Latest Developements for FAT and PDB Dummy models

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Abstract:

The need for accurate validated dummy models is growing more and more. This paper describes the latest investigations for validating the FAT and PDB dummy models. New validation test results are shown and the latest releases of the models are explained. Furthermore an outlook for future validation tests and dummy releases is given.

Keywords:

Dummy models, FAT, PDB, model validation, child safety

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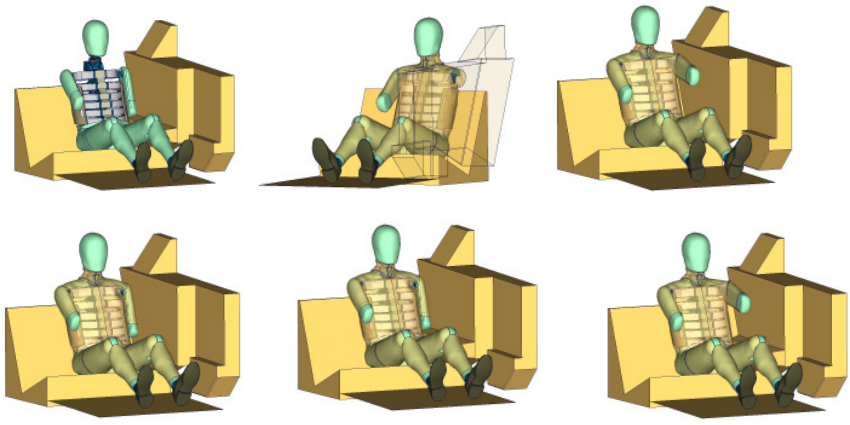
- P-Dummies
  - P3
  - P1.5

WorldSID 50th v2.0 PDB

- V2.0 PDB WSID includes barrier validation of the following test configurations
- Available since September 2010



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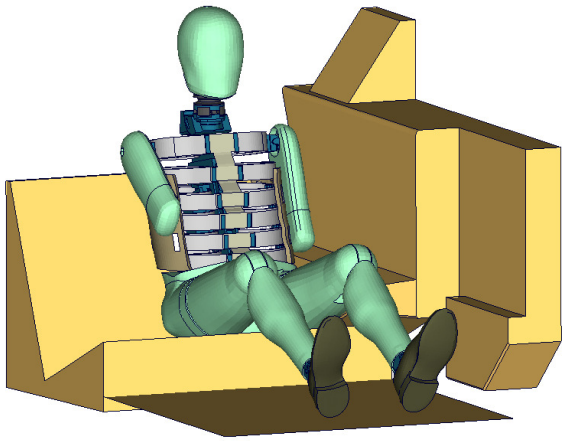
WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



WorldSID 50th v2.0 PDB

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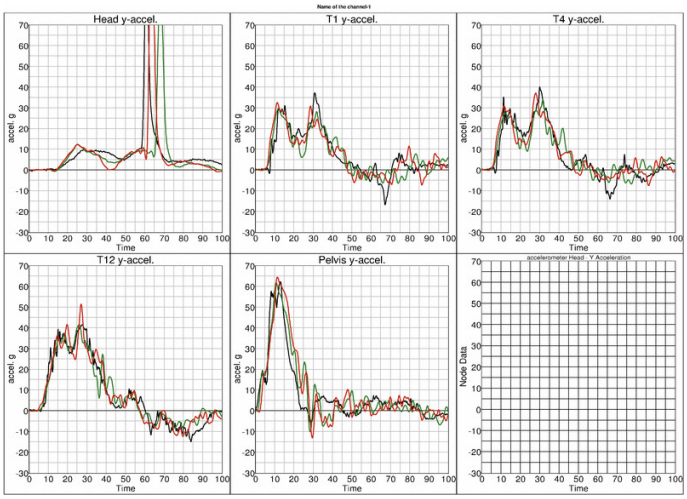
  - 6.0 m/s



WorldSID 50th v2.0 PDB

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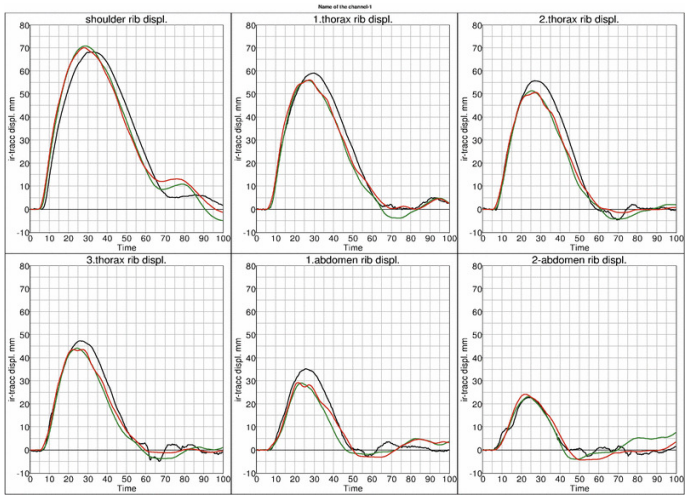

WorldSID 50th v2.0 PDB

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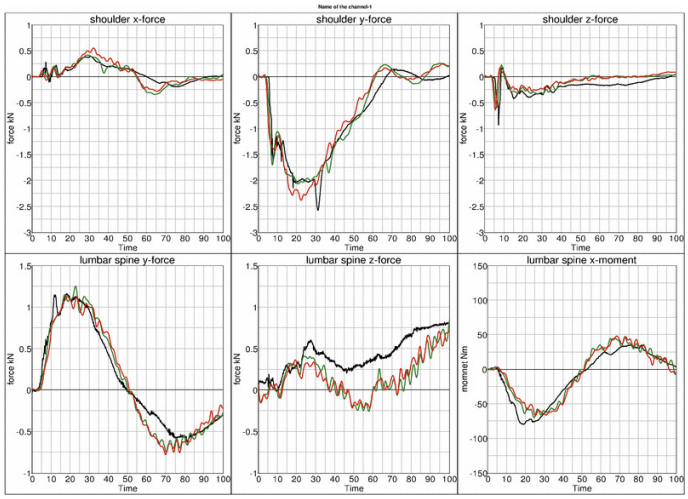

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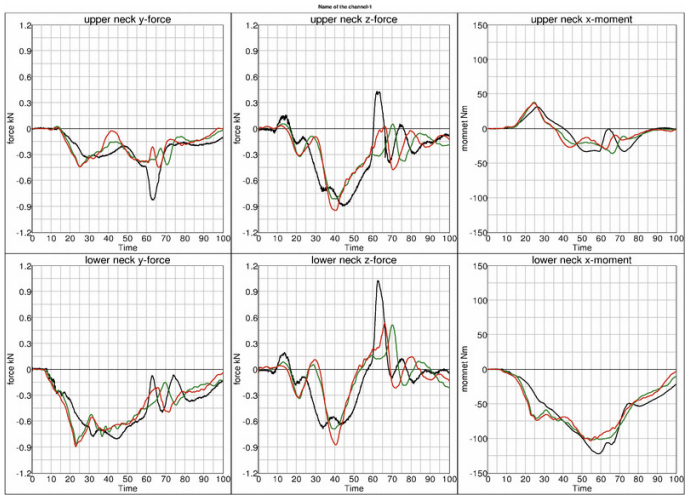
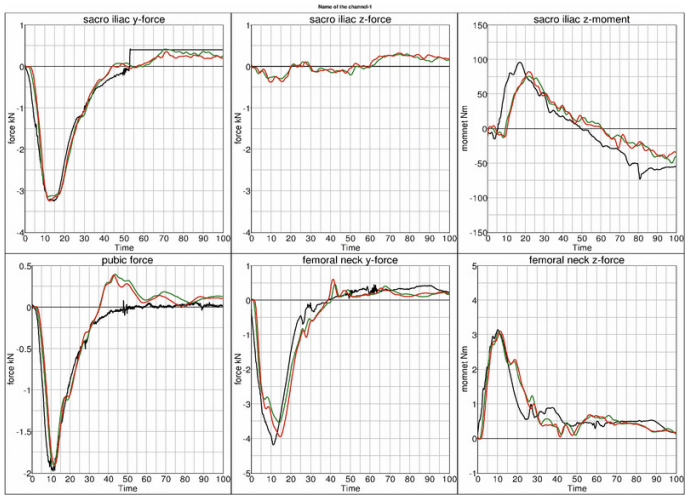
WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



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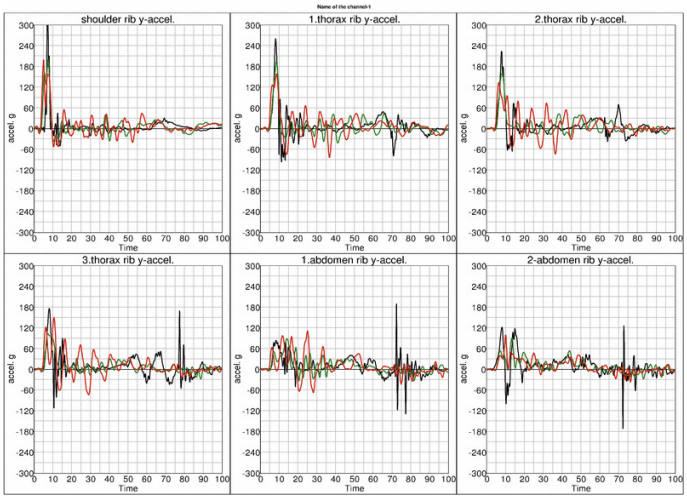
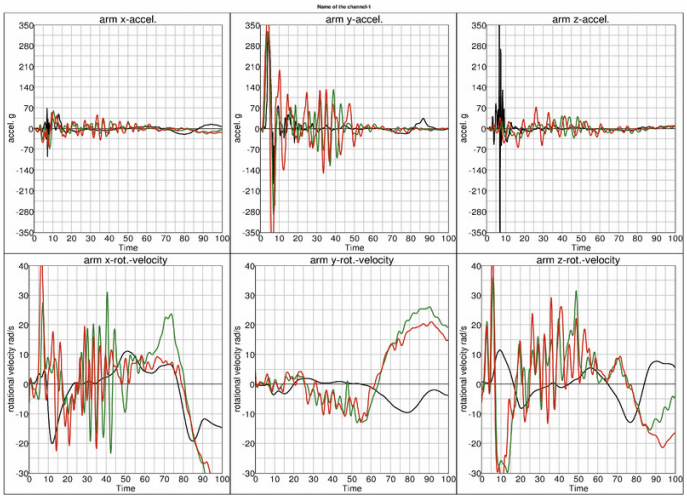
WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



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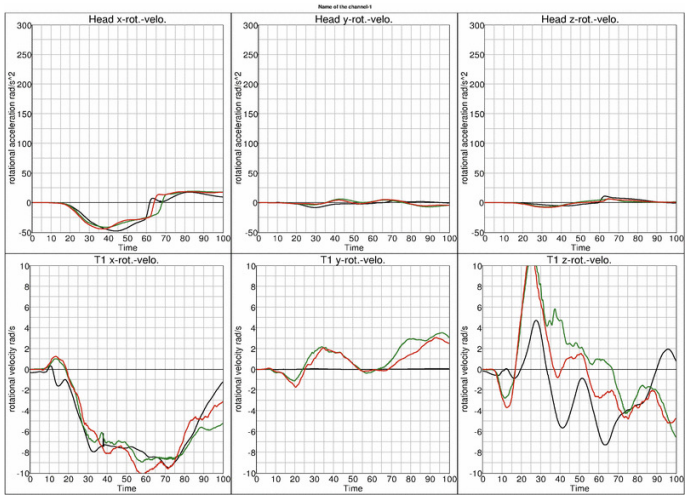
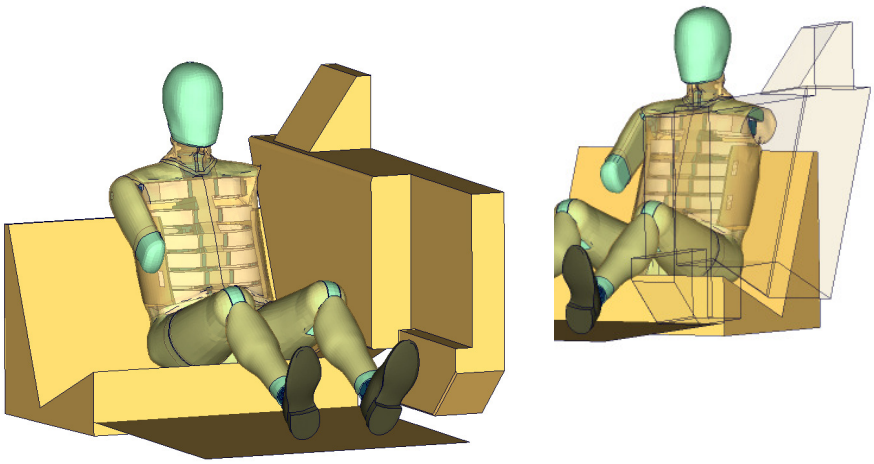
WorldSID 50th v2.0 PDB

- D3 barrier without jacket; arm first notch:
  - 6.0 m/s



WorldSID 50th v2.0 PDB

- D1 barrier with jacket; without arm:
  - 5.0 m/s



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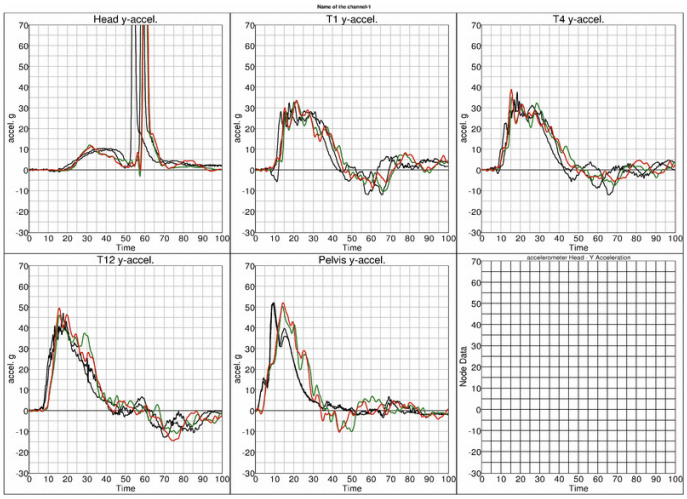
WorldSID 50th v2.0 PDB

- D1 barrier with jacket; without arm:
  - 5.0 m/s



WorldSID 50th v2.0 PDB

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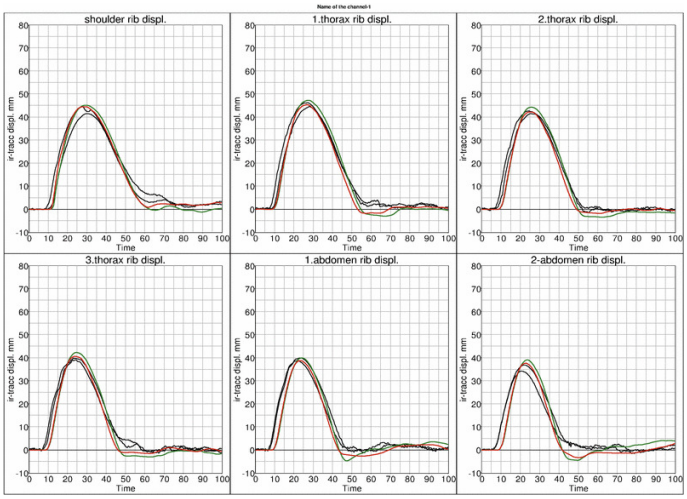

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WorldSID 50th v2.0 PDB

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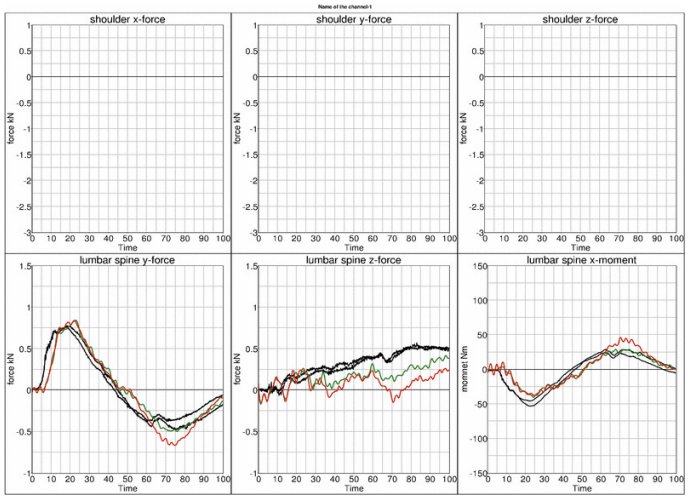

WorldSID 50th v2.0 PDB

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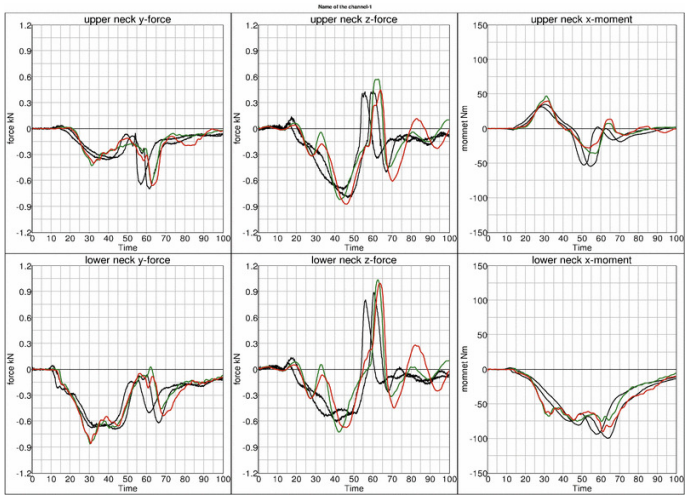

WorldSID 50th v2.0 PDB

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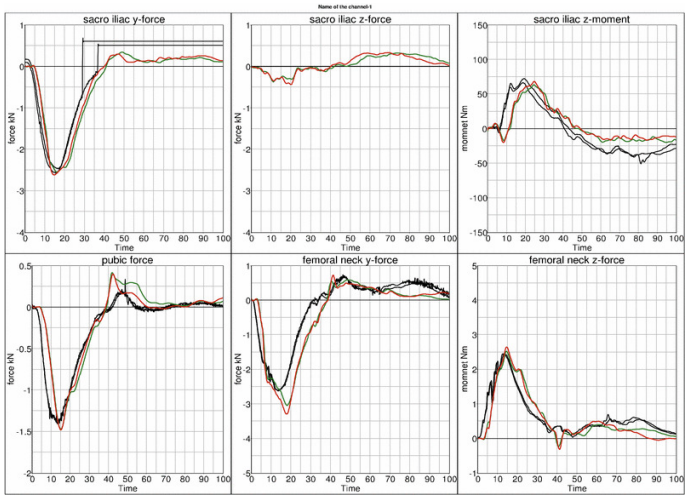

WorldSID 50th v2.0 PDB

- D1 barrier with jacket; without arm:
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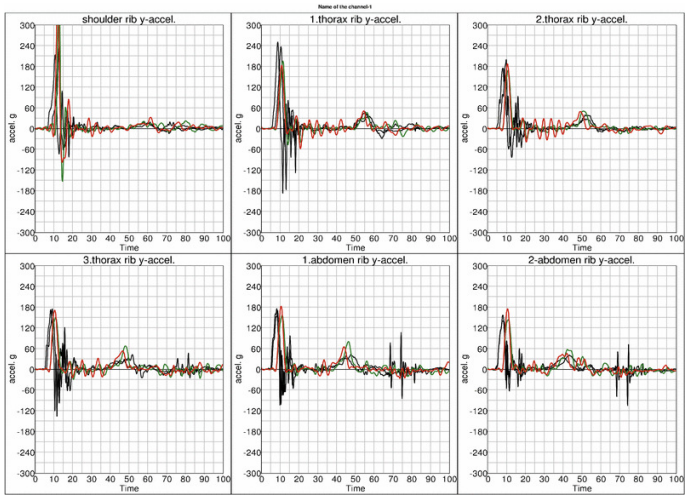

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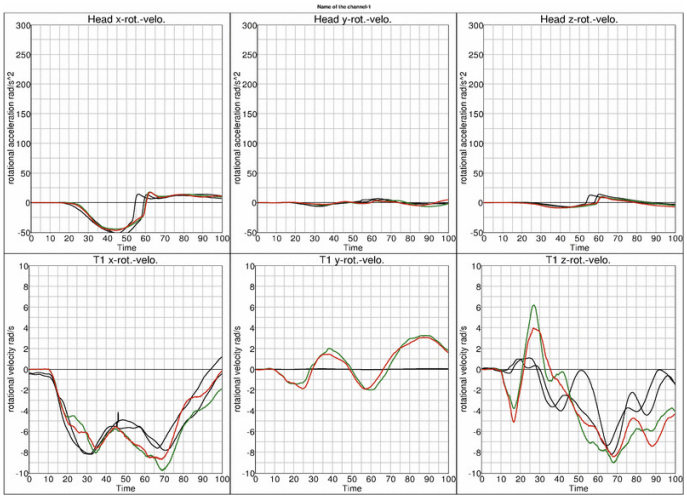
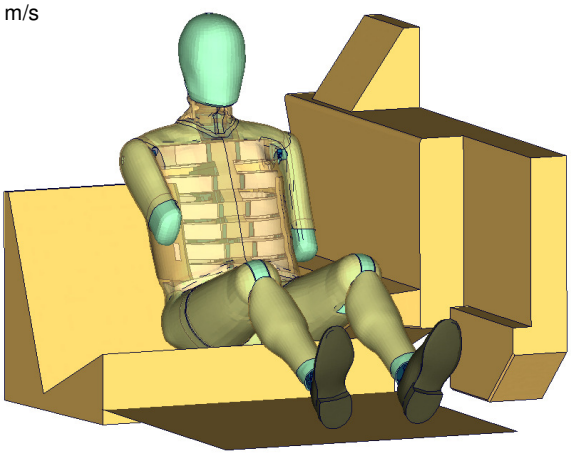
WorldSID 50th v2.0 PDB

- D1 barrier with jacket; without arm:
  - 5.0 m/s



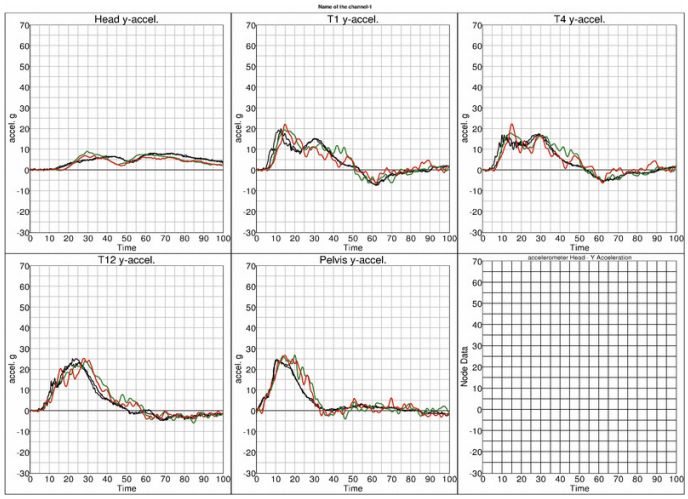
WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 3.5 m/s
  - 6.0 m/s



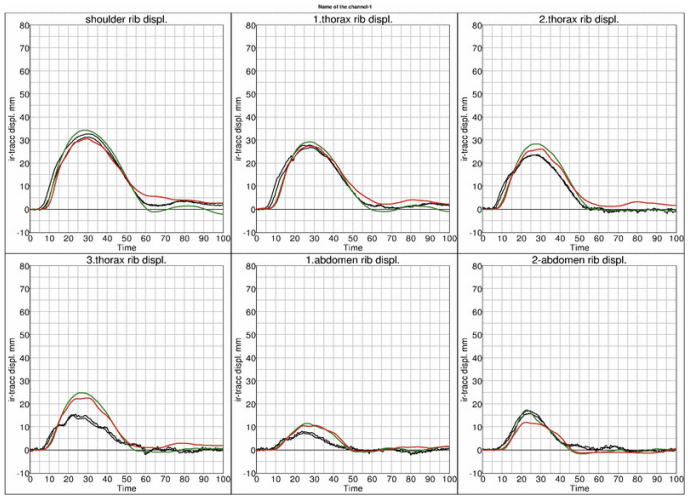
WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 3.5 m/s



WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 3.5 m/s



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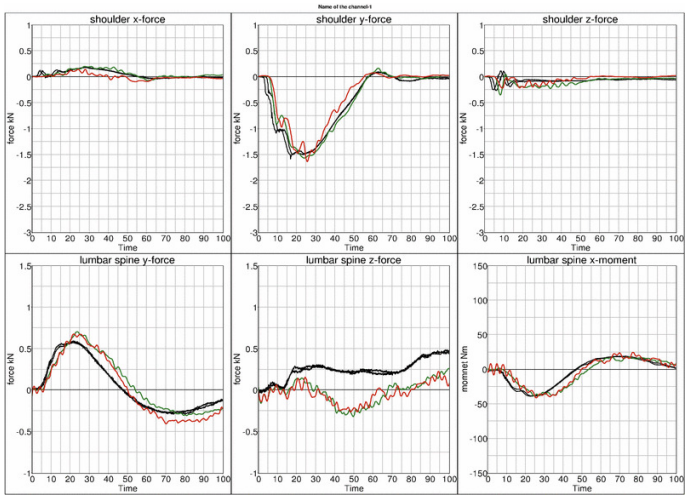
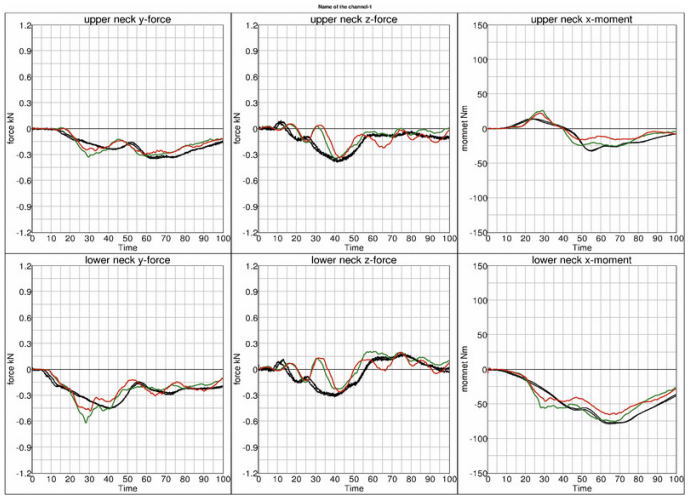
WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 3.5 m/s



WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 3.5 m/s



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WorldSID 50th v2.0 PDB

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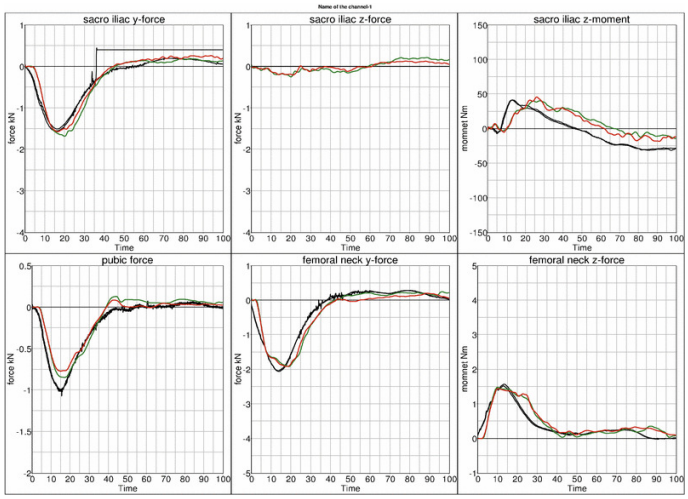
  - 3.5 m/s



WorldSID 50th v2.0 PDB

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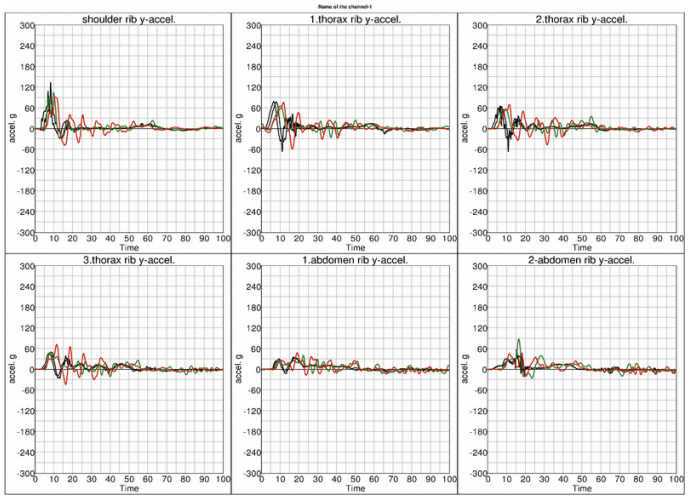

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WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
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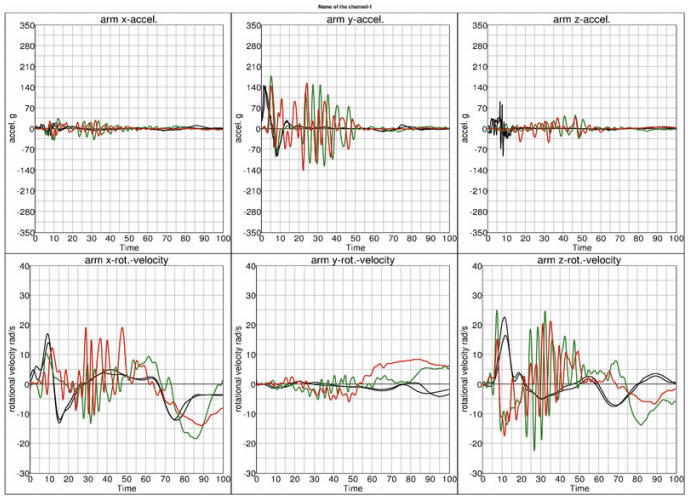

WorldSID 50th v2.0 PDB

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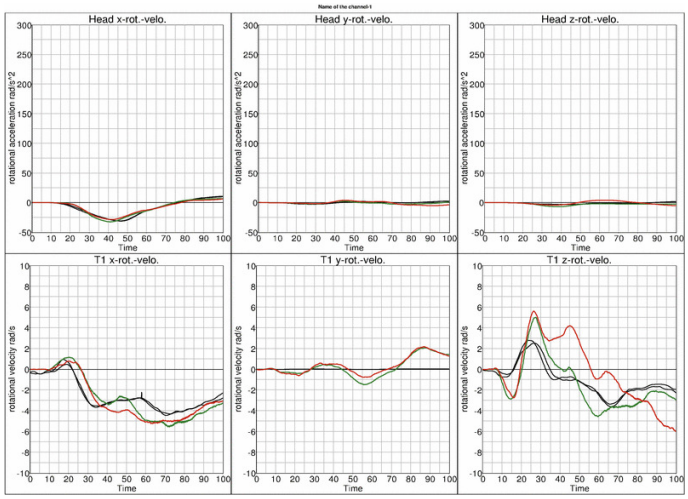

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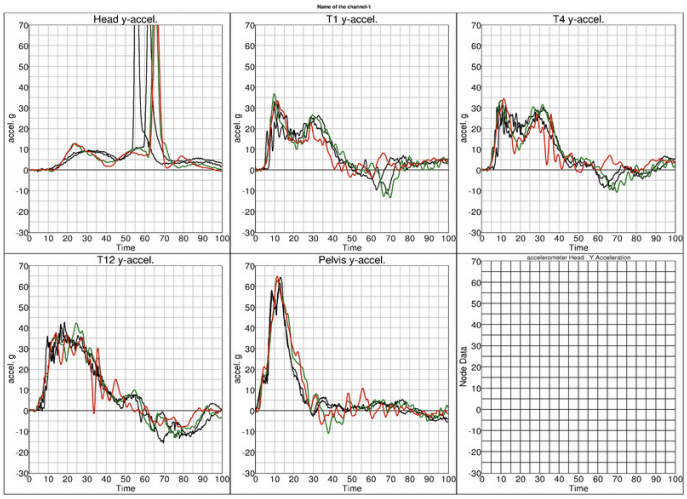
WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
  - 6.0 m/s



WorldSID 50th v2.0 PDB

- D3 barrier with jacket; arm first notch:
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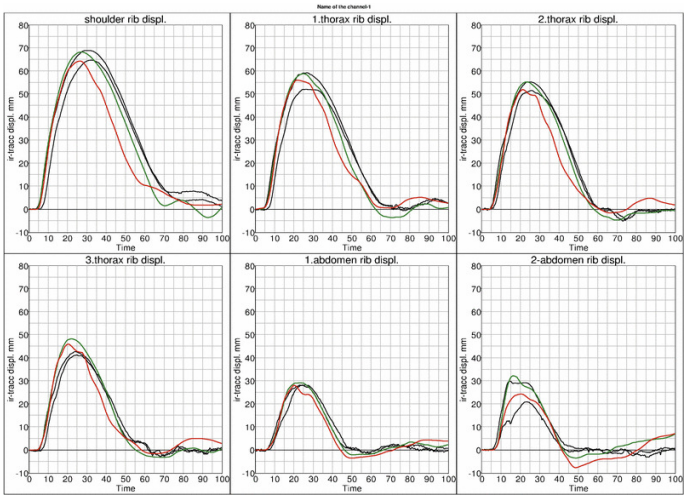

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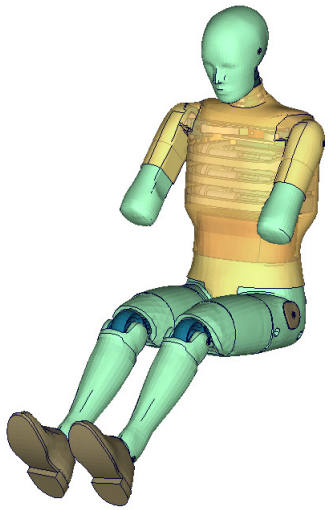
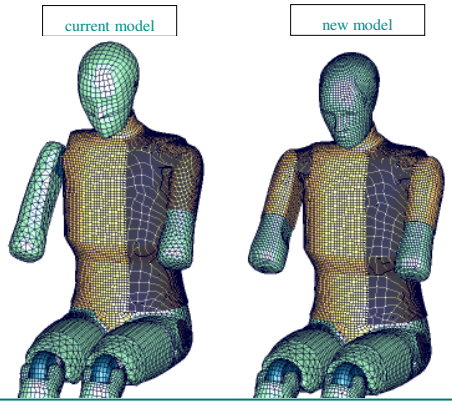
EuroSID-2 v5.0 PDB

- ES2 / ES2re v4.5 still available
- PDB ES2 / ES2re update
  - Geometric updates
  - New material tests
  - Additional components tests
  - Sled test for ES2re



EuroSID-2 v5.0 PDB

- The dummy model now provides identical arm models and a complete new mesh of the head
- The dummy jacket is now closed in the shoulder area on both sides. Furthermore the jacket is expanded in front and back and is connected to the pelvis flesh mesh.



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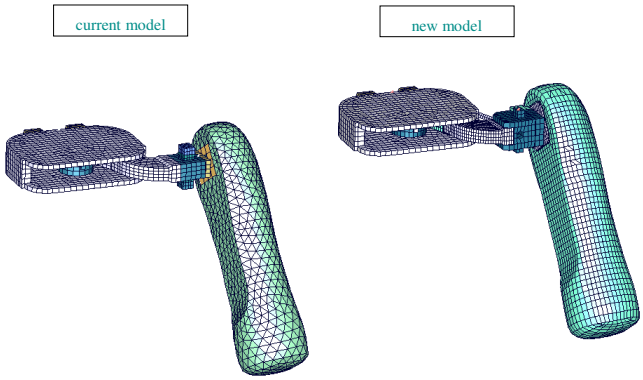
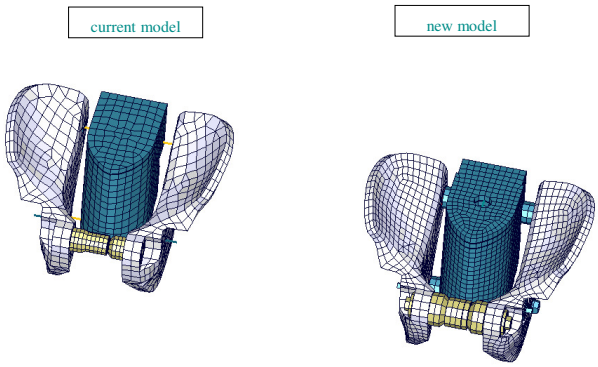
EuroSID-2 v5.0 PDB

- New mesh of the clavicle box assembly
- A hexahedron mesh is used for the arm now



EuroSID-2 v5.0 PDB

- New mesh of the inner pelvis assembly now includes screw heads, spacers and washers



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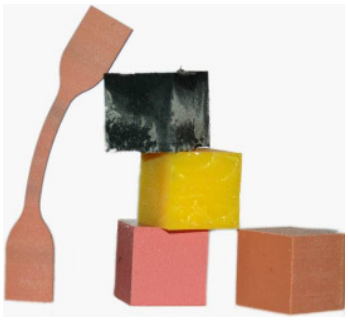
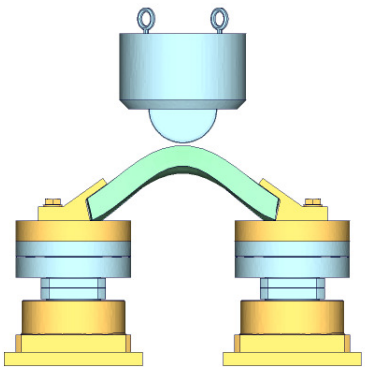
EuroSID-2 v5.0 PDB

- PDB ES2 /ES2re
- New additional material tests are conducted for:
  - shoulder foam
  - plastic clavicle
  - upper/lower arm foam
  - arm bone
  - rubber lumbar spine
  - plastic iliac wing
  - pelvis back-plate buffer
  - femur stopper



EuroSID-2 v5.0 PDB

- Tests on the abdomen slabs with impactor at 2 different velocities.
- Load cells located in the support



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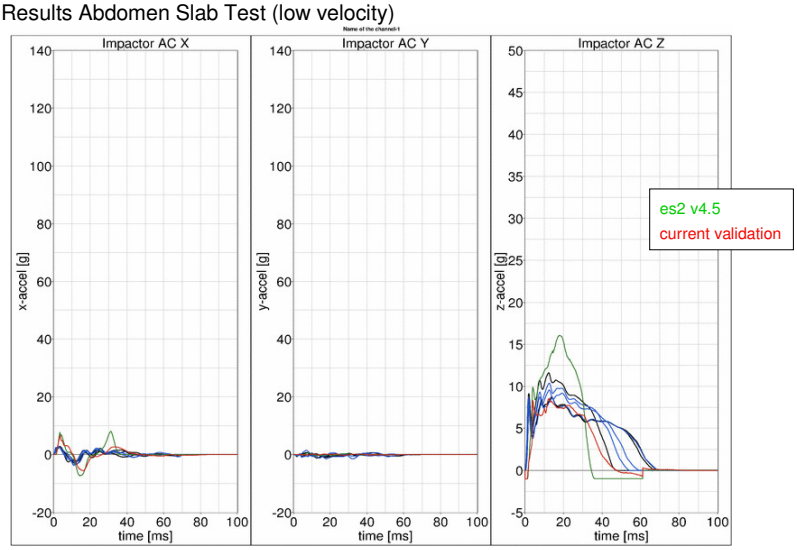
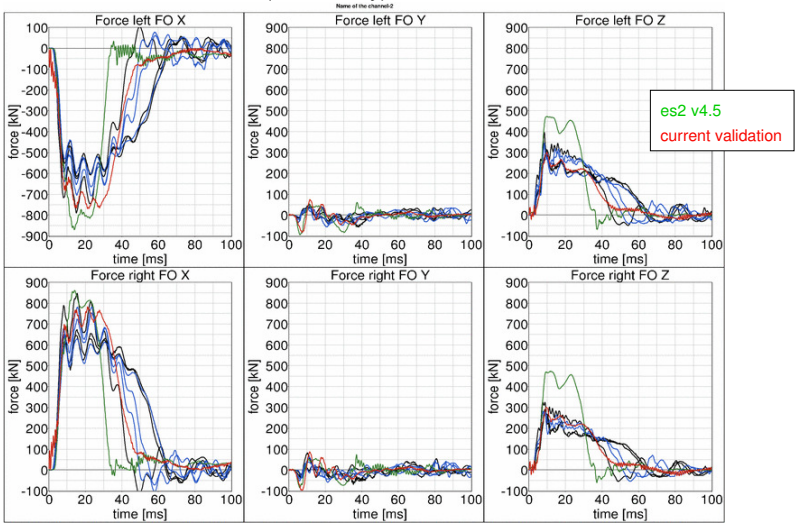
EuroSID-2 v5.0 PDB

- Results Abdomen Slab Test (low velocity)



Abdomen Slab - Test

- Results Abdomen Slab Test (low velocity)



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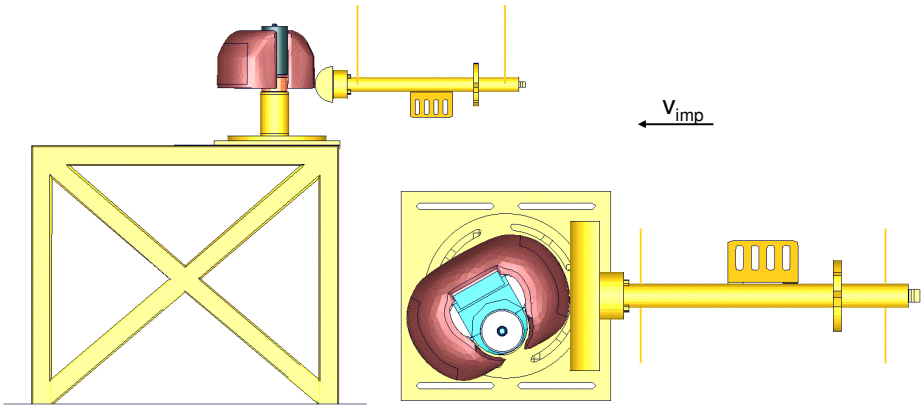
EuroSID-2 v5.0 PDB

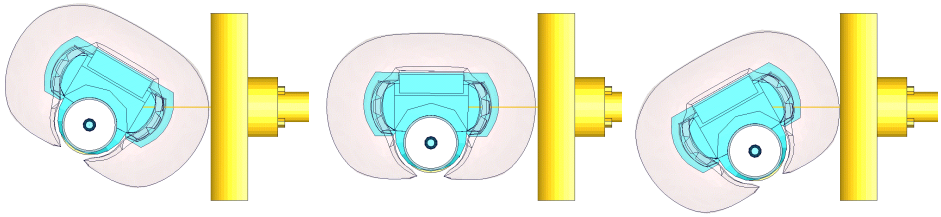
- Tests on the abdomen in to 2 different impact heights, 3 angles and 3 velocities.



EuroSID-2 v5.0 PDB

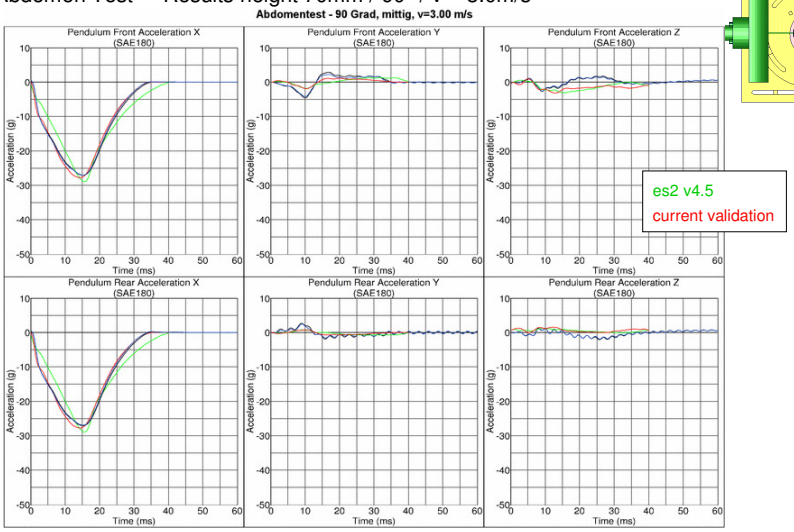
- 3 three impact angles

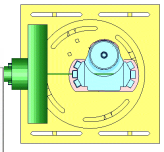
angle of 60 degree: angle of 90 degree: angle of 120 degree:

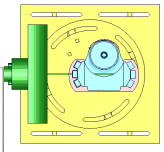


EuroSID-2 v5.0 PDB

- Abdomen Test – Results height 70mm / 90° / v = 3.0m/s







EuroSID-2 v5.0 PDB

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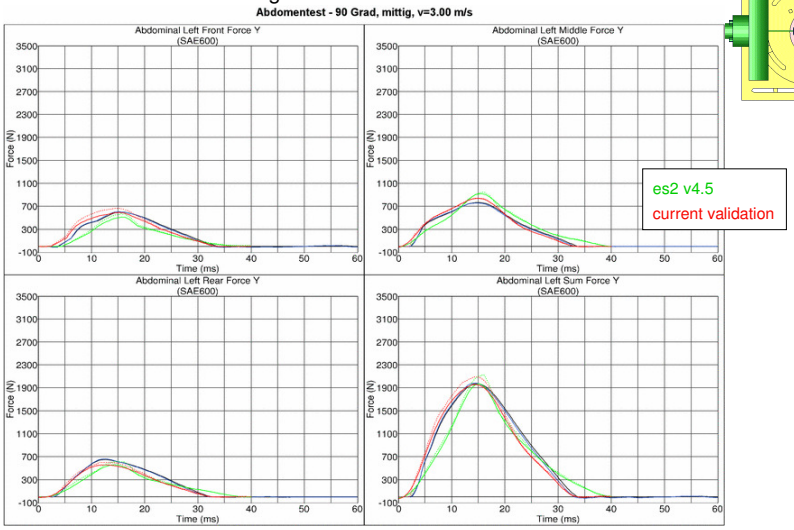

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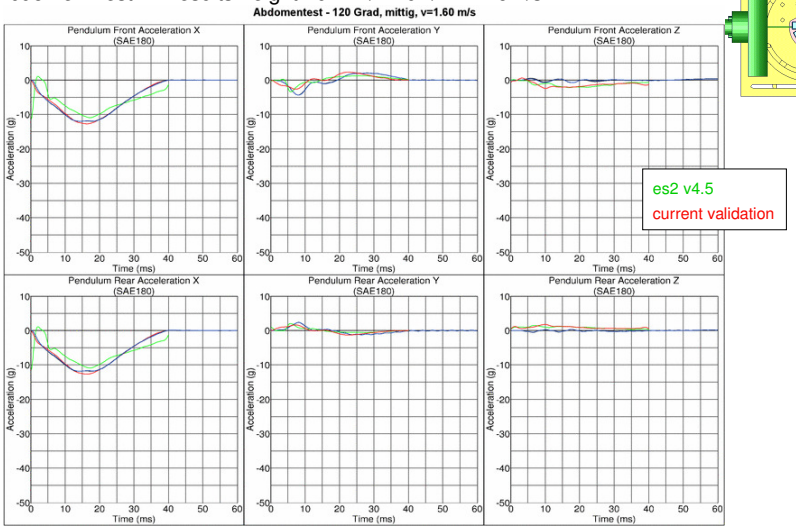
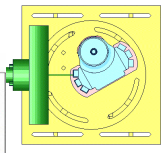
EuroSID-2 v5.0 PDB

- Abdomen Test – Results height 70mm / 120° / v = 1.6m/s

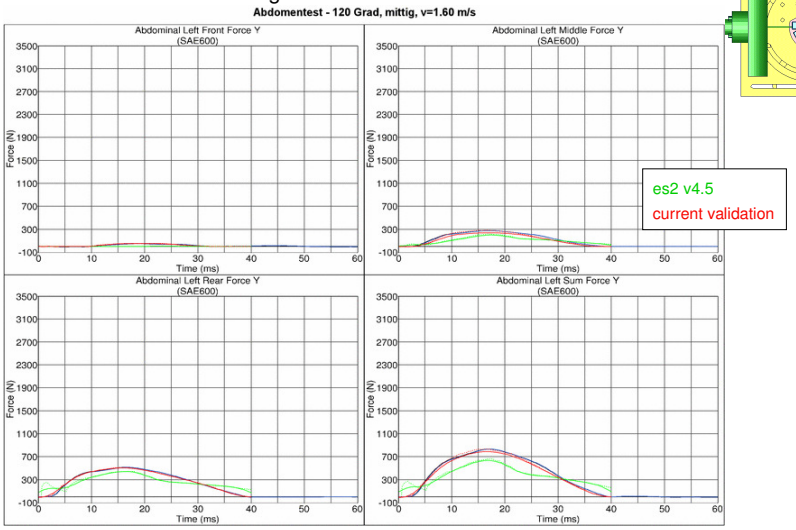


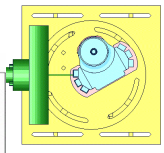


DYNA MORE

EuroSID-2 v5.0 PDB

- Abdomen Test – Results height 70mm / 120° / v = 1.6m/s

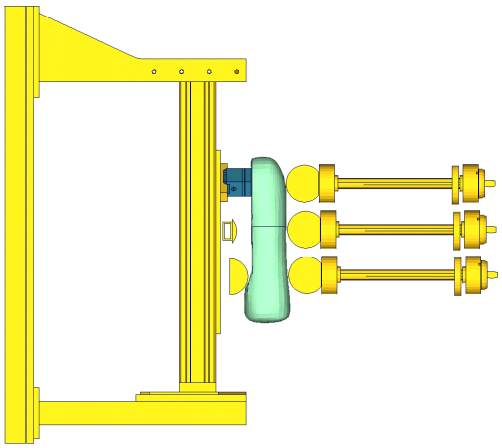




DYNA MORE

EuroSID-2 v5.0 PDB

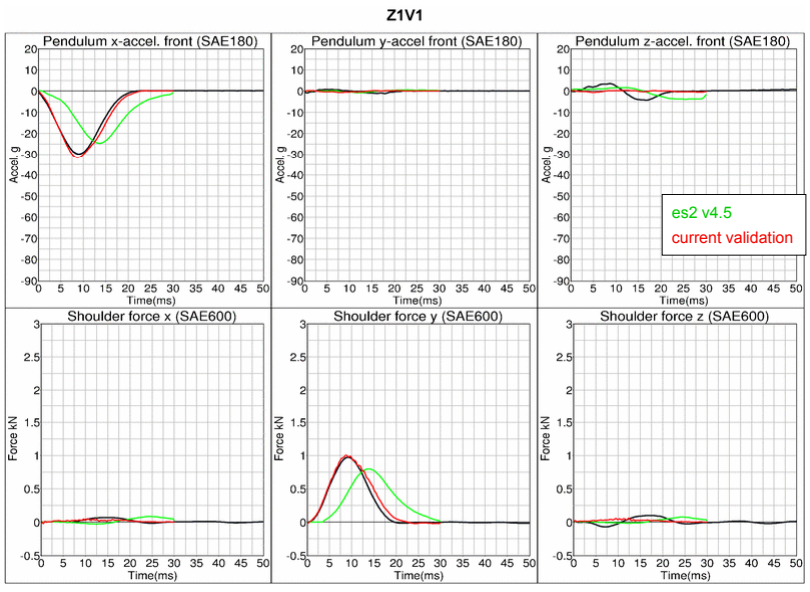
- Tests on complete arm at two velocities, at 3 locations of the arm and an additional set of tests with different positions of the middle and bottom supports of the test structure and higher velocities.



Impact positions:

Z1V[1/2]
Z2V[1/2]
Z3V[1/2]

EuroSID-2 v5.0 PDB



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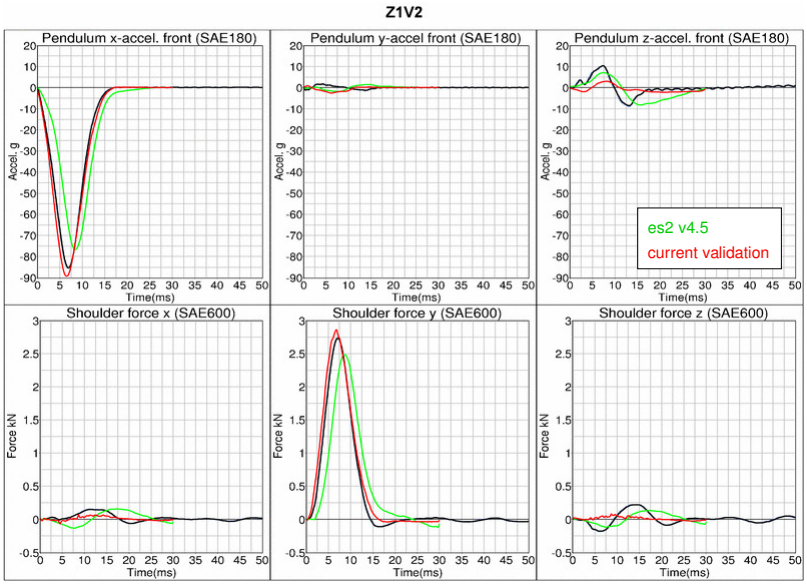
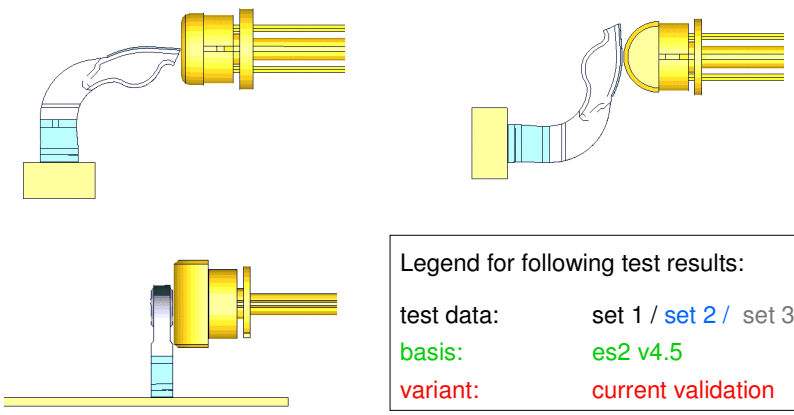
EuroSID-2 v5.0 PDB



EuroSID-2 v5.0 PDB

- Impact in three different directions and different velocities

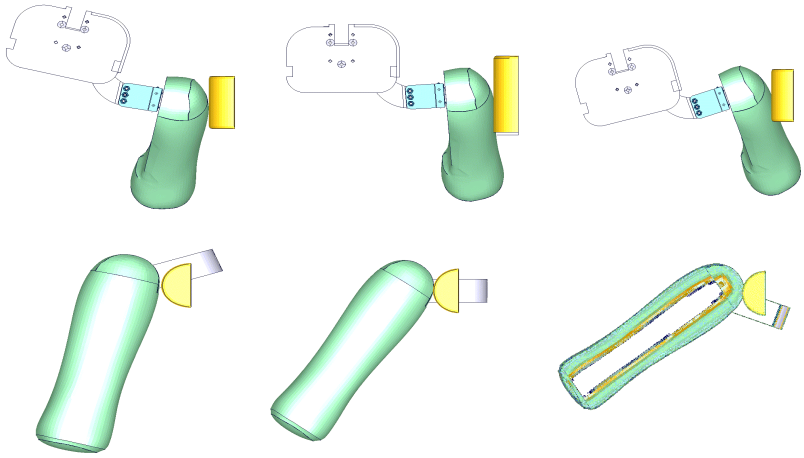


Legend for following test results:

test data:	set 1 / set 2 / set 3
basis:	es2 v4.5
variant:	current validation

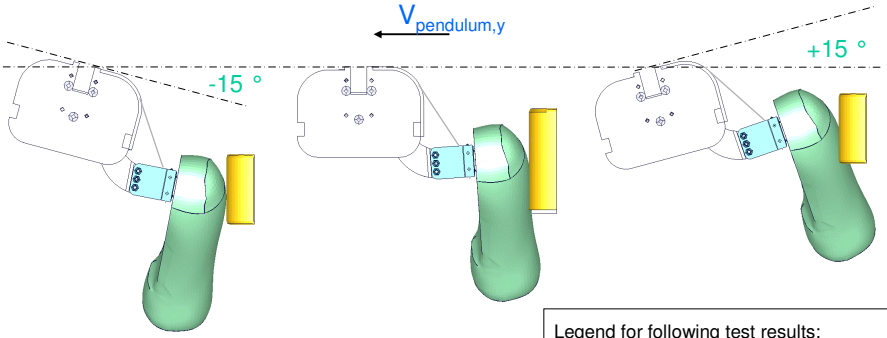
EuroSID-2 v5.0 PDB

- Impact on the arm, clavicle and clavicle box system in use of different angles and velocities.



EuroSID-2 v5.0 PDB

- Impact on the arm, clavicle and clavicle box system in use of different angles and velocities.



Legend for following test results:
test data: set 1 / set 2 / set 3
basis: es2 v4.5
variant: current validation

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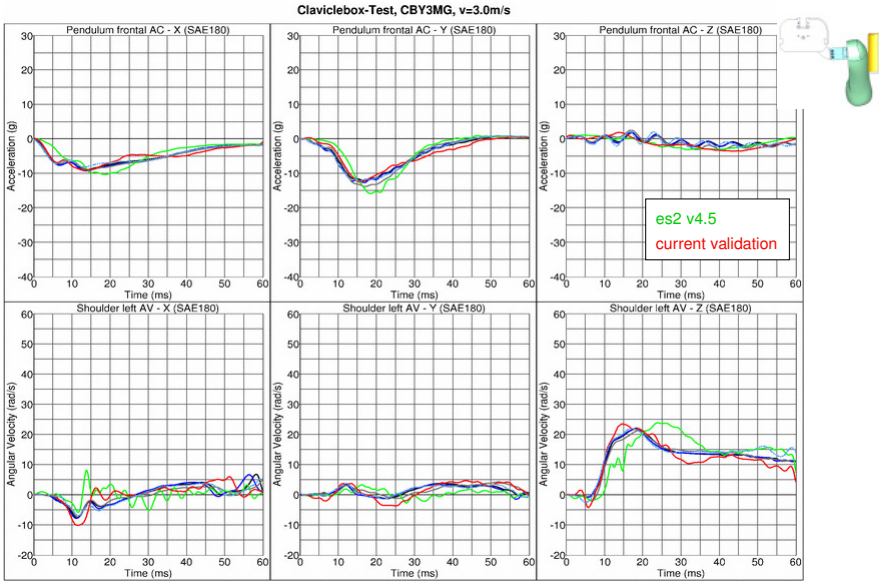
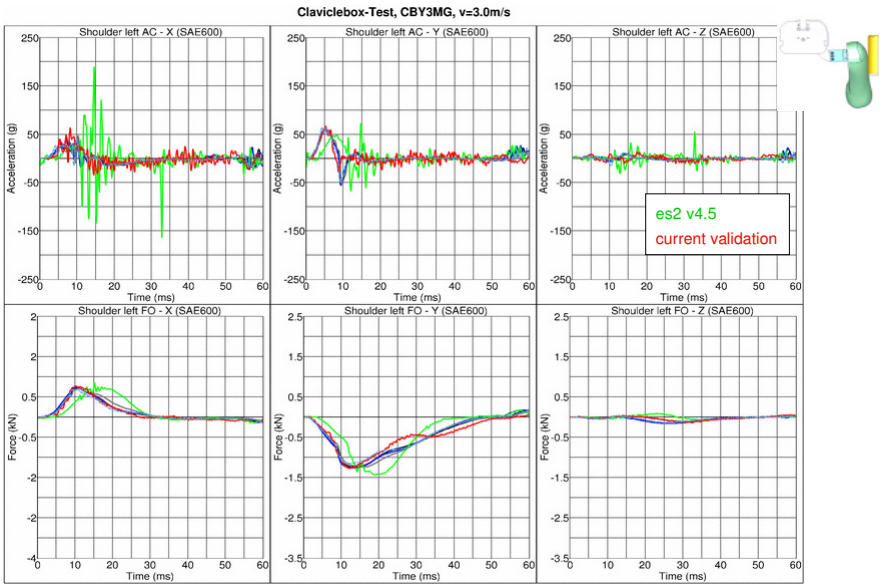
EuroSID-2 v5.0 PDB



EuroSID-2 v5.0 PDB



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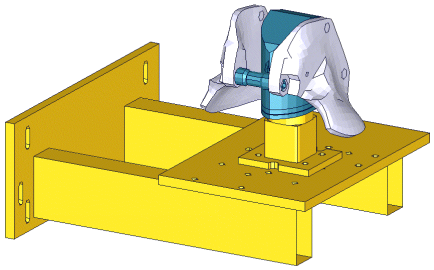
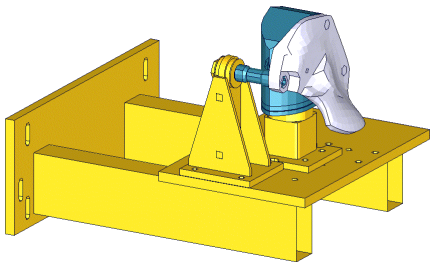
EuroSID-2 v5.0 PDB

- Tests are carried out with the Iliac wings in 2 different boundary conditions:
  + Constraint at the Sacrum block, *with both Iliac wings*
  + Constraint at the Sacrum block and at the load cell on the Pubic bone, *with one Iliac wing and additional fixture*



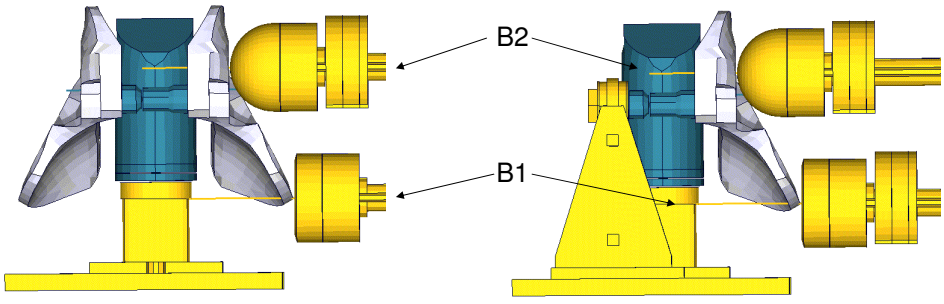
Loadcase F1



Loadcase F2

EuroSID-2 v5.0 PDB

- For each load-case F1 & F2 are 2 impact positions, each with a different pendulum head. The pendulums in turn have 2 velocities at each position.



Loadcase F1 Loadcase F2

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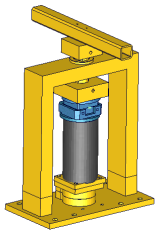
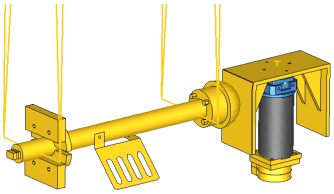
EuroSID-2 v5.0 PDB

- Modifications since v4.5:
  - completely new modeled T12 load cell
  - completely new sphere joint at the lower side
- Material used from EMI material tests:
  - Lumbar spine rubber
- Simulated tests:

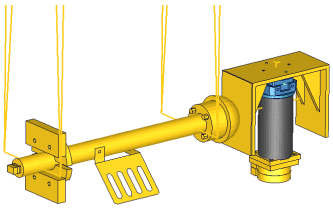
Torsion



Biegung



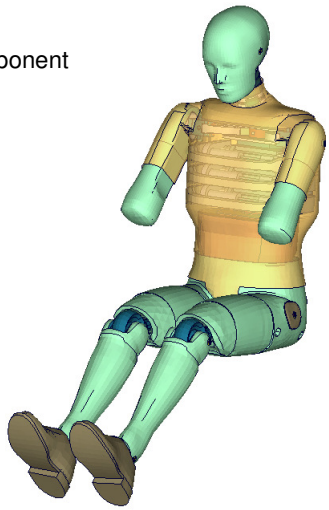
Scherung



EuroSID-2 v5.0 PDB

- Small update v4.5 available.
- Large update (v5.0) including all component tests and available sled tests

→ available at the beginning of 2011



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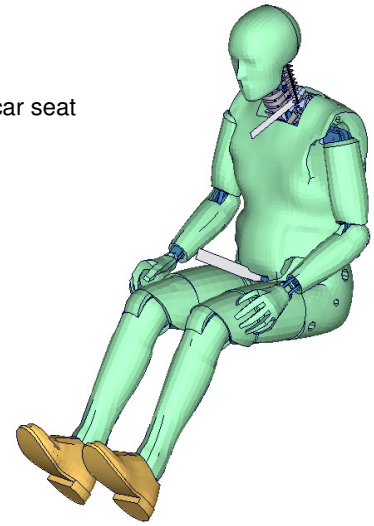
BioRID v3.0 FAT

Content:

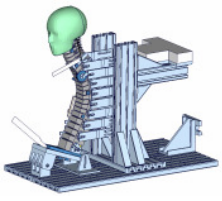
- BioRID v2.5 (still available)
  - Extraction of results in an sports car seat
- BioRID v3.0 update
  - Planned changes in the Model

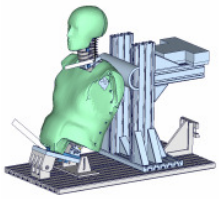


BioRID v3.0 FAT

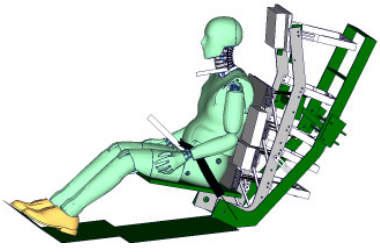
BioRID v2.5 validation tests:

- Component tests:

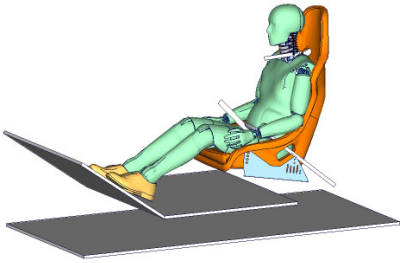




- Simplified seat tests
  (full dummy validation BioRID v2.0)



- Sports car seat tests
  (full dummy validation BioRID v2.5)



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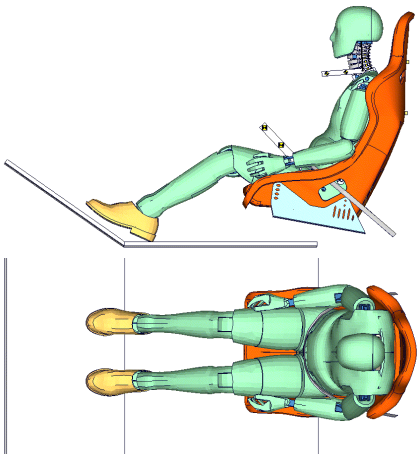
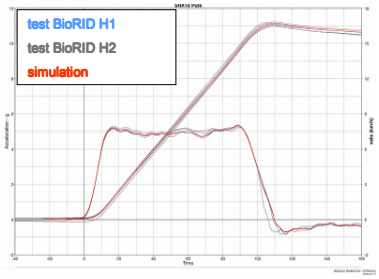
BioRID v3.0 FAT

BioRID v2.5 in sports car seat in use of the SRA16 Pulse:

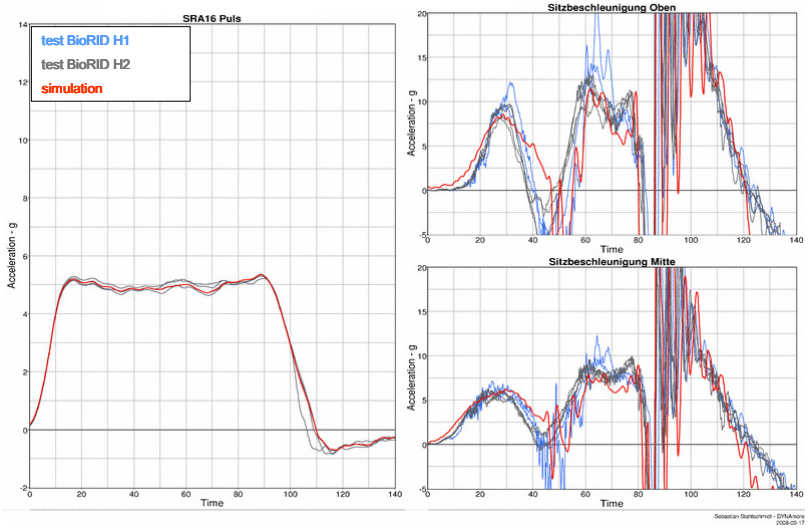
- The sled is loaded by an 5 g trapezoidal pulse.





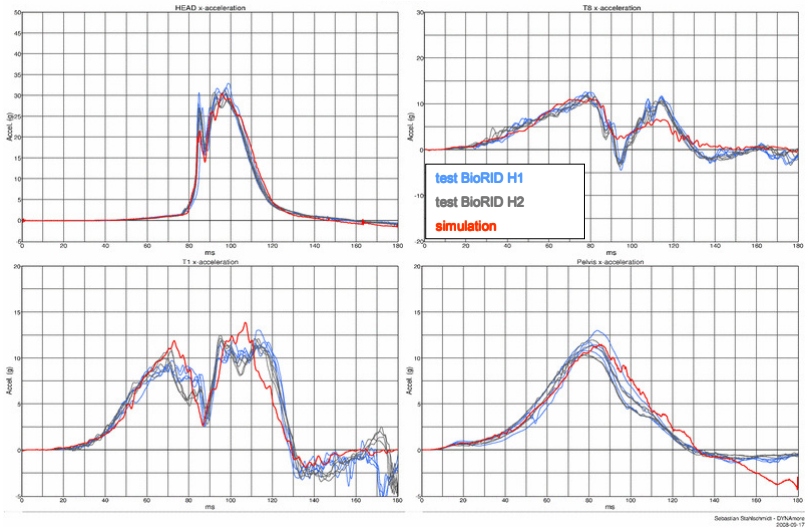
BioRID v3.0 FAT

Results of BioRID2: SRA16 pulse



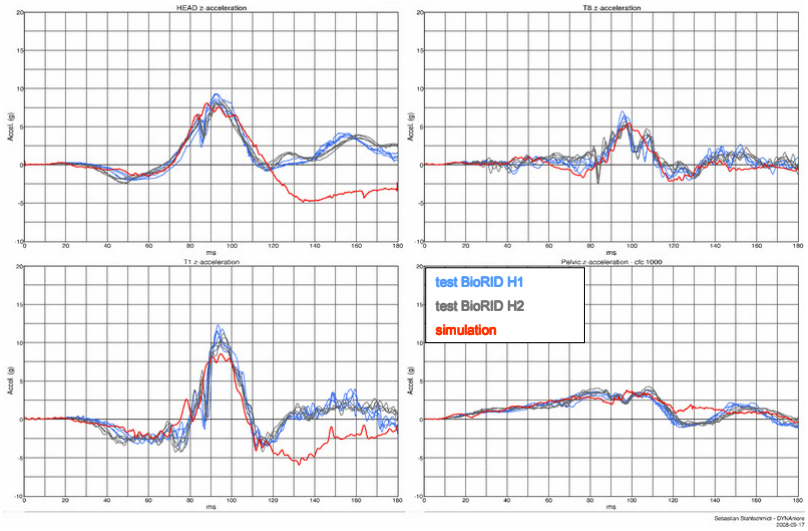
BioRID v3.0 FAT

Results of BioRID2: SRA16 pulse



BioRID v3.0 FAT

Results of BioRID2: SRA16 pulse



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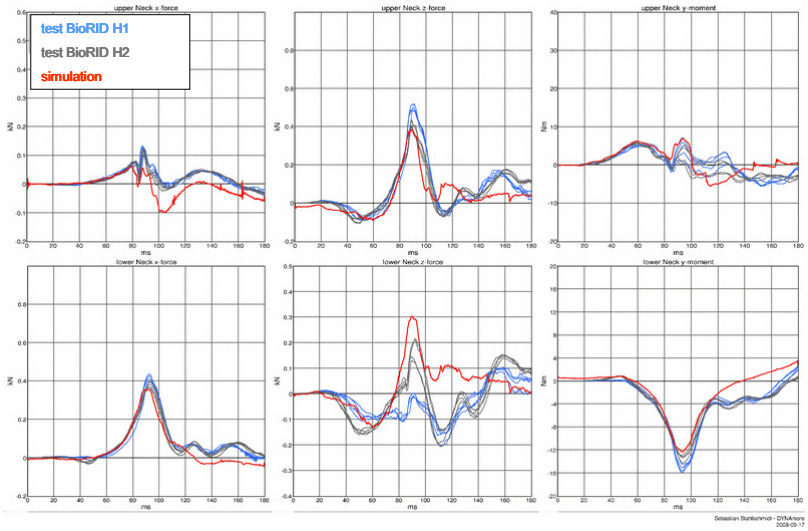
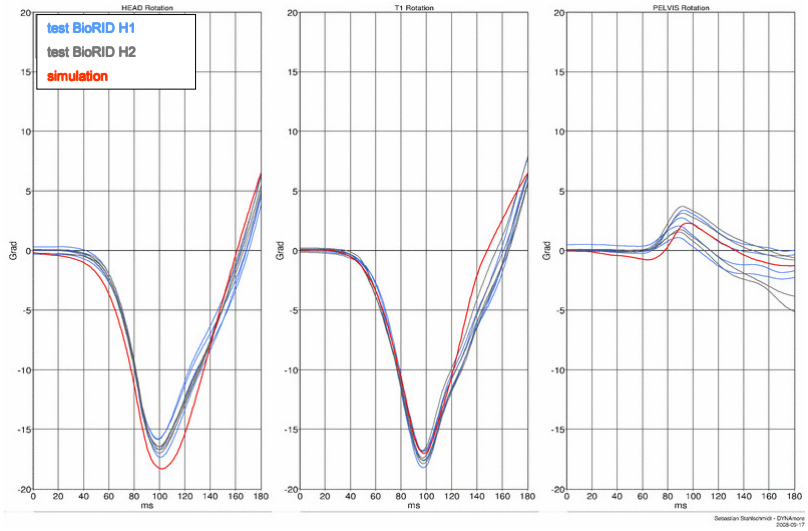
BioRID v3.0 FAT

Results of BioRID2: SRA16 pulse



BioRID v3.0 FAT

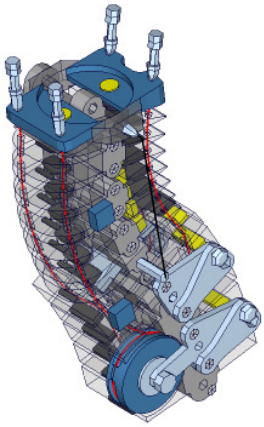
Results of BioRID2: SRA16 pulse



BioRID v3.0 FAT

BioRID v3.0 updates:

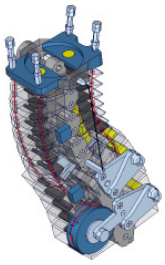
- The focus of the BioRID v3.0 update is on the usability of the model
- The current BioRID models use for the neck cable seatbelt elements and a lot of slip rings
- Due to positioning simulations in use of an full deformable BioRID model the seatbelt elements move through the slip rings because the neck is deforming
- For further simulations after this process all seatbelt elements must be meshed new, or repaired by using a small program



BioRID v3.0 FAT

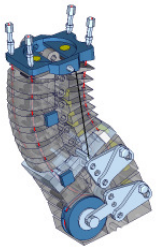
BioRID v3.0 updates:

- For the BioRID v3.0 all seatbelt and slip ring elements should be removed from the model
- The cable is then modeled in use of normal beam elements which also provide a bending stiffness in the cable
- The cable is in an normal contact to the vertebras and the cable path is backed by an CONTACT_GUIDED_CABLE



Seatbelt elements guided by slip rings

Beam elements guided by contacts



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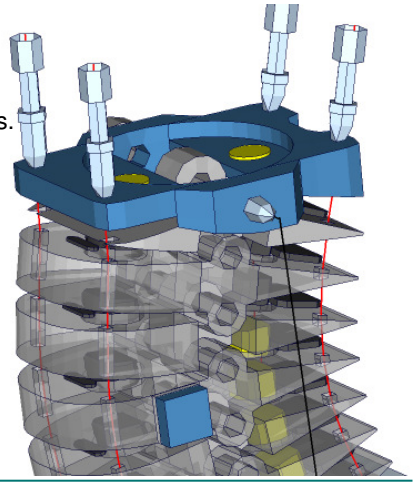
BioRID v3.0 FAT

BioRID v3.0 updates:

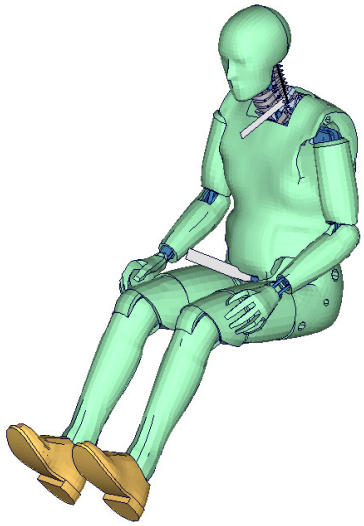
- Because of this modeling technique the BioRID tests have to be validated all over again
- The main component of the BioRID model is changed and the validation of the component tests is at the moment in progress.
- After the validation of component tests the full dummy tests are validated for the BioRID v3.0



BioRID v3.0 FAT

BioRID releases schedule:

- BioRID v2.5 is still available
  - Since November 2008
- BioRID v3.0 is still in progress
  - Planed for end of 2010



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P-Dummies v0.0

Content:

- Motivation and targets for the development of the P-Dummies (P1.5 and P3.0)
- Planned Project workflow
  - Geometry scan
  - CAD data creation
  - Mesh creation
  - Model assembling and input data
  - Validation simulations

P1.5 Child Dummy USERS Manual, March 2004

P-Series Child Dummies P3/4,P3,P6,P10, November 2000

P-Dummies v0.0

Targets for the model development:

- The models should be developed in a very short time window
- Mass validated model
- No material tests should be done
- Only similar material data of other dummies are used and being adjusted
- The calibration test of the manual should be fulfilled
  - Joint stiffness adjustments
  - Static neck and lumbar spine test
- Seat tests of the P3 was provided by Opel
- Daimler Chrysler Bangalore will provide sled tests including the P1.5

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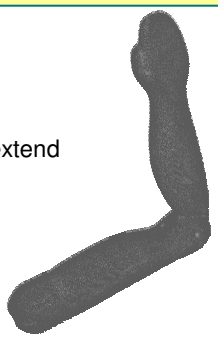
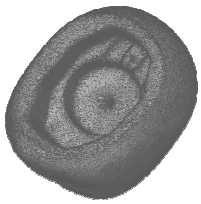
P-Dummies v0.0

Workflow – Geometry scan:

- The geometry creation is done by laser scanning
- The models were disassembled to a reasonable extend
- Scanned components:
  - Head
  - Neck
  - Neck load cell
  - Torso
  - Lumbar spine
  - Pelvis
  - Arms/Legs

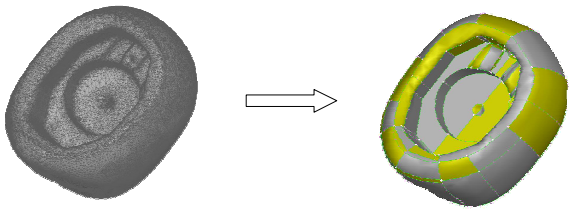




P-Dummies v0.0

Workflow – CAD data creation:

- Target is not to get complete CAD data set of the models
- The step from STL data to meshed parts should be very short
- Important surfaces are joint together for meshing
- Highly concave sections or geometry are added by hand (ANSA, Hypermesh)
- Thus design of a few contours is not based on approximated data



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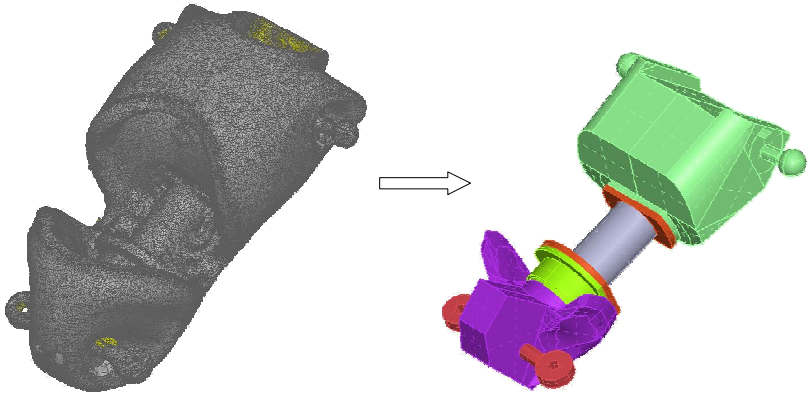
P-Dummies v0.0

Workflow – CAD data creation:

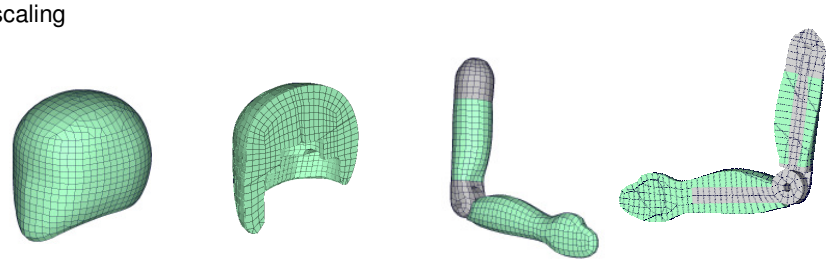
- Hidden contours were generated manually:



P-Dummies v0.0

Workflow – Mesh creation:

- The single components will be meshed by using a element length of 5-8mm
- All parts are meshed by solid elements covered with contact shells if needed
- The time step size will approximately be 1.0E-3 ms without mass scaling



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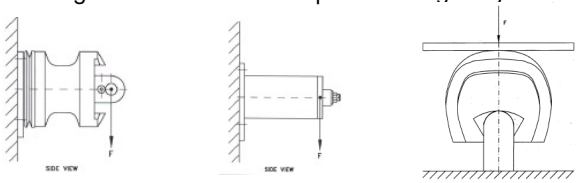
P-Dummies v0.0

Workflow – validation simulations:

- In a first step the calibration definitions of the manual are used to adjust the first behavior of the models
  - Joint stiffness under gravity load

P1.5 Child Dummy USERS Manual, March 2004

  - Bending of neck and lumbar spine under gravity load

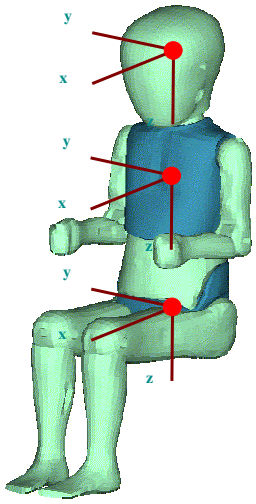


P1.5 Child Dummy USERS Manual, March 2004

P-Dummies v0.0

The P3 dummy model v0.0

- Model size: 45000 nodes, 75000 elements
- Masses validated
- Fulfills calibration tests
- Provides 3 accelerometers (SAEJ211 norm)
- Upper neck load cell avialable in V1.0
- Step size: 1 µs
- No encryption of the model input
- Provides a primer tree file for positioning
- V1.0 including sled test validation will be available in October 2010



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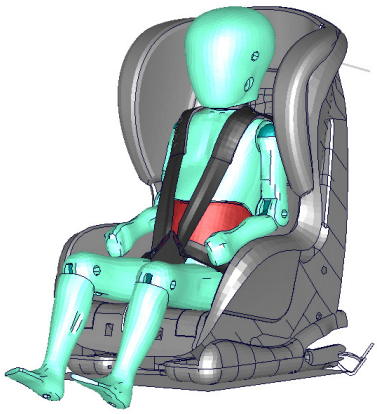
P-Dummies v0.0

P3 model validation

- Sled test on a Britax Römer Duo Plus provided by Opel
- 4 different pulses
- Signals for validation
  - Kinematics
  - Seat rotation
  - Dummy accelerations
  - Upper neck load cell

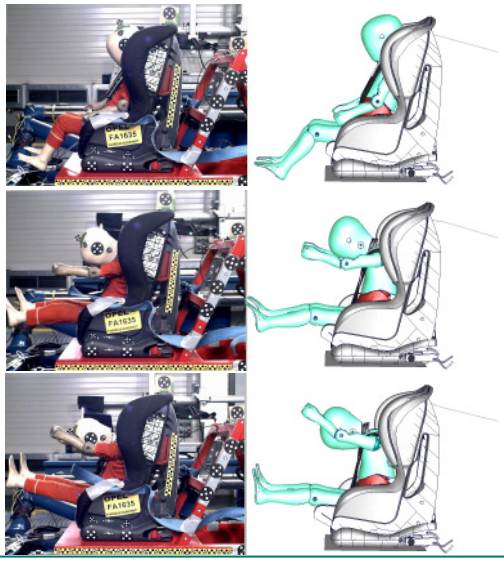
    forces and momentum



P-Dummies v0.0

Kinematic screenshots

- Sled test
  - 50ms
  - 90ms
  - 110ms



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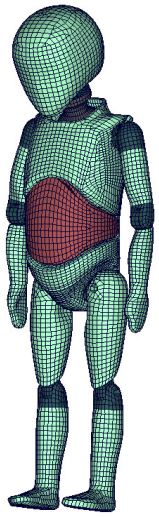
P-Dummies v0.0

The P1.5 dummy model v0.0

- Model size: 39000 nodes, 50000 elements
- Masses validated
- Fulfills calibration tests
- Provides 3 accelerometers (SAEJ211 norm)
- Upper neck and lumbar load cell available
- Step size: 1 µs
- No encryption of the model input
- Provides a primer tree file for positioning
- V1.0 including sled test validation will follow



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