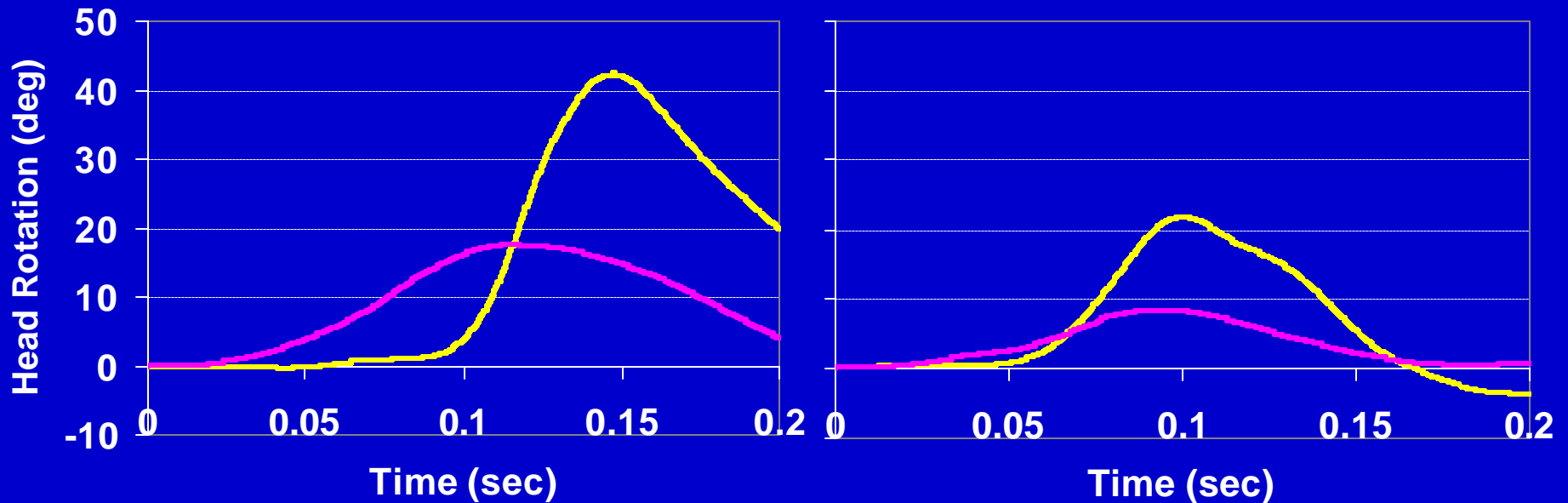
Relationship between Seat Rotation and Head Rotation in Optional 202 Dynamic Tests



Seat and head rotation in 202 sled tests with 50th percentile male

Taurus 99

Volvo 2000



— Head rotation with respect to torso — Seat Rotation

Peak N_{ij} occurs approximately at time of peak head rotation



Summary of Results

- Relative head rotation with respect to torso depends on the seat rotation as well as the head restraint height.
- Nij and other neck measures increase with the increase in relative head rotation.
- Seat cushion, head restraint flexibility, upholstery and other characteristics of the seat may also influence dummy head and torso kinematics

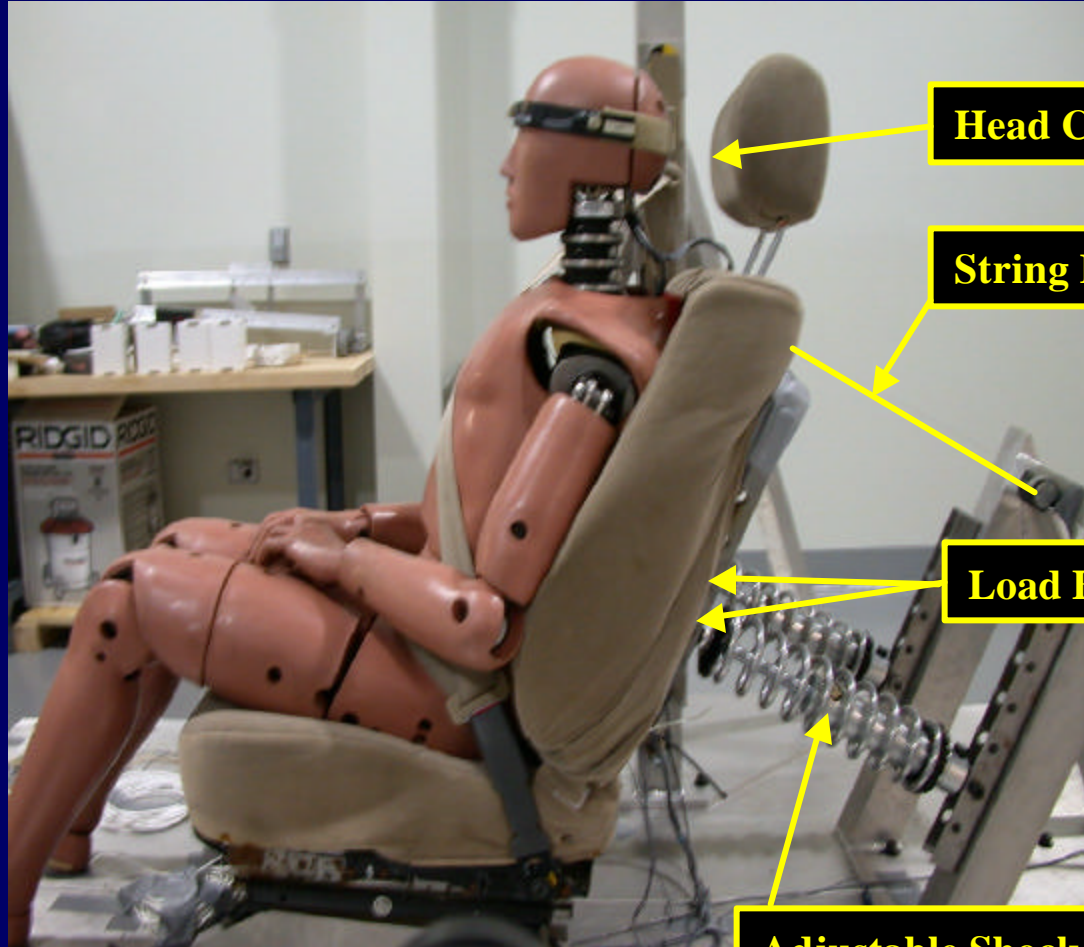


Seat Back Stiffness and Head Rotation

- Additional sled tests conducted with the FMVSS 202 pulse (17.5 km/h) using the 95th percentile male HIII dummy
 - Head restraint height=800 mm
 - Backset=50 mm
 - Seat strength = varied
 - Baseline: 35 Nm/deg
 - 200% : 70 Nm/deg
 - 500%: 175 Nm/deg
 - rigid



Tests Conducted at JHU-APL



Head Contact Switch

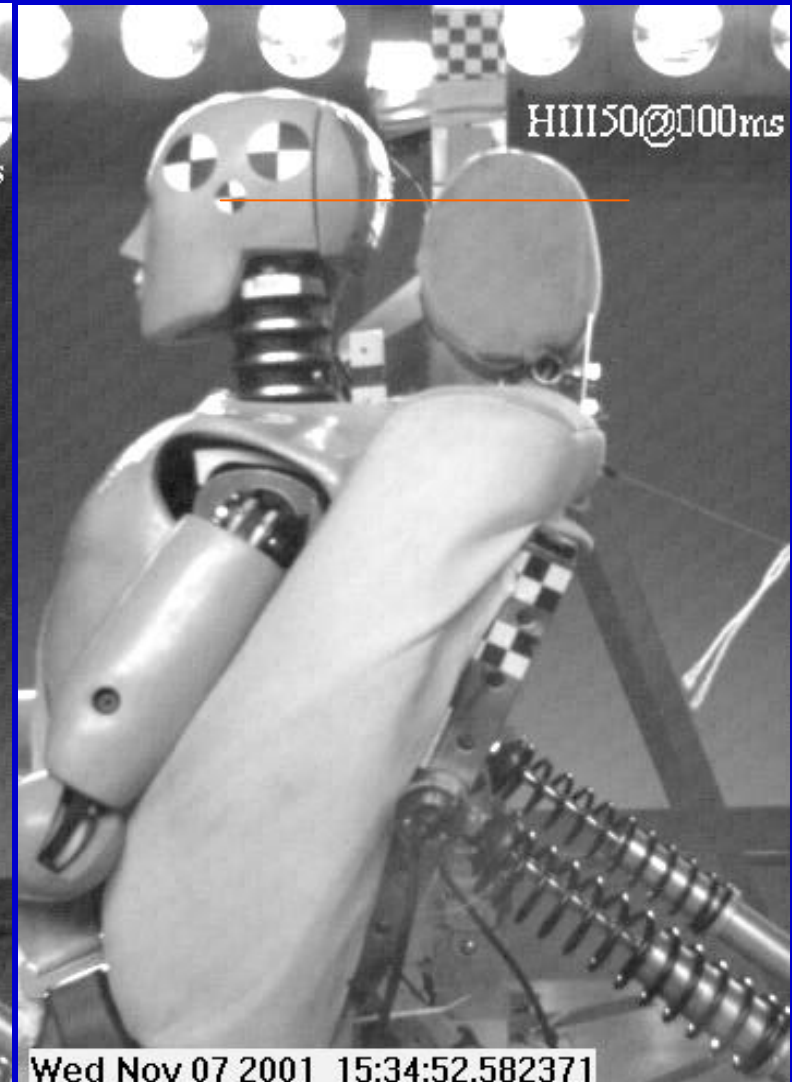
String Potentiometer

Load Bolts

Adjustable Shock Absorbers



Initial Position (95M vs. 50M) (800 mm head restraint height, backset=50 mm)



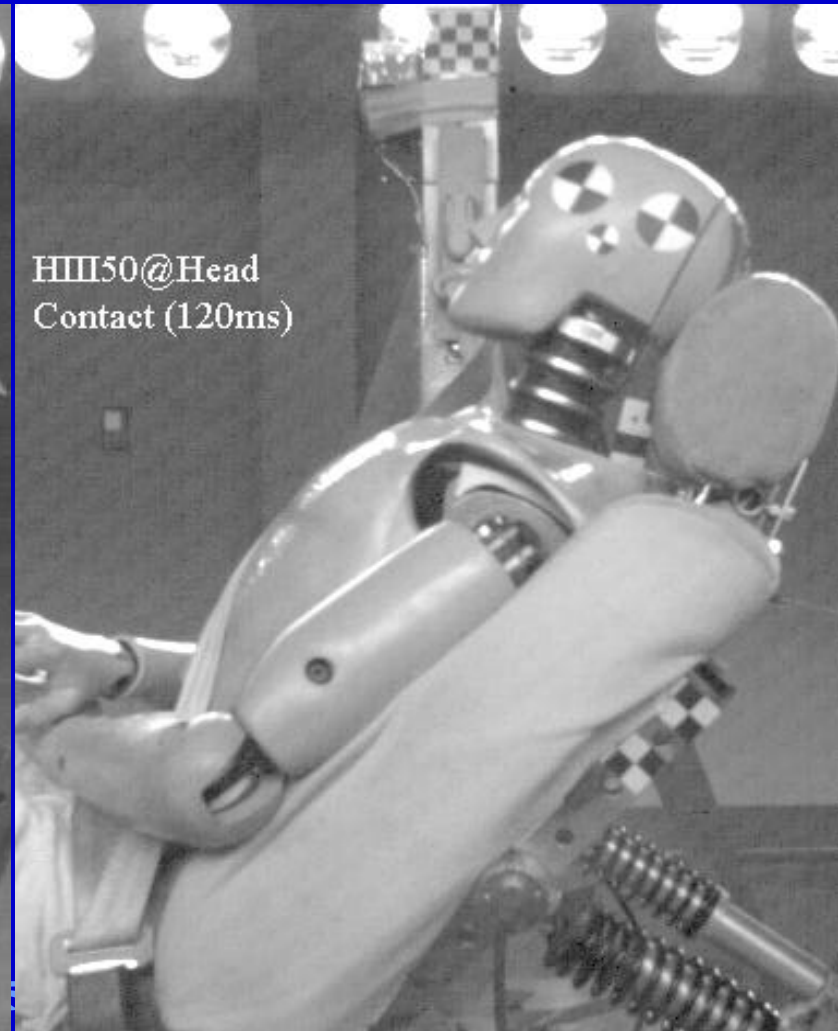
Head CG Level at Max Torso Height (95M vs. 50M)



Thu Jan 10 2002 14:18:20.047661

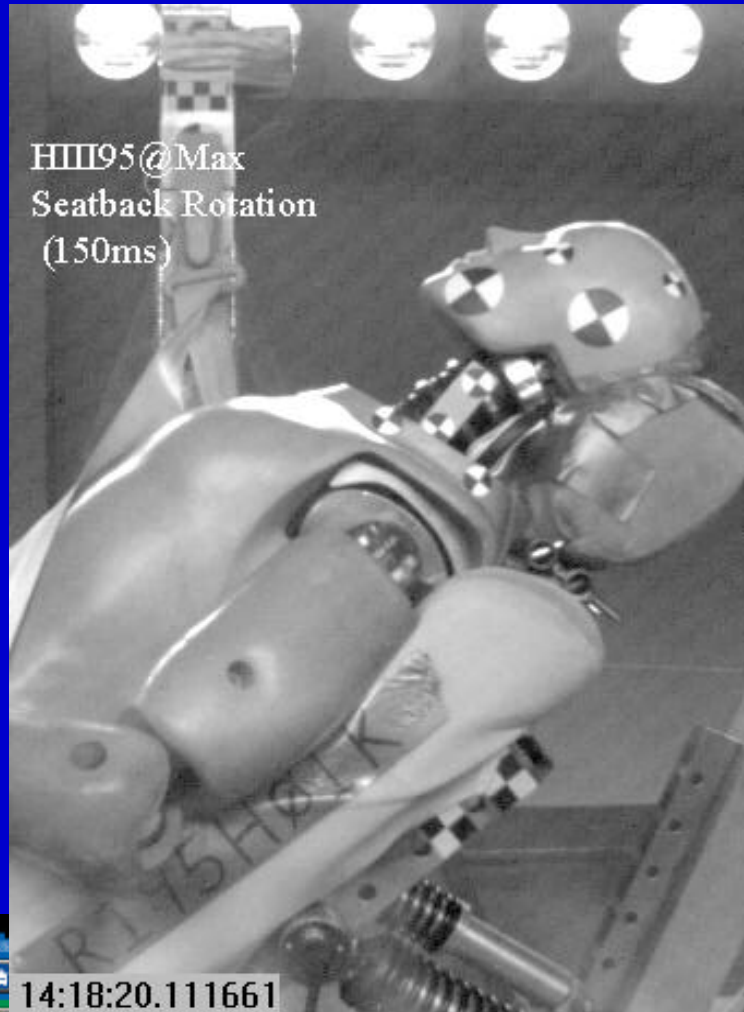


Initial Head Contact (95M vs 50M)



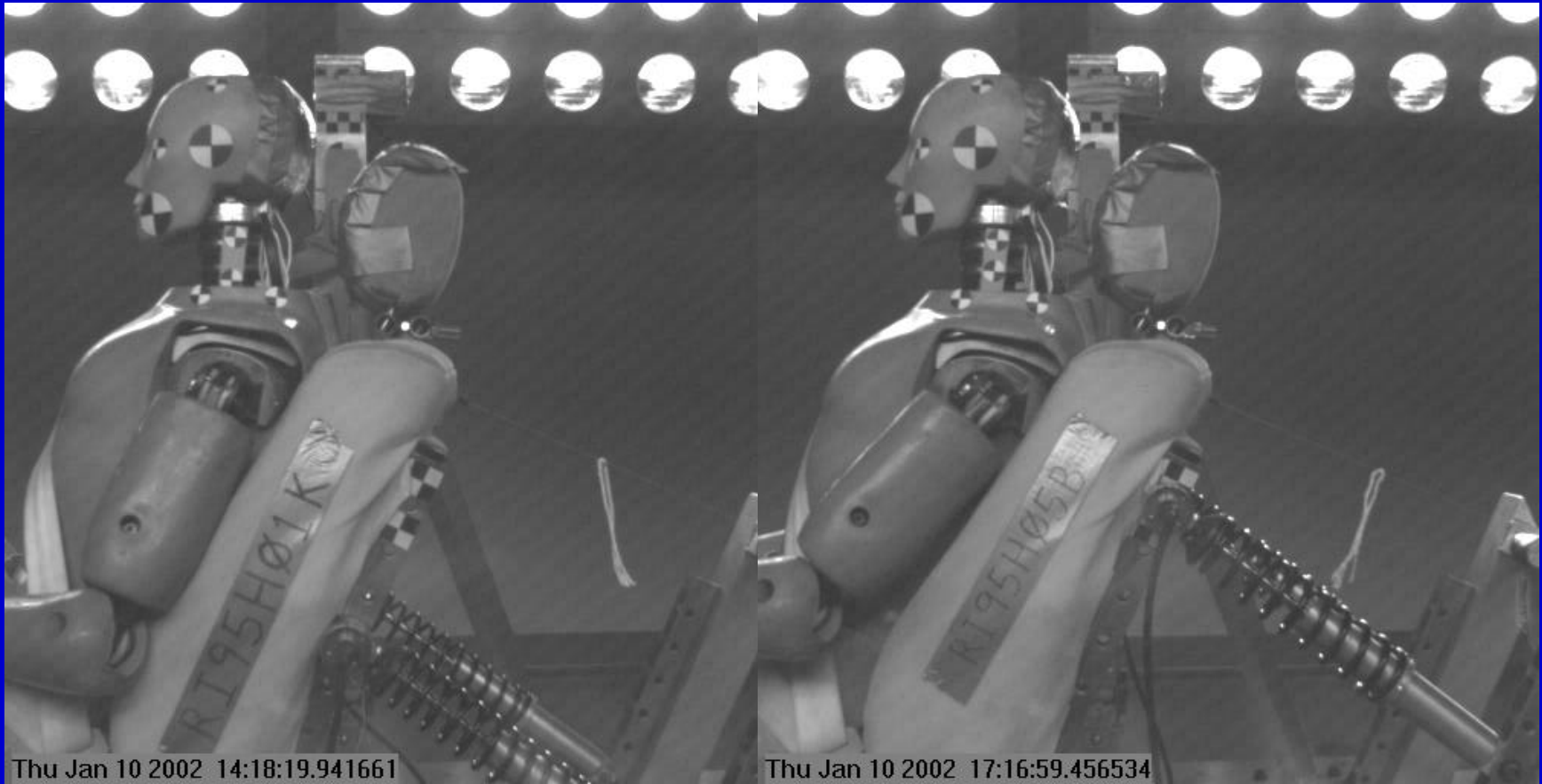
14:18:20.086661

Max Head Rotation (95M vs 50M)



14:18:20.111661

Effect of Seatback Stiffness on Dummy Kinematics

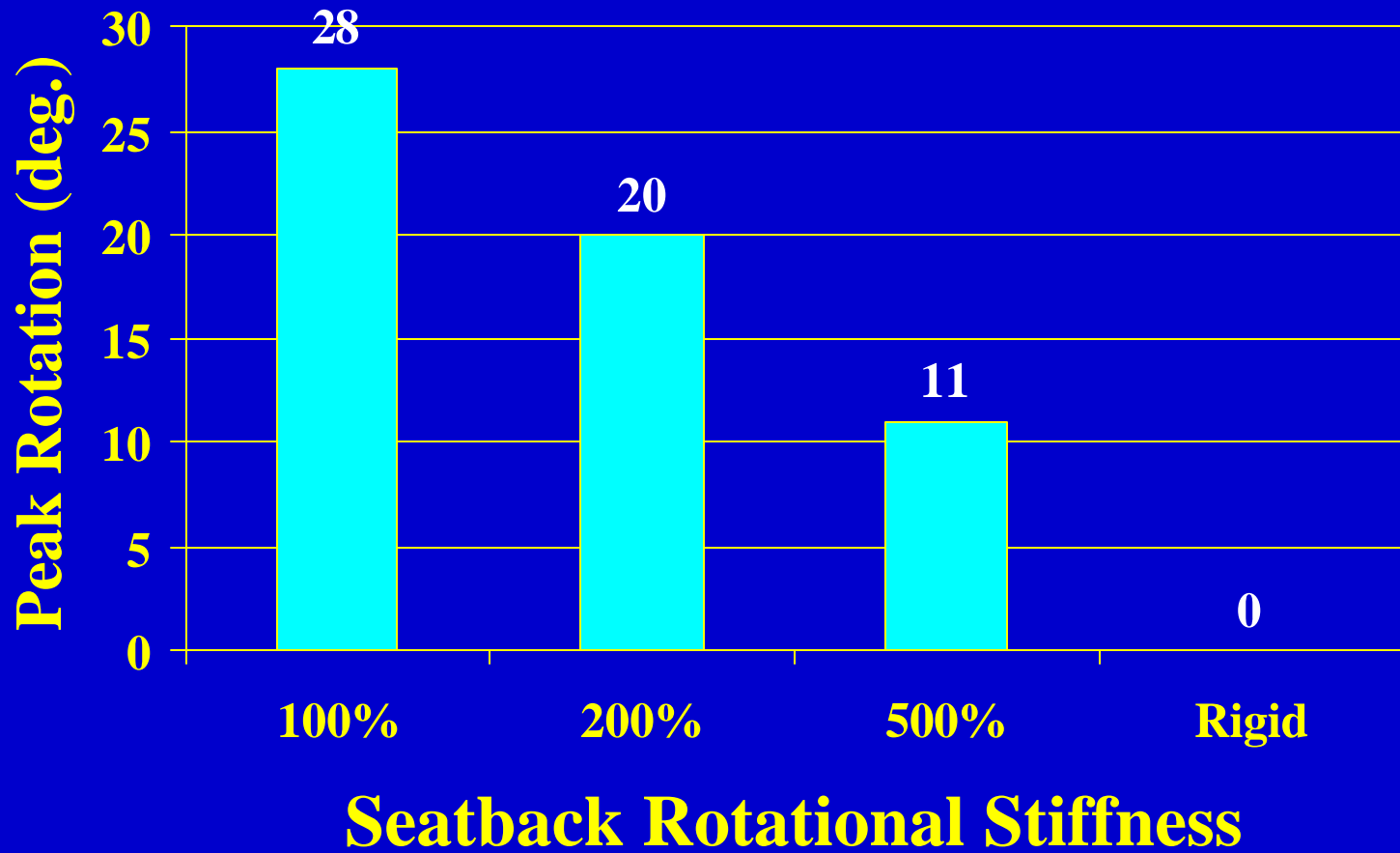


Baseline stiffness

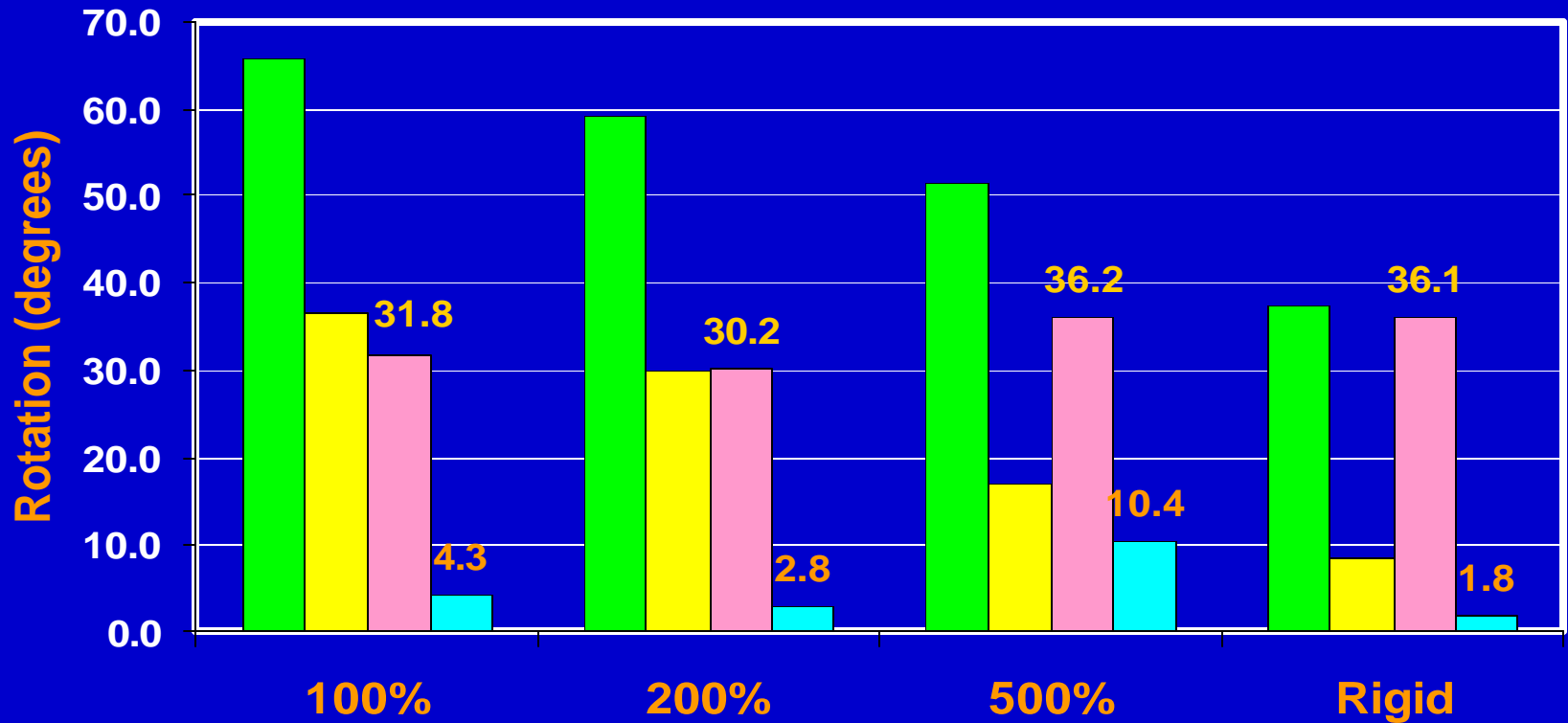
500% stiffness



Effect of Seatback Stiffness on Rearward Seat Rotation



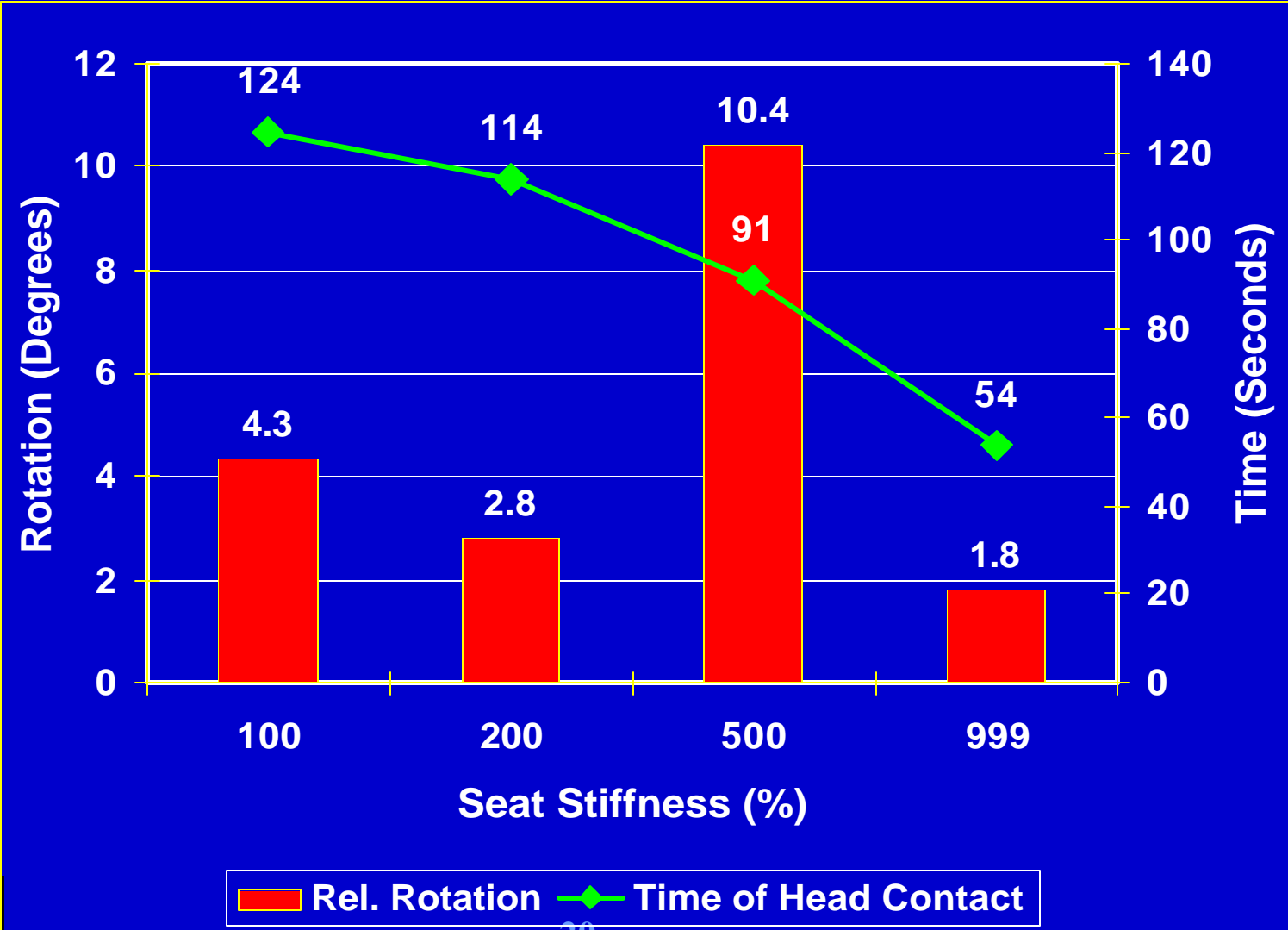
Effect of Seatback Stiffness on Head and Chest Rotation



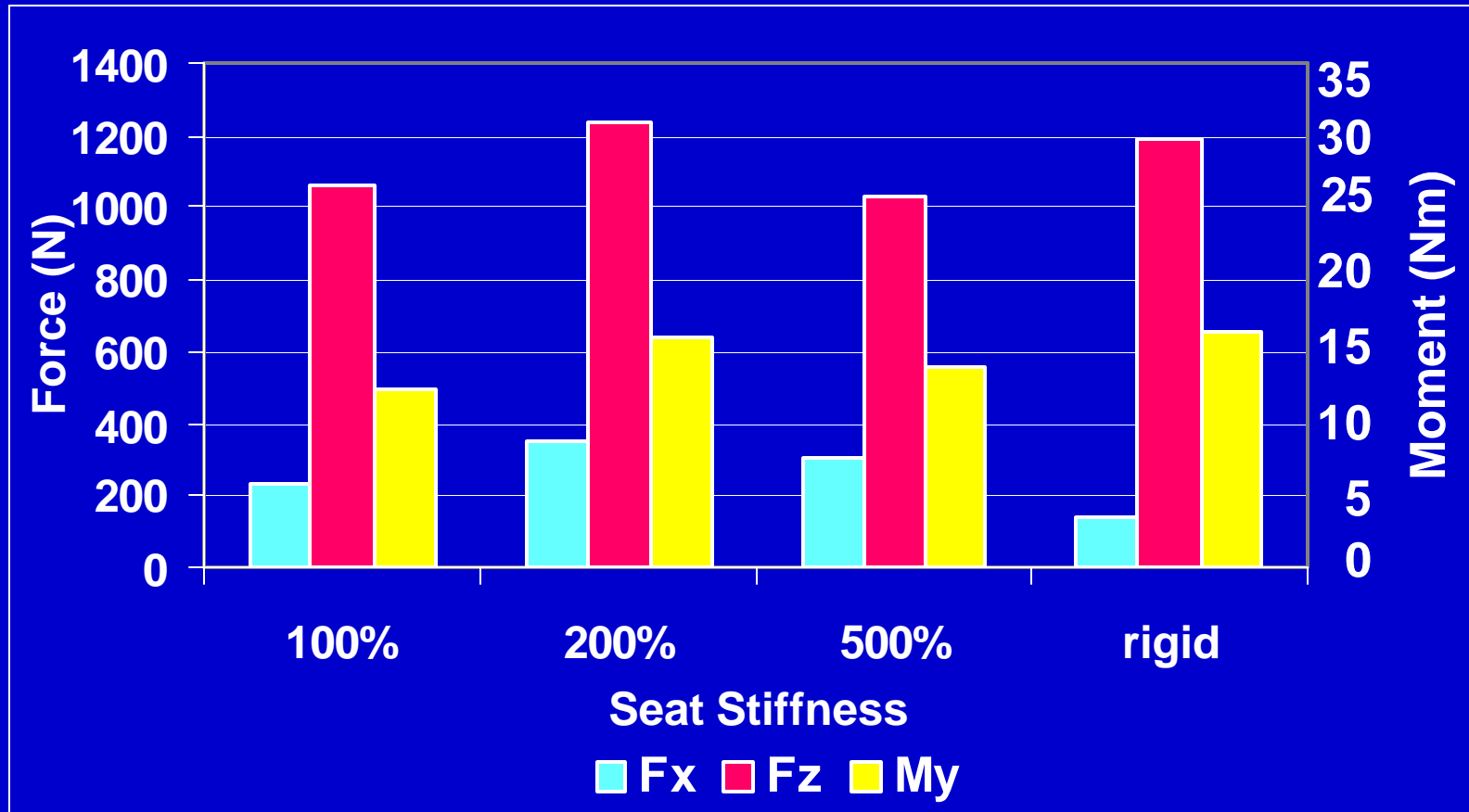
- Head Rotation
- Chest Rotation
- Head Rotation wrt Chest
- Head wrt Chest Rot. at Contact Time



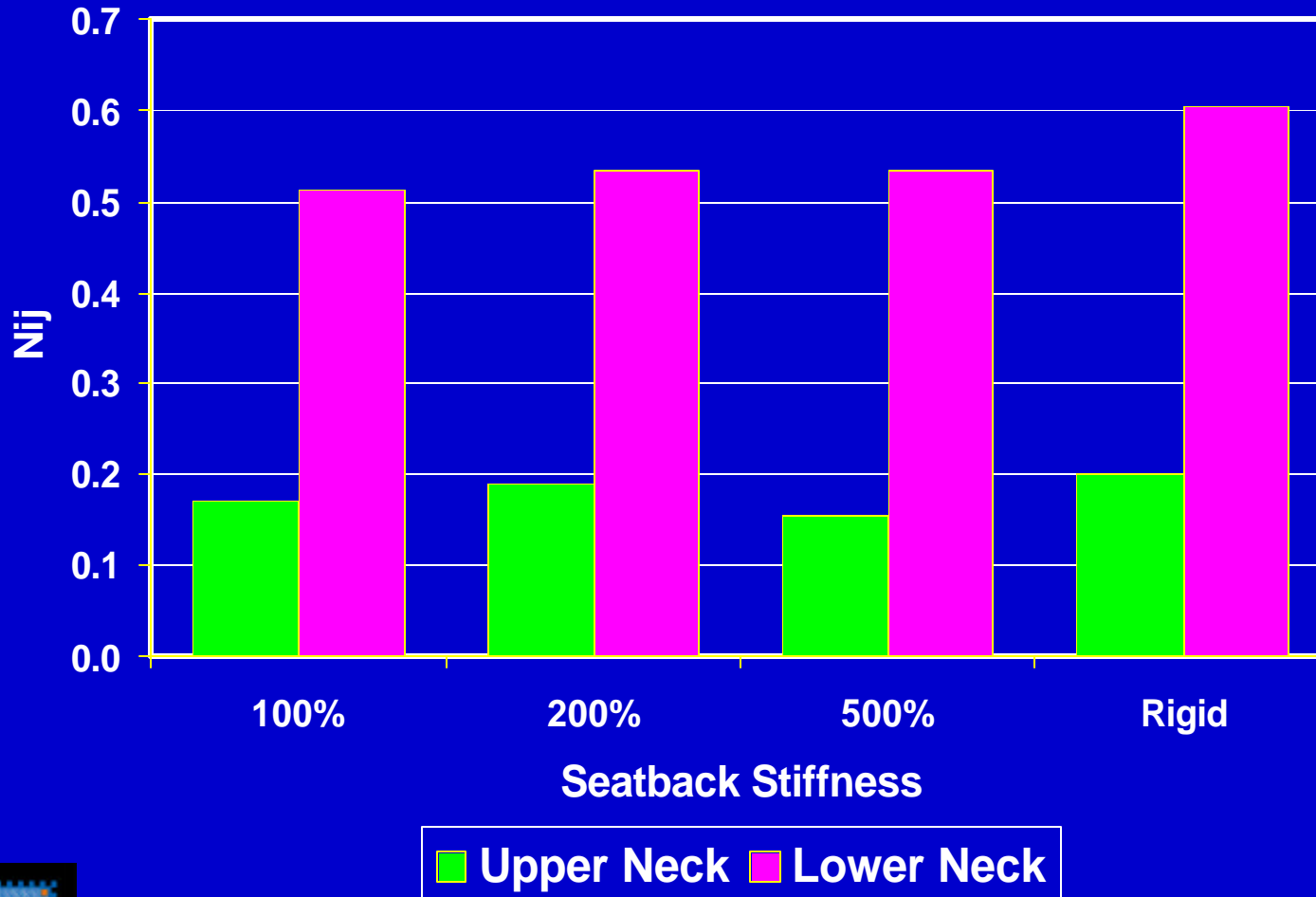
Effect of Seatback Stiffness on Head Rotation and Contact Time



Effect of Seatback Stiffness on Upper Neck Response



Effect of Seatback Stiffness on Nij Neck Injury Criteria



Conclusions

- Tests conducted at APL did not show conclusive trends between seatback stiffness and relative head to torso rotation for the 95th male HIII dummy.
- The flexibility of head restraint influenced head kinematics after head contact.
- Future testing: Similar sled tests at 17.5 km/h DeltaV with 50th % male HIII dummy.

