Sled Tests and Simulation Results with the Q10 Update Kit for Euro NCAP 2020

12th European LS-DYNA Conference

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Mercedes-Benz

Das Beste oder nichts.

Content

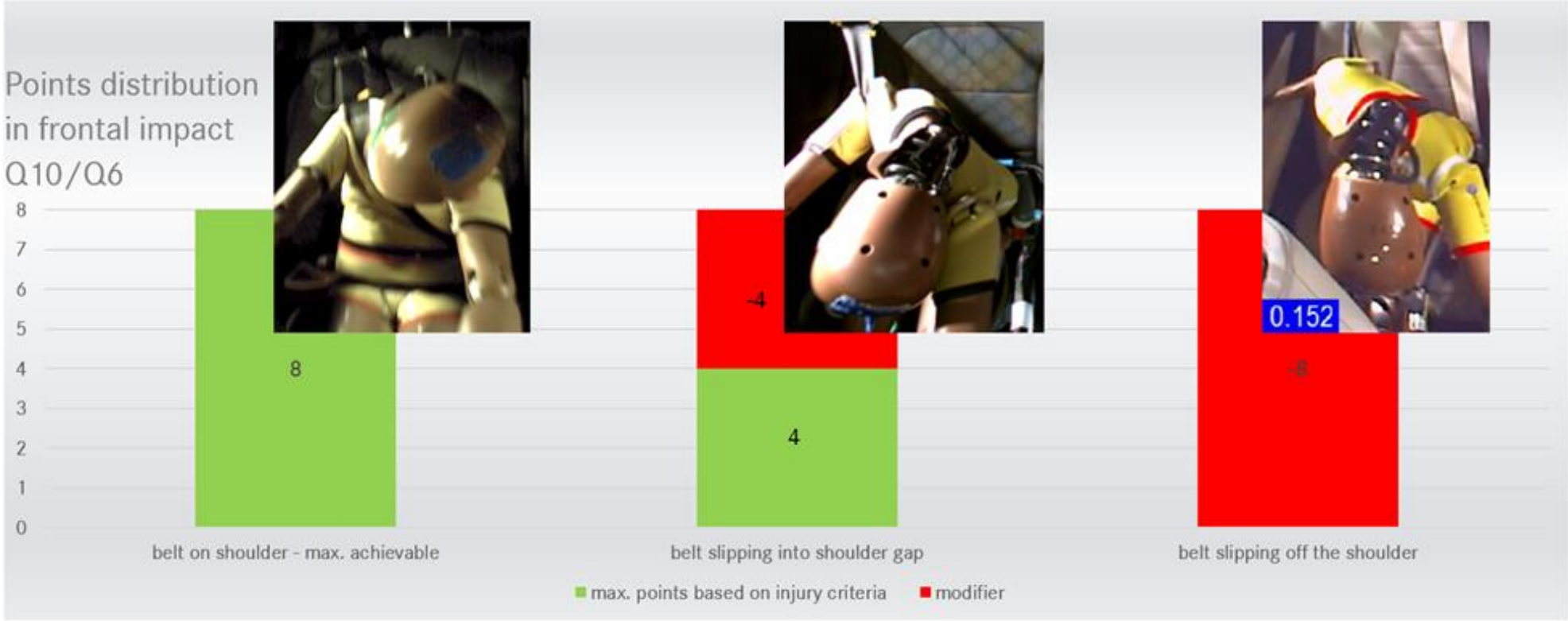
1. Motivation and Current Status for 2020
2. Cellbond Shoulder Update Kit and Simulation Model Availability
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results
4. Conclusions

Content

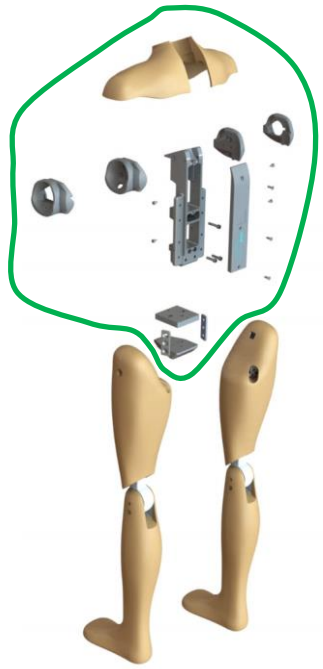
Motivation

The assessment of the seat belt slip leads to unclear situations due to the partial penalty allocation for slipping into the shoulder joint gap. Moreover, this behavior is biomechanically questionable. => Request for an update.

- The first update prepared by Humanetics in 2017 was rejected by Euro NCAP due to extensive changes.
- A reduced shoulder update kit was introduced in 2018 by Cellbond ATD.



Current Status for Q10 Dummy in 2020



Euro NCAP Decision for 2020

- Implementation of Cellbond Shoulder Update Kit
- Implementation of Cellbond upper thigs with stiffer material
- Implementation of Cellbond lower leg with shortened foot

Decisions were communicated end of 2018 and are described in the draft Protocol:

Testing Protocol – Child Occupant Protection, Version 7.3

3.2.3 Additions and modifications to the dummies

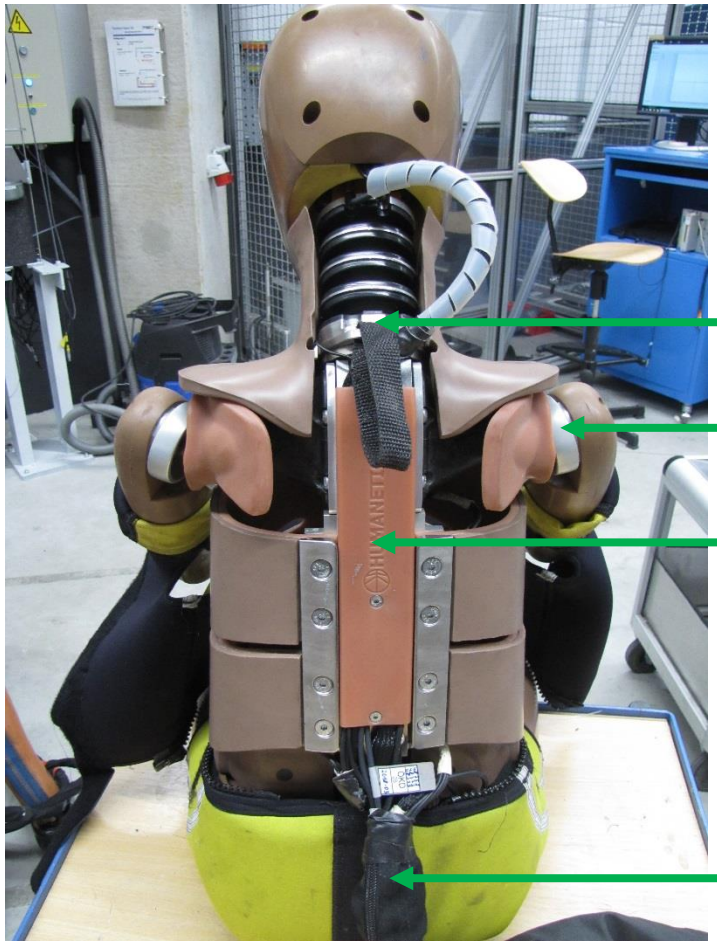
a) The Q6 dummy shall be standard build level A, and the Q10 standard build level C. See the relevant user manual for each dummy.

b) The Q10 dummy is used with the full arms for frontal impact testing. The Side Impact Kit including half arms on both sides of the dummy shall be used in the side impact test. The approved 2018 Q10 upgrade kit, consisting of shoulders, spine box, sacrum, femur flesh and short feet shall be used in both the front and side impact tests.

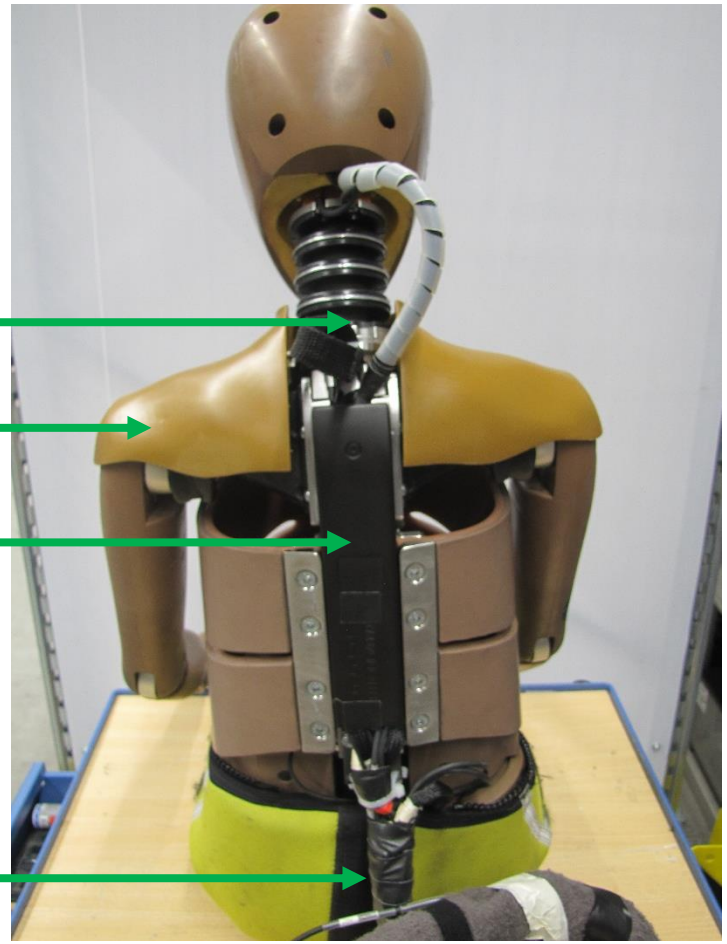
Content

Cellbond Shoulder Update Kit
Geometry – Overview

Current Q10 Design



Q10 with Cellbond Update Kit



Neck Connection Angle

Shoulder Cover, Scapulae

Spine Box (Density)

Sacrum (Density)

Cellbond Shoulder Update Kit Geometry – All Affected Parts

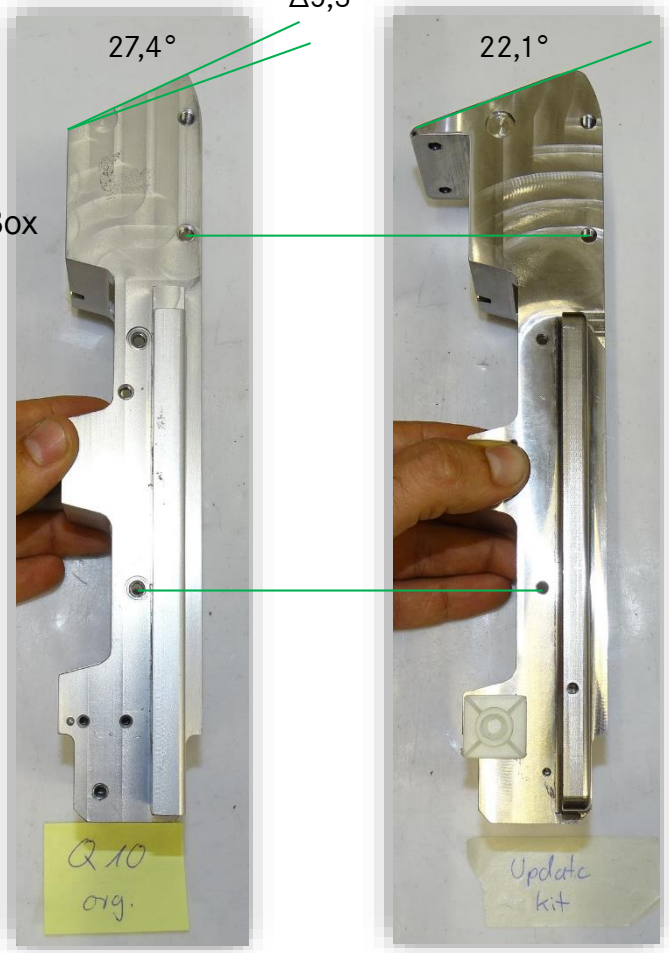
Original Parts

Neck and Shoulder

Shoulder Blades

Sacrum Ballast

Spine Box



Modified Parts

Spine Box (modified, heavier) +1093g

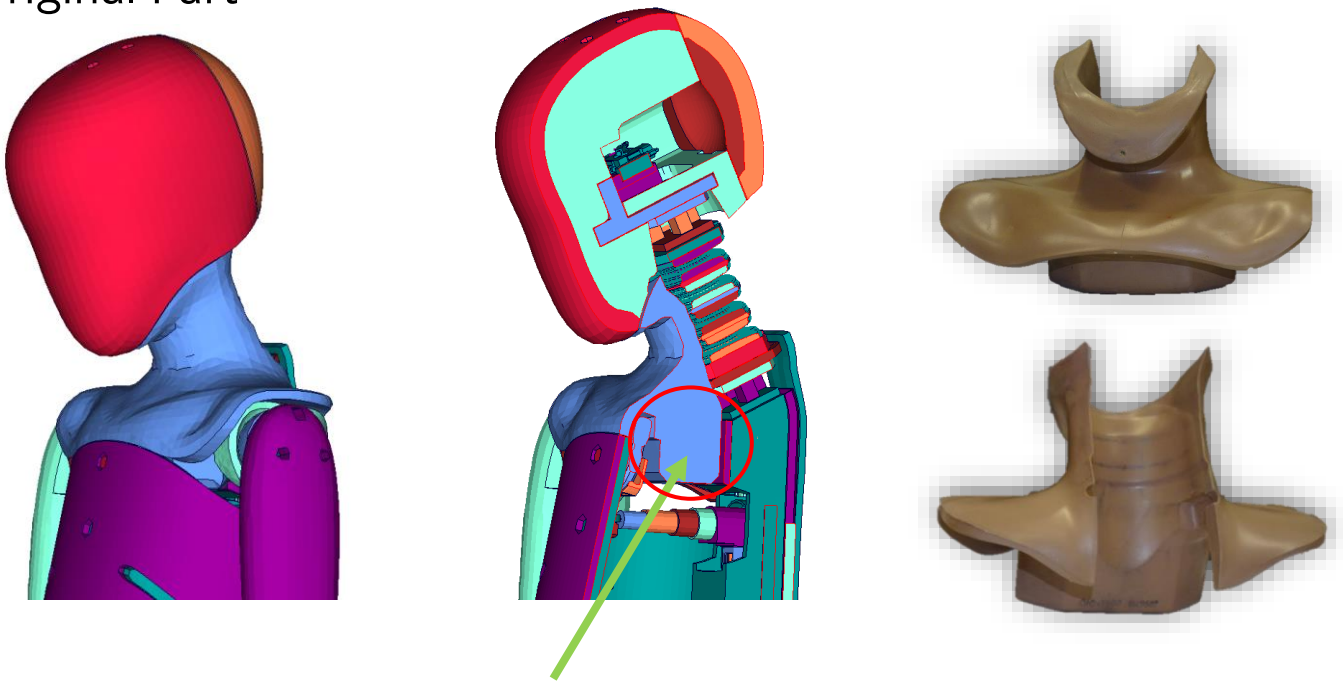
Neck and Shoulder (modified, heavier) +227g

Shoulder Blades (modified, lighter) -282g

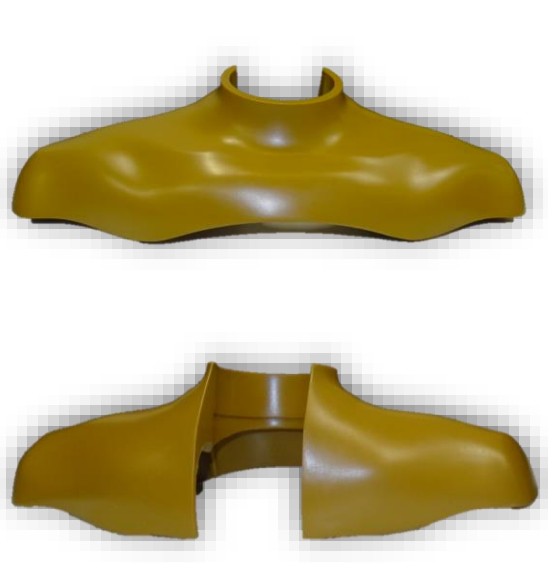
Sacrum Ballast (lighter, -1210g)

Cellbond Shoulder Update Kit
Geometry – Shoulder Cover

Original Part



Modified Part

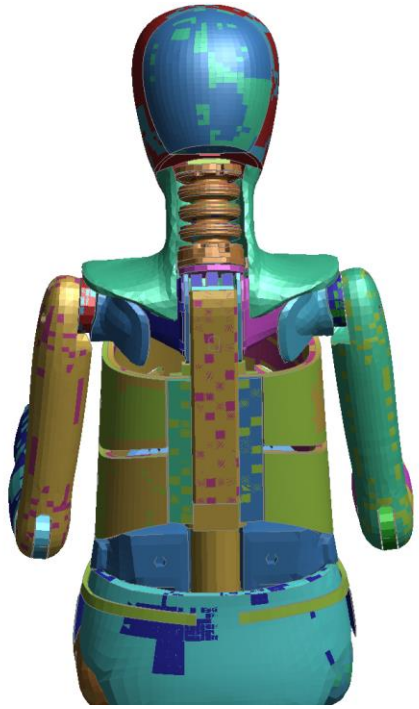


- A significant foam volume between the spine box and the sternum is omitted in the new design of the update kit.
- The thickness of the rubber covered foam block varies between 47mm to 55mm.

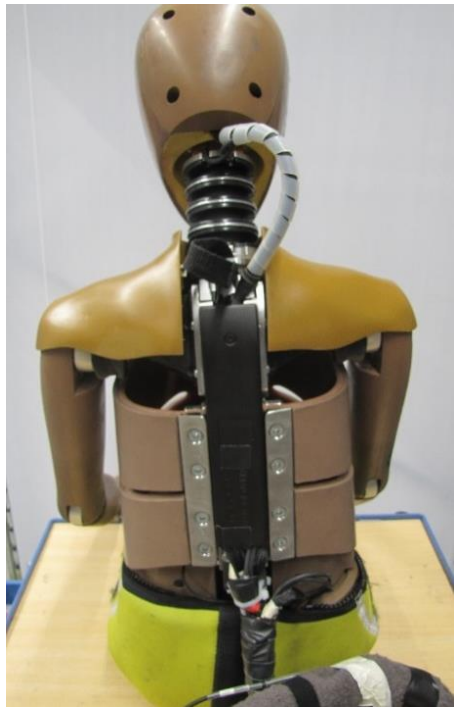
Simulation Aspects

Humanetics Q10 - Hardware

Humanetics Q10 - Software



Humanetics Q10 with Cellbond Update Kit for Euro NCAP 2020



Q10 Update Kit - Software

?

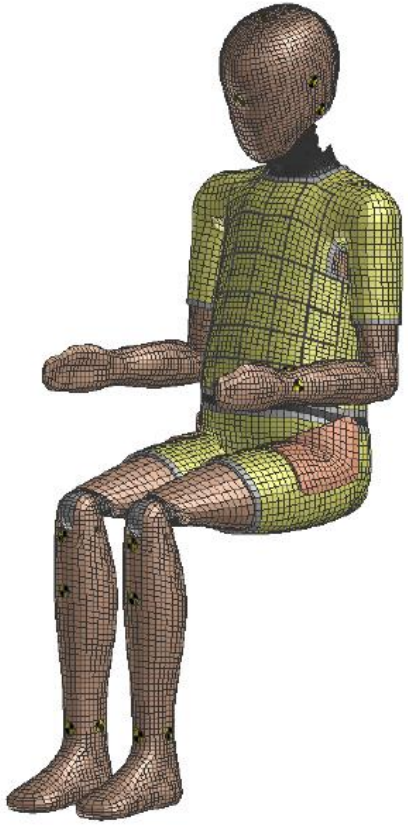
- Occupant simulations are essential for the restraint system set up. Usually these simulations are carried out in the early development phase.

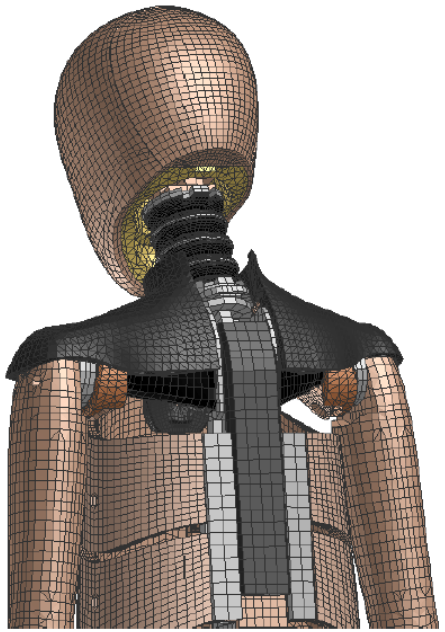
➢ Therefore simulation models are necessary and should be provided with such modifications.

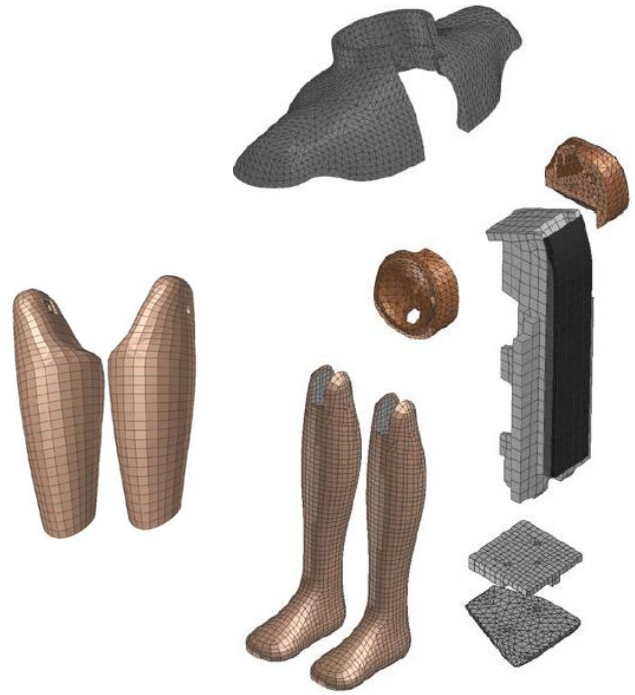
➢ Complicated development of simulation models based on two different hardware supplier parts.

Parallel Development of the Humanetics Euro NCAP 2020 Q10 Dummy

Humanetics Q10 with the 2018
developed update kit for
Euro NCAP 2020 (Light Beta Update Kit)







Will it be possible to use the Humanetics model to represent or validate the results of the combined Humanetics / Cellbond hardware in the simulation?

Content

Sled Test Comparisons with the Update Kit, **Hardware** Test Series Specification and Goals

ACEA European Automobile Manufacturers Association

The hardware study was financed and organized from the ACEA Working Group Child Safety.

- All tests were carried out in a Mercedes-Benz family car sled set up.
  The sled pulses are based on the same family car crash test readings.
- The seat belt system is a separate configuration optimized for current rating and internal requirements.
  Pretensioner, force limiter and crash locking tongue were used in this basic study.

Test no.	Dummy	Angle	Pulse
1	Q10 HUMANETICS	12,5	ODB
2	Q10 HUMANETICS	12,5	ODB
3	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
4	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
5	Q10 HUMANETICS	30	ODB
6	Q10 HUMANETICS	30	ODB
7	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
8	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
9	Q10 HUMANETICS	12,5	MPDB
10	Q10 HUMANETICS	12,5	MPDB
11	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB
12	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB

ODB 64kph without shoulder belt slip. → Kinematics and injury values.

ODB 64kph with risk of shoulder belt slip. → Kinematics (injury values).

MPDB 50kph without shoulder belt slip. → Kinematics and injury values.

Sled Test Comparisons with the Update Kit, **Hardware** Shoulder and Seatbelt Kinematics, Effect on Injury Values

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 12.5° rotated sled

Test no.	Dummy	Angle	Pulse
1	Q10 HUMANETICS	12,5	ODB
2	Q10 HUMANETICS	12,5	ODB
3	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
4	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
5	Q10 HUMANETICS	30	ODB
6	Q10 HUMANETICS	30	ODB
7	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
8	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
9	Q10 HUMANETICS	12,5	MPDB
10	Q10 HUMANETICS	12,5	MPDB
11	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB
12	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB

ODB 64kph without shoulder belt slip. → Kinematics and injury values.

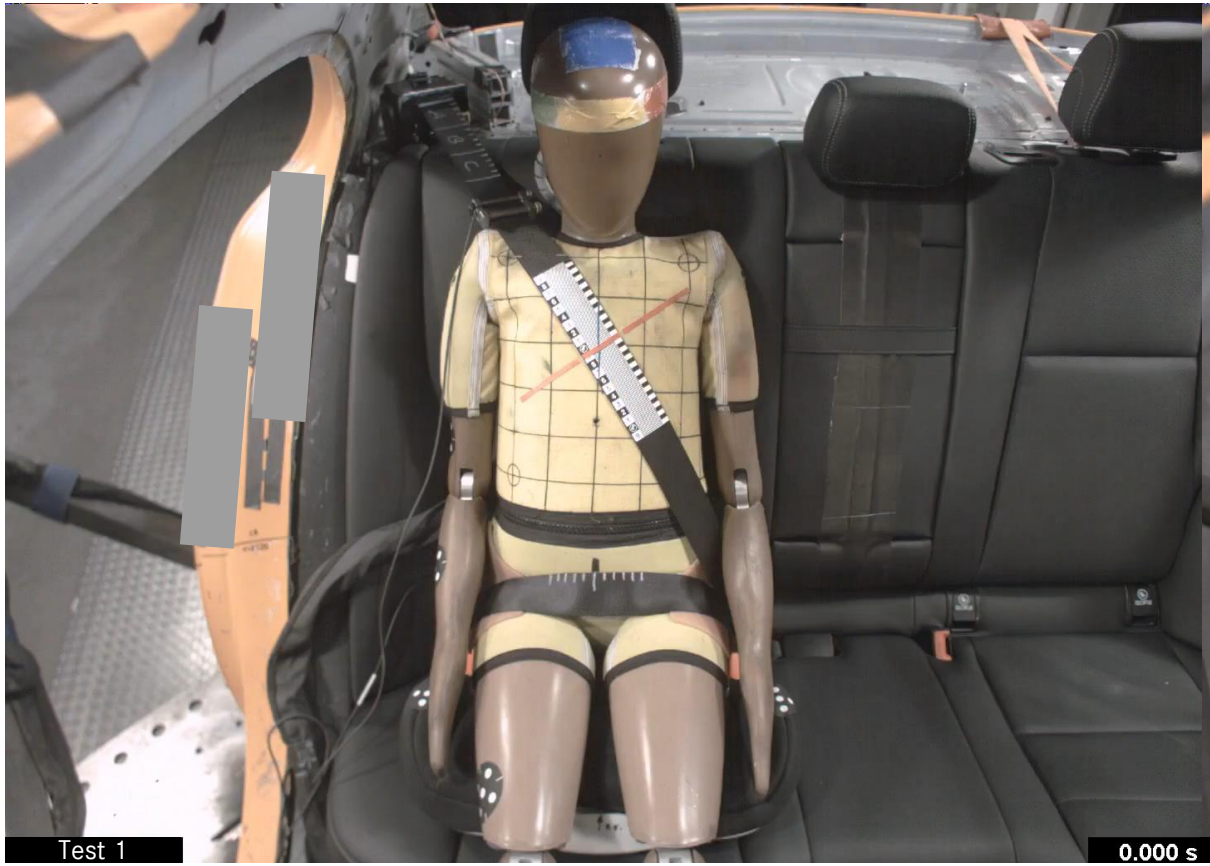
ODB 64kph with risk of shoulder belt slip. → Kinematics (injury values).

MPDB 50kph without shoulder belt slip. → Kinematics and injury values.

Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. and Cellbond Update Kit, ODB 64kph, 12.5°

Q10 Current



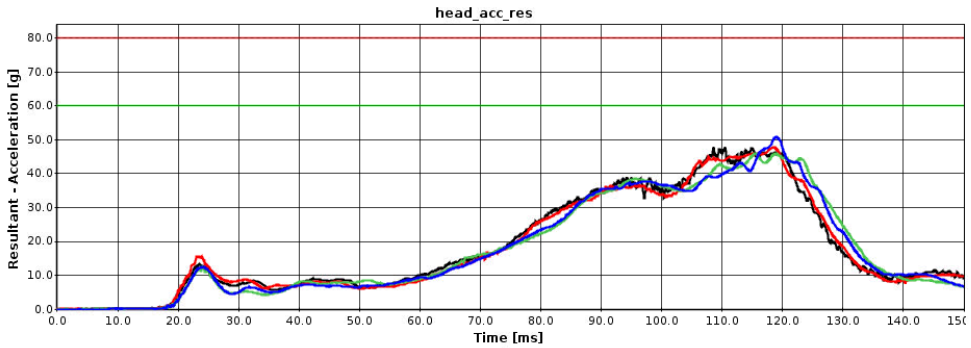
Q10 Cellbond Update Kit

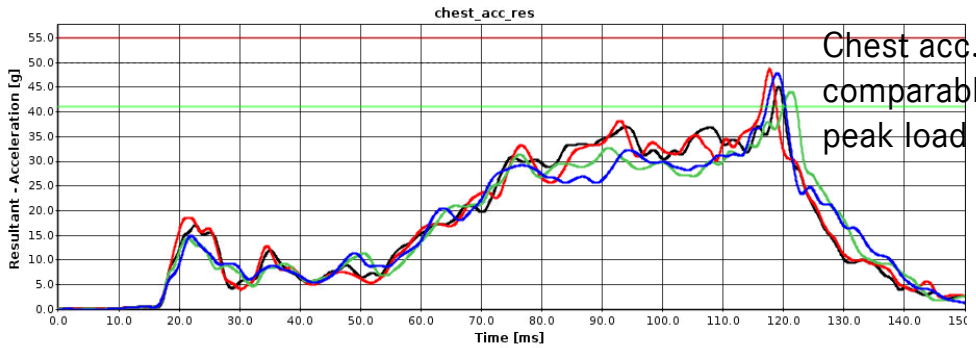
Sled Test Comparisons with the Update Kit, **Hardware** Shoulder and Seatbelt Kinematics, Effect on Injury Values

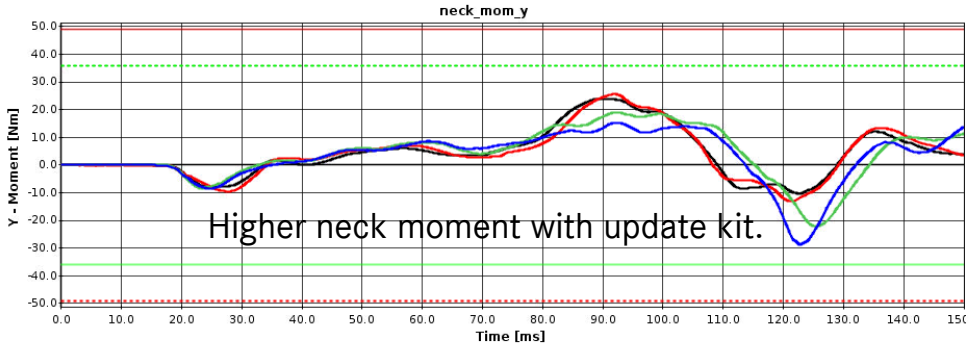
Q10 cur. - Q10 Cellbond Update Kit, ODB, 12.5°

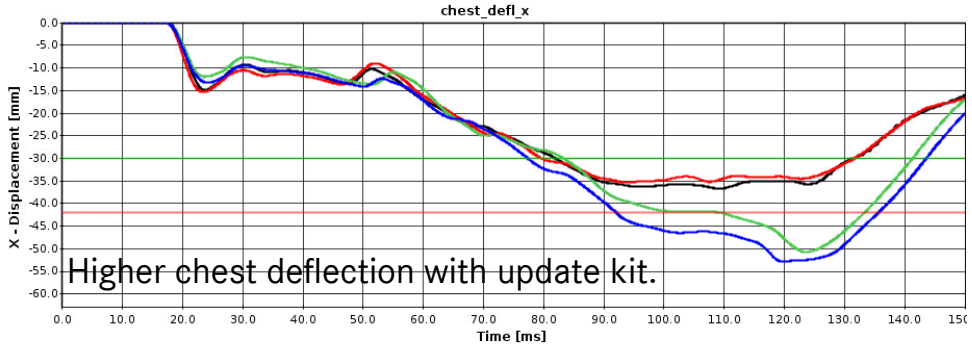
Current

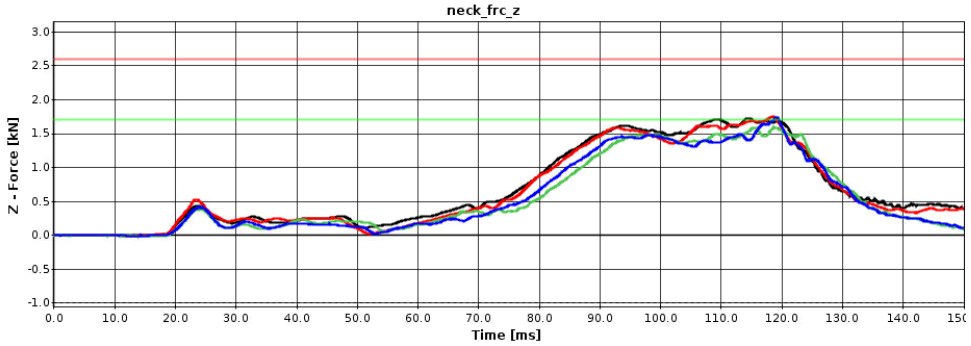
Update Kit

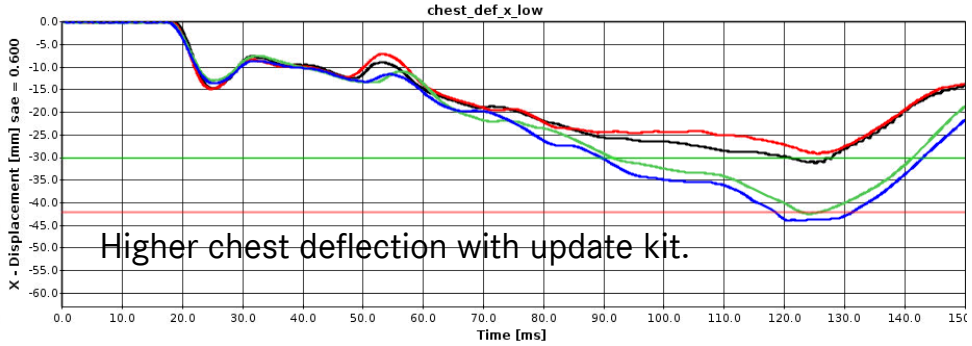






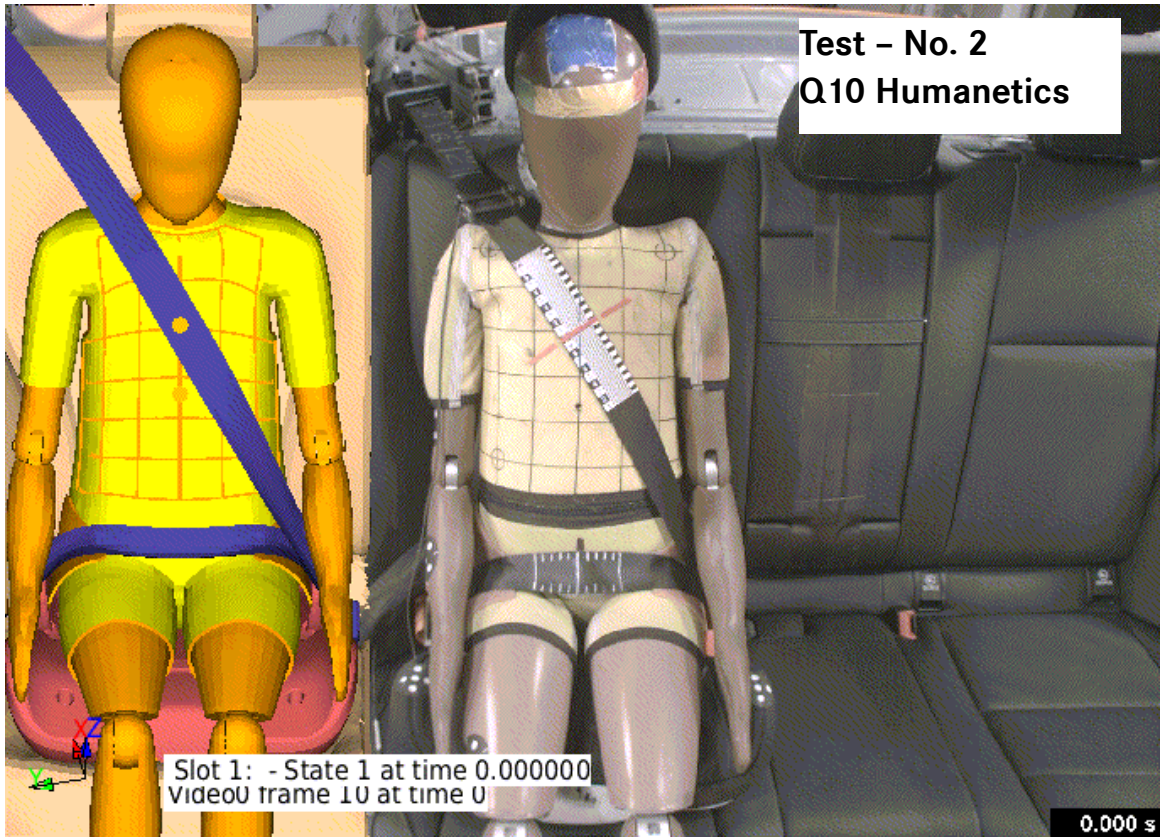


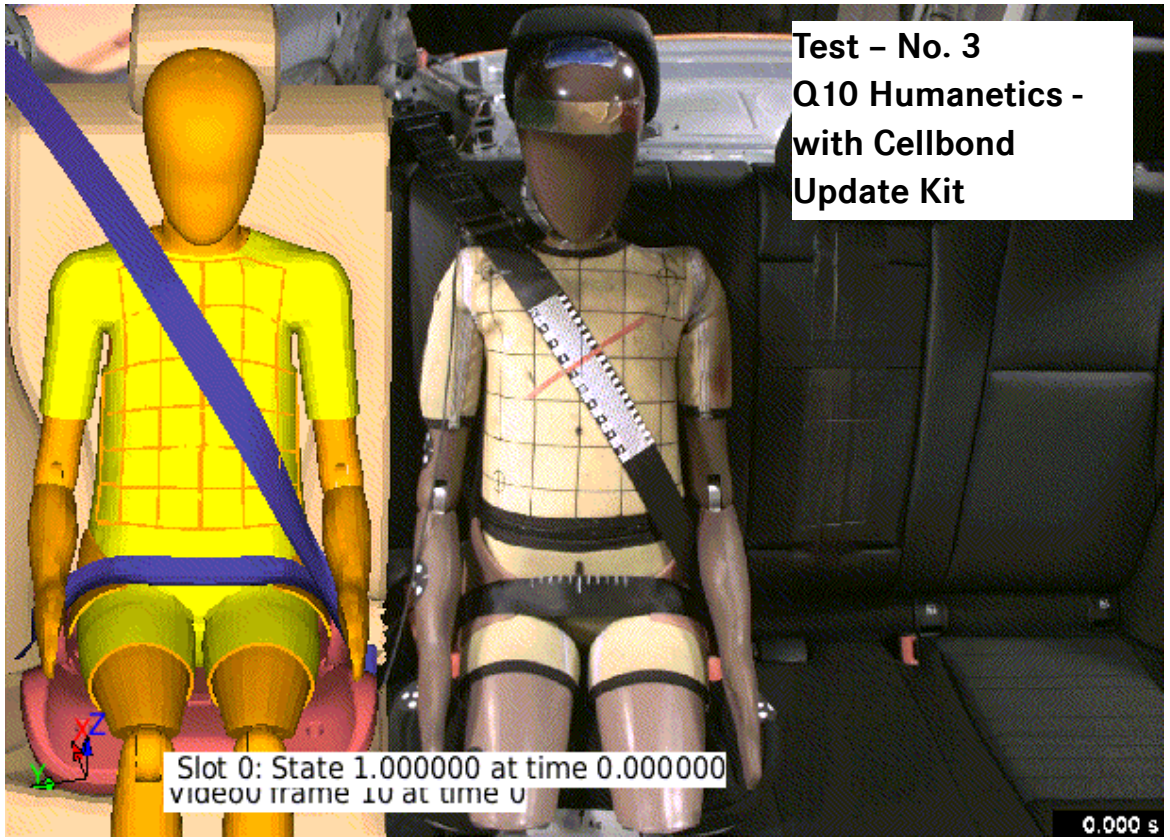




Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 2 and Test No. 3 Validations (ODB + 12p5 deg rotation)

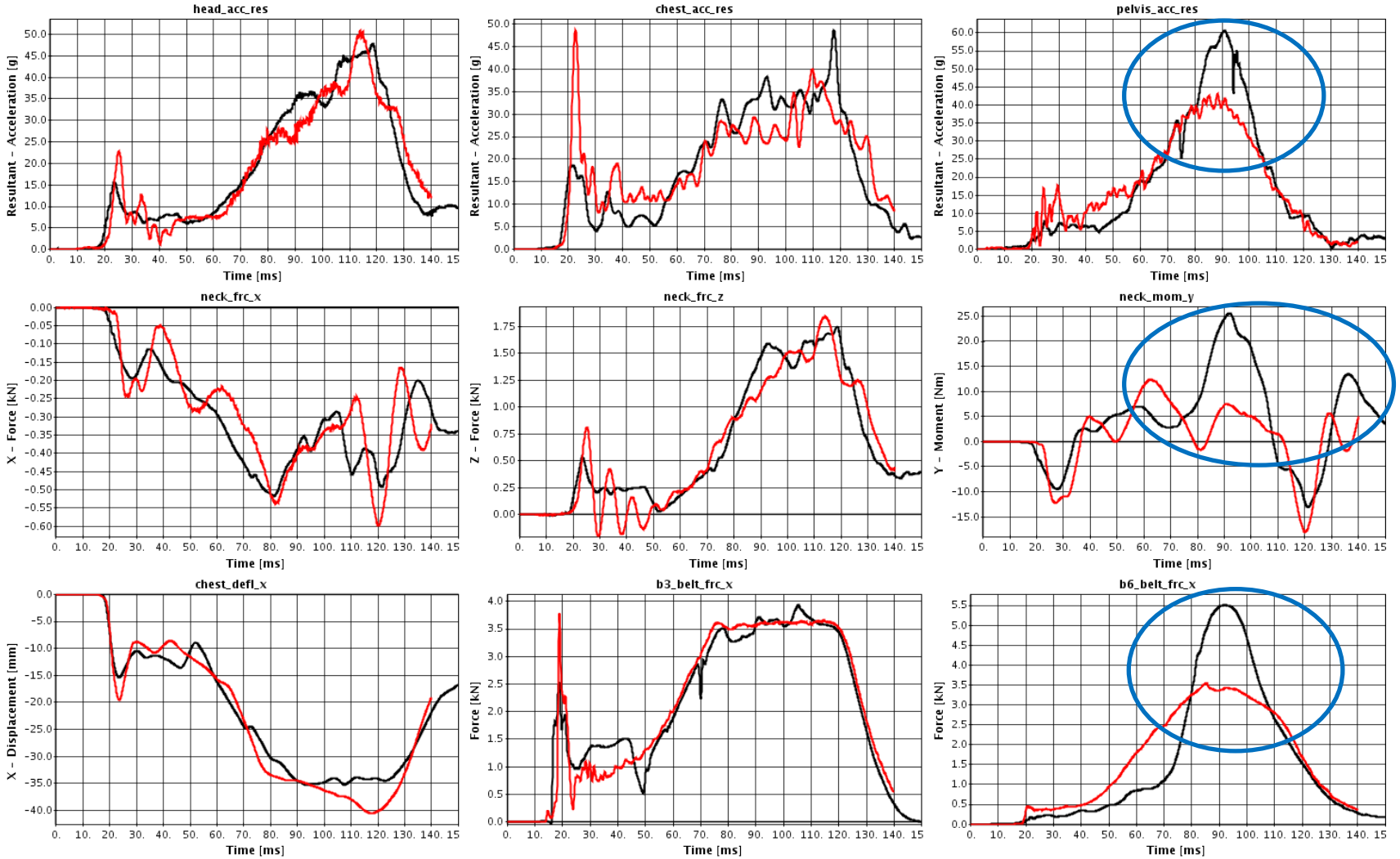




- Compared to test the seatbelt on dummy in simulation moves closer to shoulder joint.
- The Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation.

Sled Test Comparisons with Current Q10, **Hardware and Simulation**

Test No. 2 Validations (ODB + 12,5 deg. rotation)

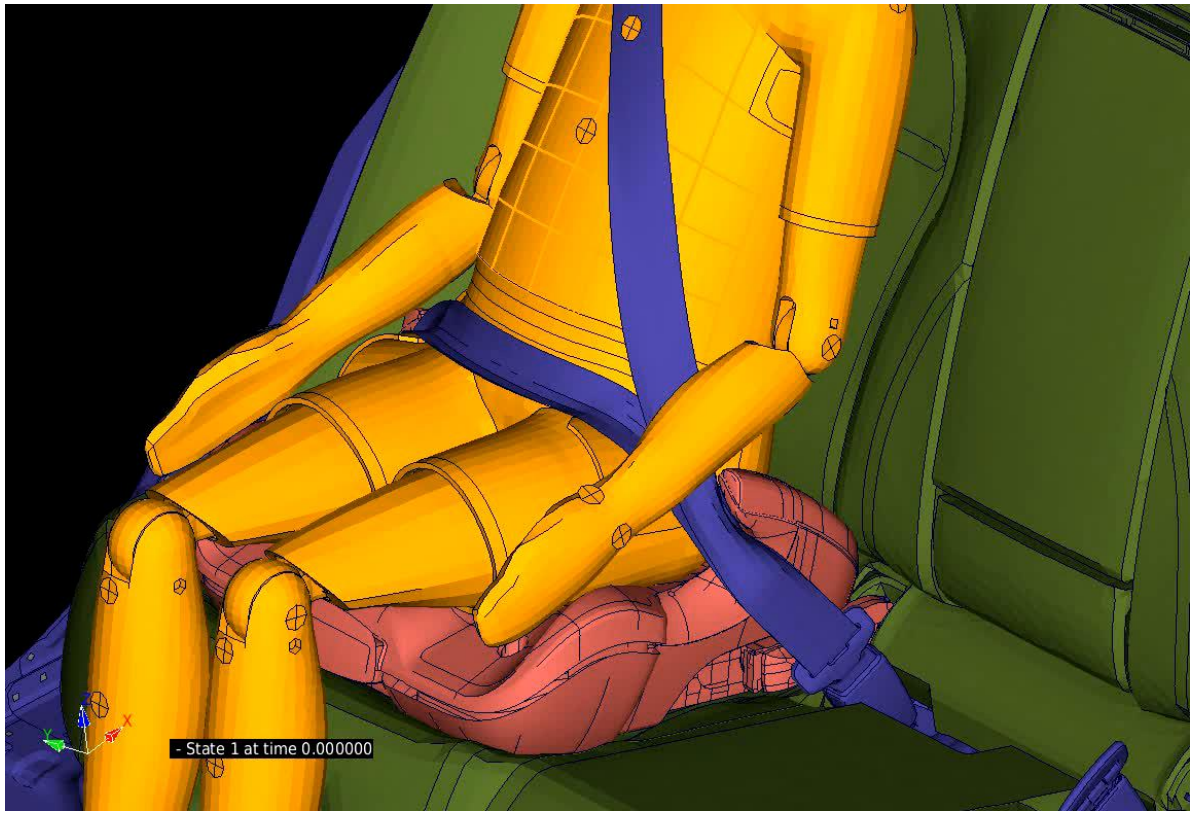


Test No. 2 Humanetics Q10

Simulation – Q10 V1.6.2

Significant difference in pelvis restraint and neck y moment.

Sled Test Comparisons with Current Q10, **Hardware and Simulation**
Test No. 2 Validations (ODB + 12p5 deg. rotation)

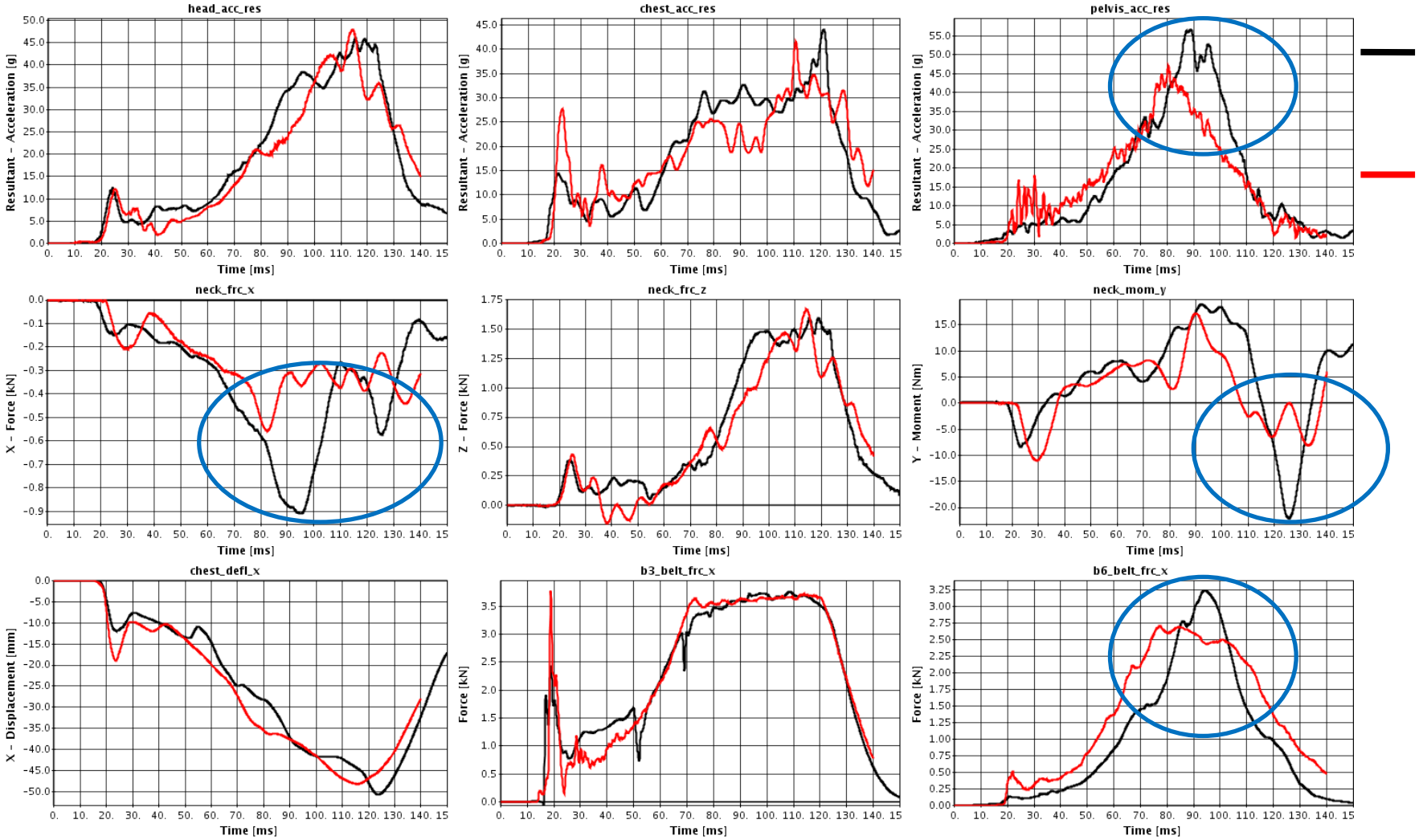


Current Q10 Dummy
- ➢ Deformation and folding of hip shields.

Q10 Dummy Modell 1.6.2
- ➢ Almost no deformation of hip shields.

Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 3 Validations (ODB + 12p5 deg. rotation)



Test No. 3 - Humanetics Q10 Dummy with Cellbond Update Kit

Simulation – Q10 Humanetics Light Beta Update Kit

Significant difference in pelvis restraint, neck y moment and neck shear forces.

Sled Test Comparisons with the Update Kit, **Hardware** Shoulder and Seatbelt Kinematics, Effect on Injury Values

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 30° rotated sled

Test no.	Dummy	Angle	Pulse
1	Q10 HUMANETICS	12,5	ODB
2	Q10 HUMANETICS	12,5	ODB
3	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
4	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
5	Q10 HUMANETICS	30	ODB
6	Q10 HUMANETICS	30	ODB
7	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
8	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
9	Q10 HUMANETICS	12,5	MPDB
10	Q10 HUMANETICS	12,5	MPDB
11	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB
12	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB

ODB 64kph without shoulder belt slip. → Kinematics and injury values.

ODB 64kph with risk of shoulder belt slip. → Kinematics (injury values).

MPDB 50kph without shoulder belt slip. → Kinematics and injury values.

Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. and Cellbond Update Kit, ODB 64kph, 30°

Q10 Current

4 point shoulder belt modifier

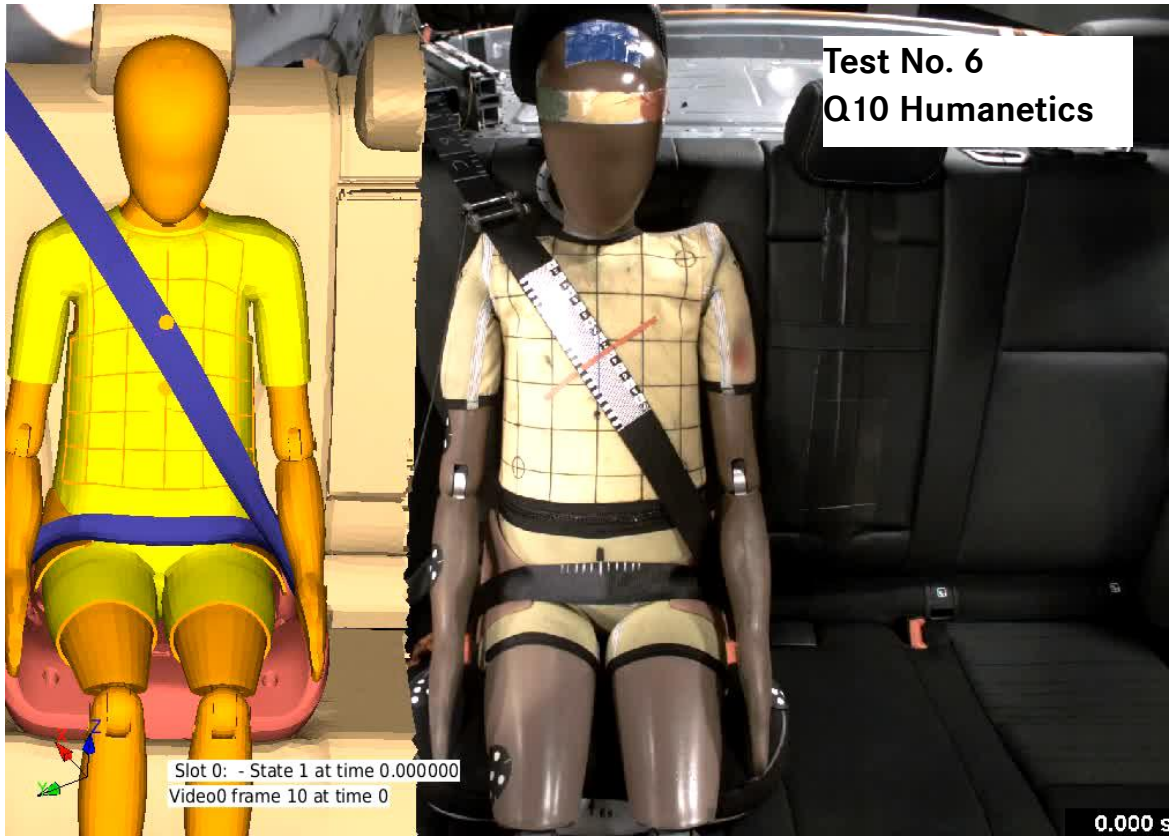
Q10 Cellbond Update Kit

8 point shoulder belt modifier

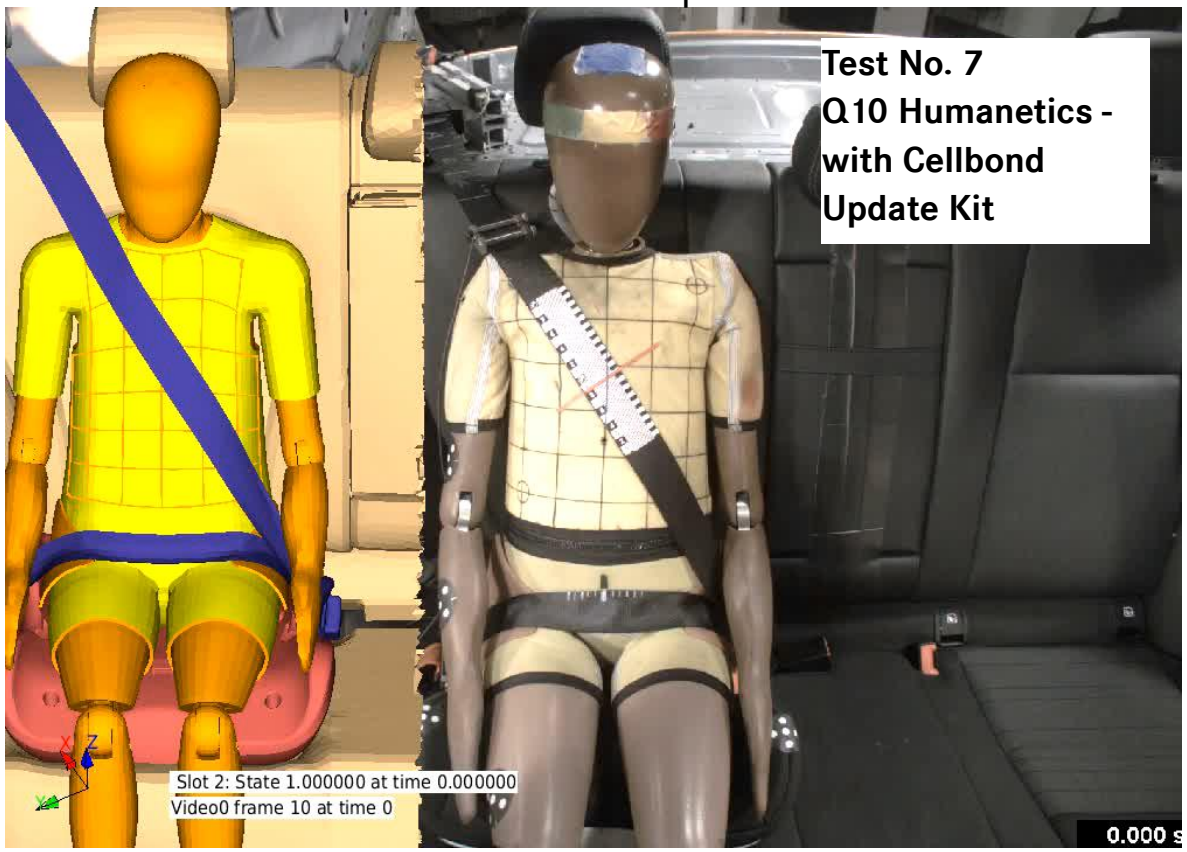
Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 6 / Test No. 7 Validations (ODB + 30 deg rotation)

Q10 Current



Q10 Cellbond Update Kit



- Kinematics of dummy matches to good extent with the test till 80ms.
- Belt slips away on the shoulder in simulation whereas it gets struck in the shoulder joint in the Test No. 6.
- Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation.

Sled Test Comparisons with the Update Kit, **Hardware** Shoulder and Seatbelt Kinematics, Effect on Injury Values

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 12.5° rotated sled

Test no.	Dummy	Angle	Pulse
1	Q10 HUMANETICS	12,5	ODB
2	Q10 HUMANETICS	12,5	ODB
3	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
4	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	ODB
5	Q10 HUMANETICS	30	ODB
6	Q10 HUMANETICS	30	ODB
7	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
8	Q10 HUMANETICS mit UpdateKit Cellbond	30	ODB
9	Q10 HUMANETICS	12,5	MPDB
10	Q10 HUMANETICS	12,5	MPDB
11	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB
12	Q10 HUMANETICS mit UpdateKit Cellbond	12,5	MPDB

ODB 64kph without shoulder belt slip. → Kinematics and injury values.

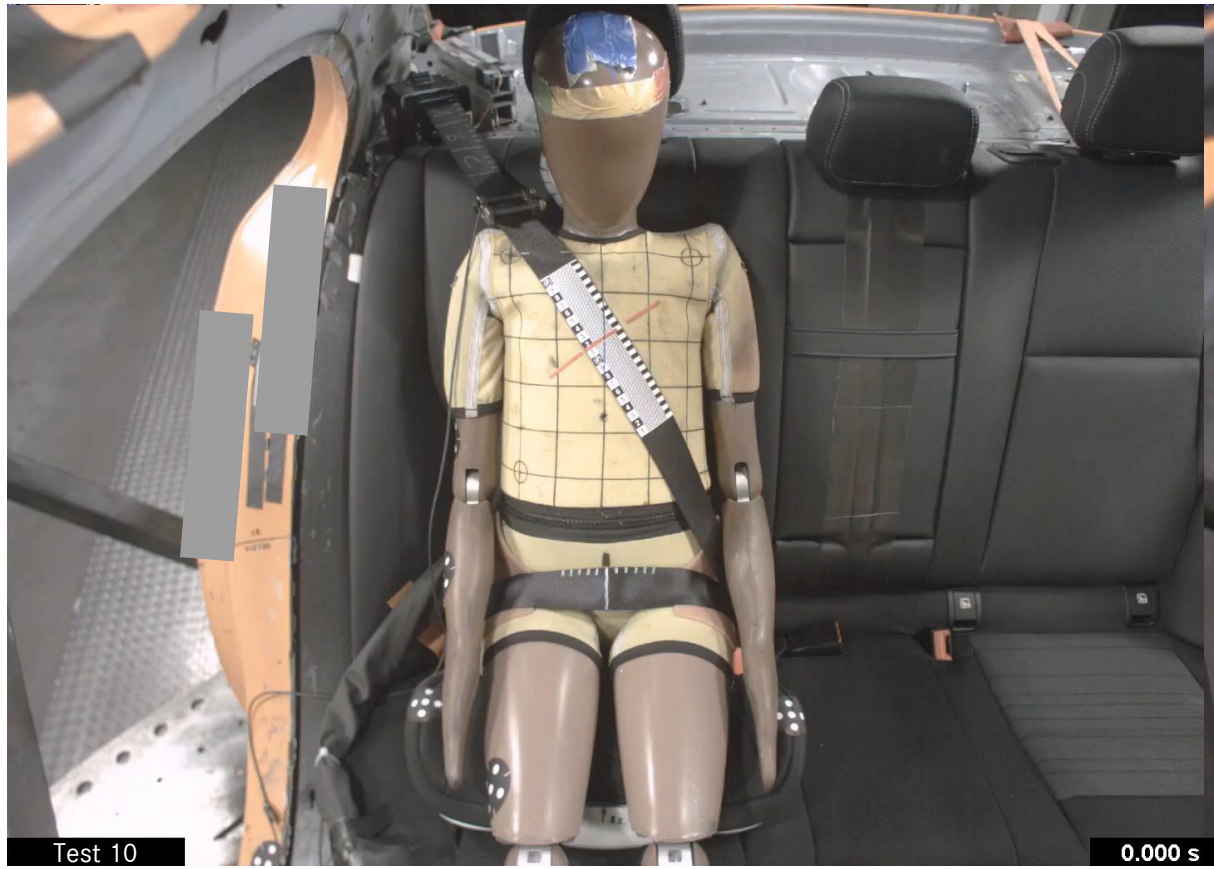
ODB 64kph with risk of shoulder belt slip. → Kinematics (injury values).

MPDB 50kph without shoulder belt slip. → Kinematics and injury values.

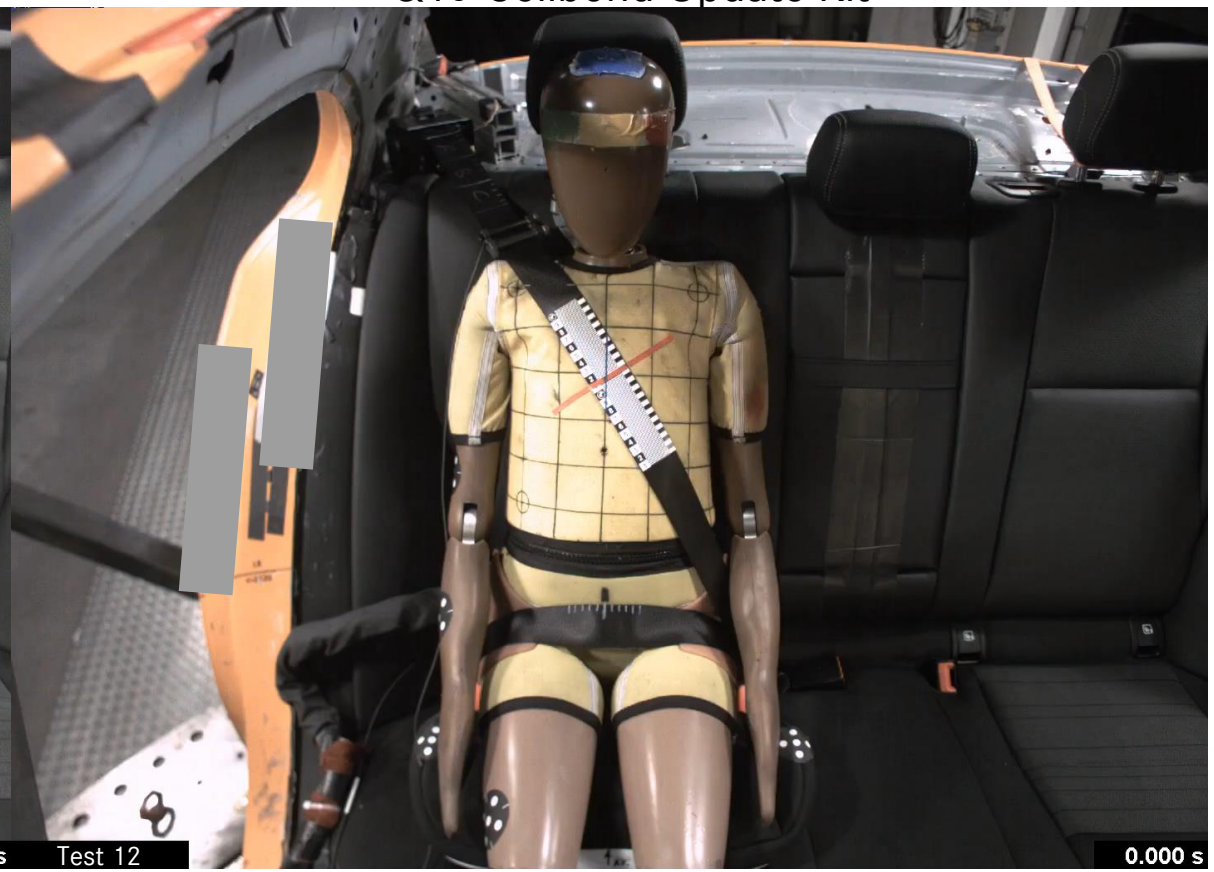
Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. and Cellbond Update Kit, MPDB 50kph, 12.5°

Q10 Current



Q10 Cellbond Update Kit

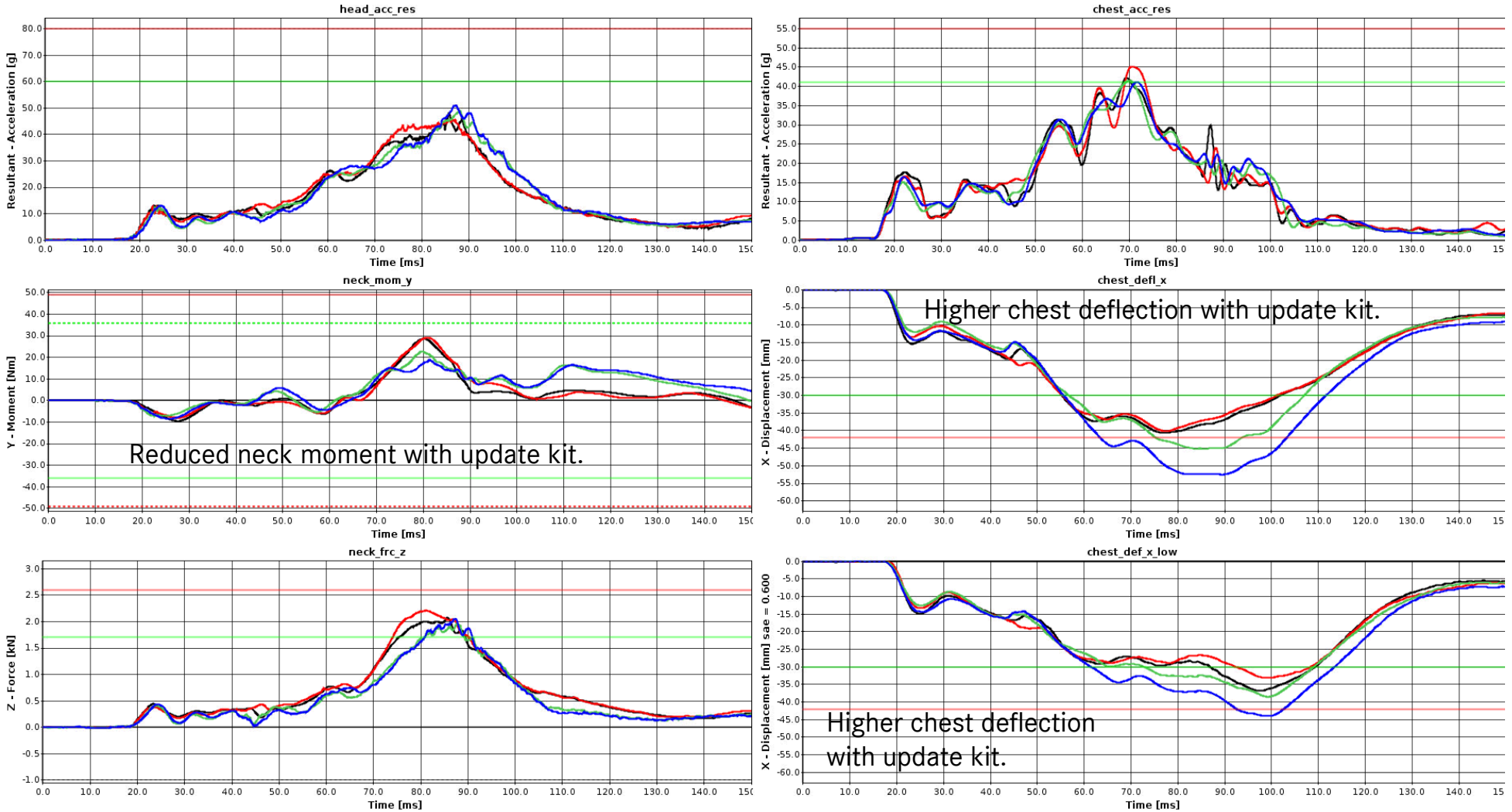


Sled Test Comparisons with the Update Kit, **Hardware** Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. - Q10 Cellbond Update Kit, MPDB, 12.5°

Current

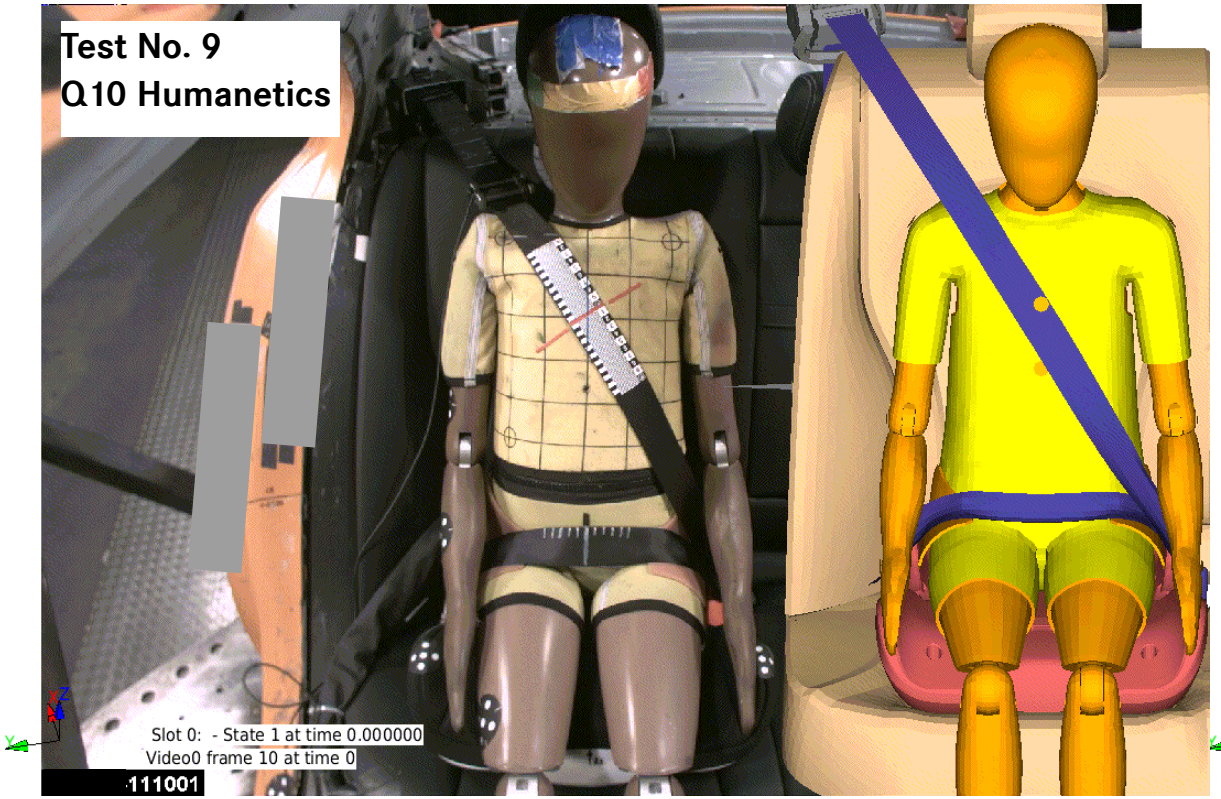
Update Kit



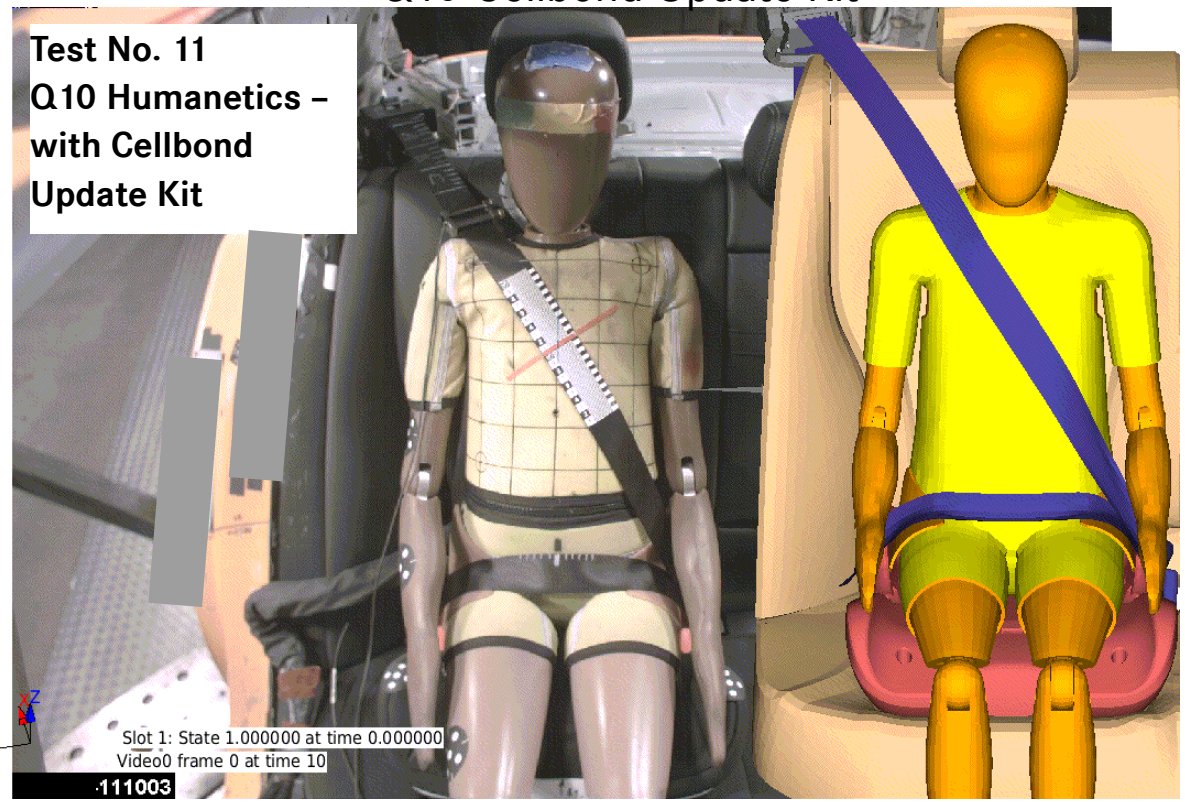
Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 9 / Test No. 11 Validations (MPDB + 12,5 deg. rotation)

Q10 Current



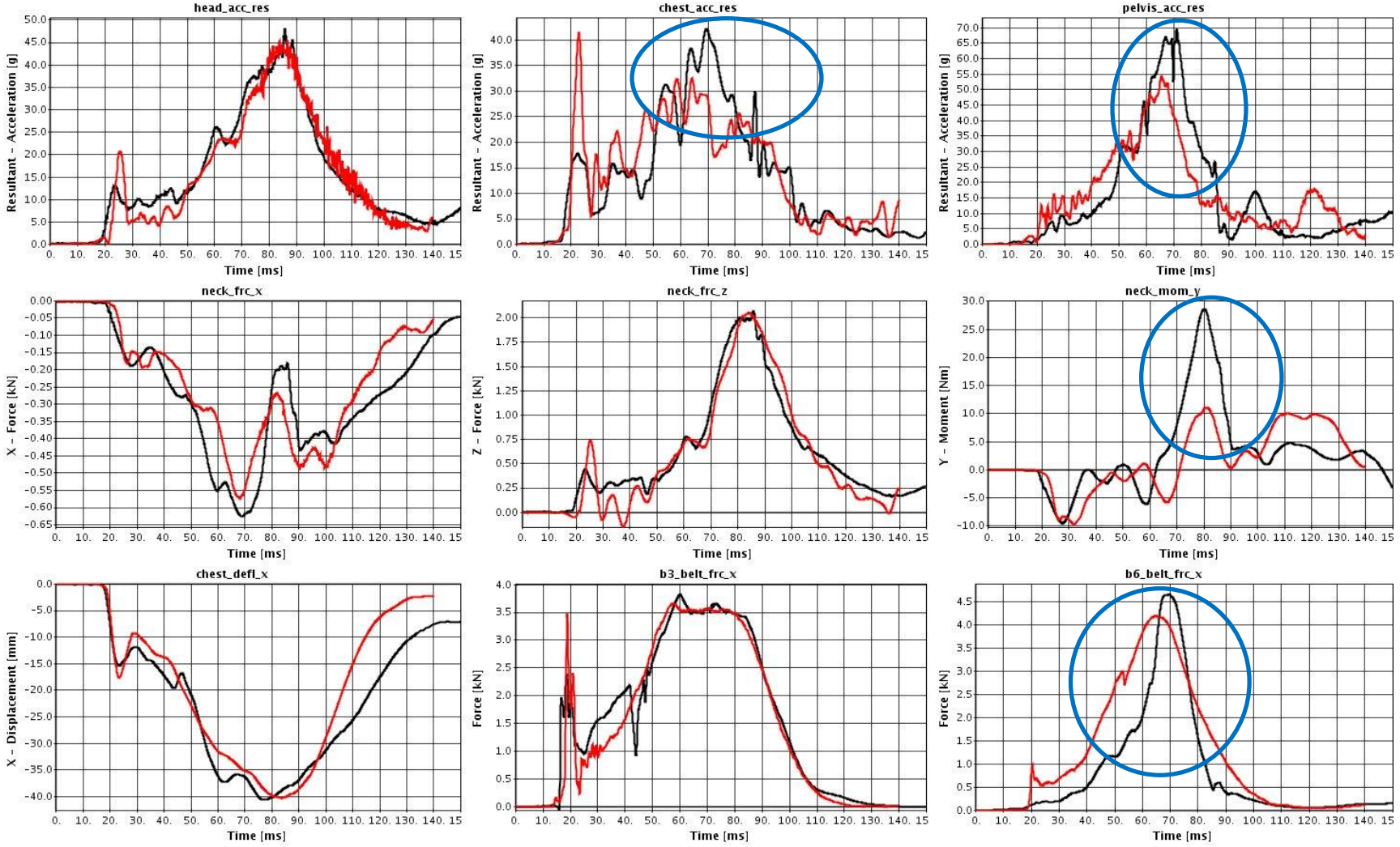
Q10 Cellbond Update Kit



- Kinematics of dummy matches to good extent with the test
- Injury Values match in loading and unloading phase to good extent
- Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation

Sled Test Comparisons Current Q10, **Hardware and Simulation**

Test No. 9 Validations (MPDB + 12p5 deg rotation)



Test No. 9 Humanetics Q10

Simulation – Q10 v1.6.2

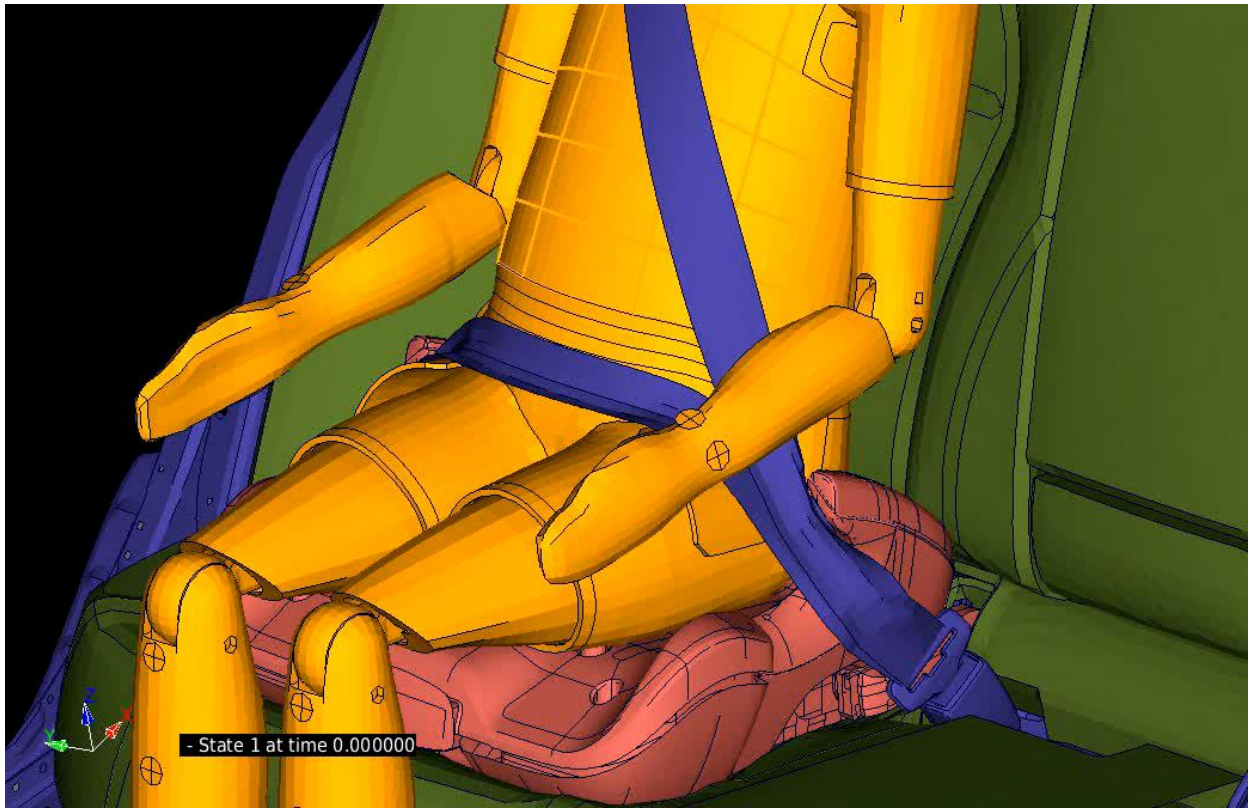
Significant difference in pelvis restraint, neck y moment and chest acceleration.

Sled Test Comparisons Current Q10, **Hardware and Simulation**

Test No. 9 Validations (MPDB + 12p5 deg rotation)

Q10 Current

Q10 V1.6.2



Current Q10 Dummy

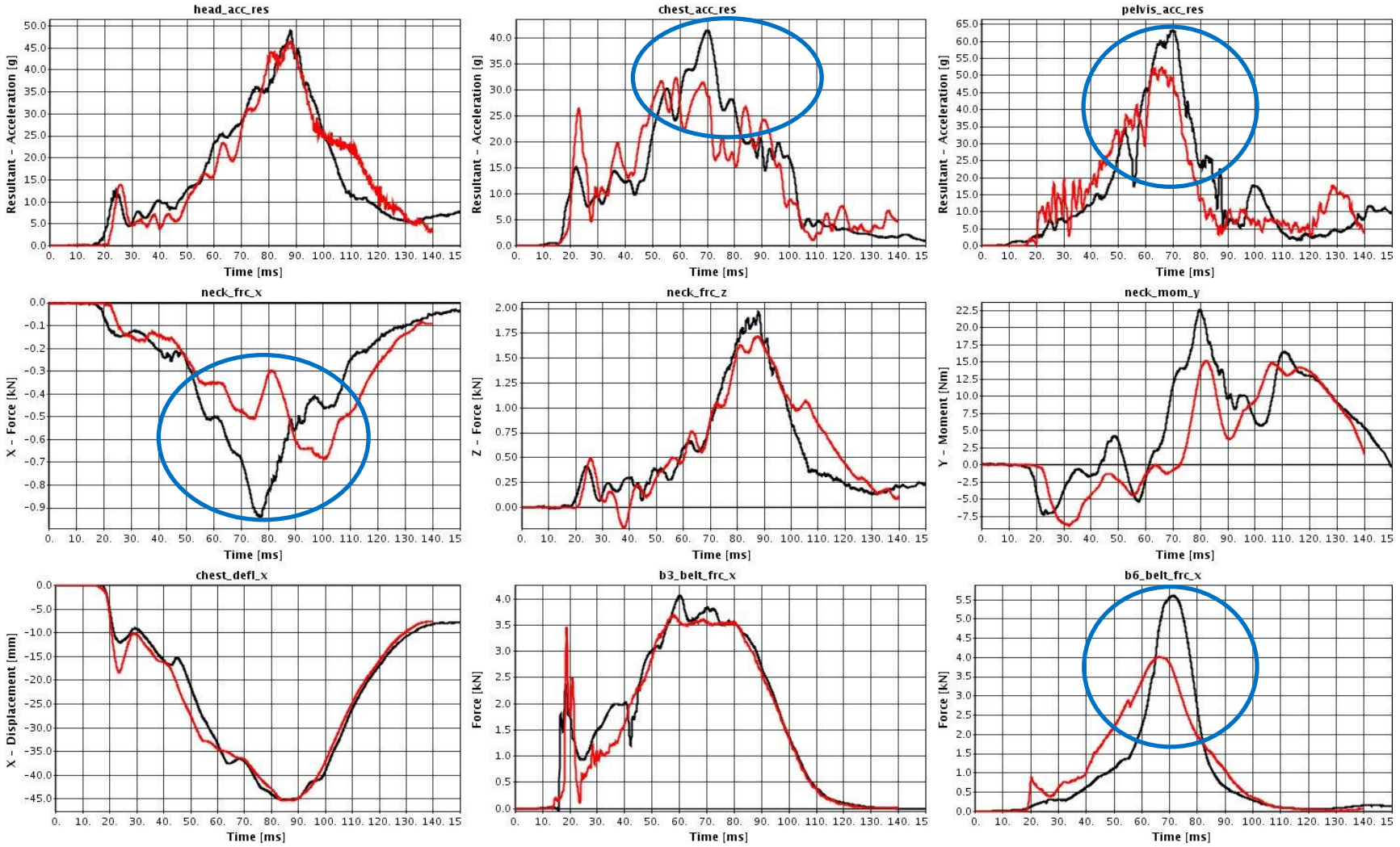
➢ Deformation and folding of hip shields.

Q10 Dummy Light Update Kit

➢ Almost no deformation of hip shields.

Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 11 Validations (MPDB + 12.5 deg. rotation)



Test No. 11 - Humanetics Q10 Dummy with Cellbond Update Kit

Simulation – Q10 Humanetics Light Beta Update Kit

Significant difference in pelvis restraint, neck shear forces and chest acceleration .

Content

Q10 Dummy – Comparisons with Update Kit
Summary

- In general good correlation between Humanetics Euro NCAP 2020 simulation model and the Humanetics Q10 hardware dummy equipped with the Cellbond shoulder update kit.

- Clearer shoulder slip prognosis and correlation between hardware and simulation.

- Chest acceleration is lower calculated in the simulation result.
  It is especially noticeable in the MPDB tests.

- Pelvis, Abdomen and mainly the Hip Shield deformation should be improved in the simulation models.

Thank You For Your
Kind Attention