

### **MADYMO Quality Report Release Update**

Hybrid III 50<sup>th</sup> ellipsoid Q model, version 1.2.2 (R7.4.1)  
Hybrid III 50<sup>th</sup> facet Q model, version 4.2.2 (R7.4.1)

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## 2 Dummy properties

This section shows the comparison of the dummy properties between the simulation models and the specifications. The comparison is made for the external dimensions and the mass measurements according to the specifications described in "User's Manual for the 50th Percentile Male Hybrid III Test Dummy: June 1998".

### 2.1 External dimensions

This section shows the result of the external dimensions for the simulation models. The models were positioned according to the specification (see the picture below). Additional planes were added and contacts were defined. The penetrations found are measures for the dimensions.

The reference values of the H-point height and distance to seat back dimensions are used to position the reference planes of the rigid seat. From these two planes most of the dimensions are determined.

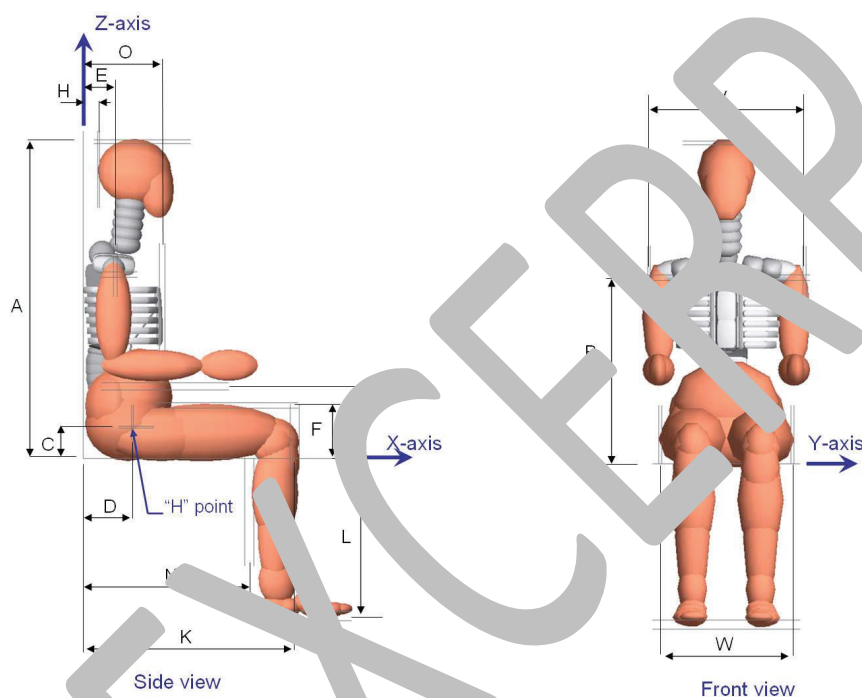


Figure 2.1 External dimensions set to specification for the ellipsoid Q model.

### 3 Experiments

For the validation and rating of the model, many experiments have been used. This chapter presents the descriptions of the experiments that are used for the quality rating. The information is as complete as possible, but is restricted to non-confidential data.

In the first section, all experiments used for the rating are listed in tables. These tables contain 8 columns. Below you can find the description of the column headers:

ID = Identification number

#F = number of loading signals (forces and moments/torques) measured

#P = number of positional signals (displacements and rotations) measured

#V = number of velocity signals measured

#A = number of acceleration signals measured

#I = number of injury values rated

In the second section of this chapter, more detailed descriptions are presented in order to give the reader more insight into the validation set. For tests that originally were conducted for clients, this detailed description is not printed because of confidentiality reasons. No extra information with respect to these tests can be supplied.

#### 3.1 Test overview

All experiments that have been used to calculate the ratings in the report are listed in the tables below. The total experimental validation set is divided into different categories. Each table represents a different category. The ID of the test includes a reference to the category:

F = full dummy test,

H = head component test,

N = neck component test,

T = thorax component test,

L = lumbar spine component test,

P = pelvis component test,

A = abdomen/pelvis component test,

S = hip component test,

E = leg assembly test,

K = knee component test,

I = tibia component test and

O = foot/shoe component test.

Table 3.1 Full dummy tests

ID	Description	Conditions	#F	#P	#V	#A	#I
F1	Frontal sled test, unbelted driver, includes airbag	Velocity 14 m/s		1		9	39
F2	Frontal sled test, unbelted passenger, incl. airbag	Velocity 14 m/s		1		9	41
F3	Full dummy frontal test, driver NCAP set-up	Velocity 16 m/s	3	1		9	32
F4	Full dummy frontal test, passenger NCAP set-up	Velocity 16 m/s	3	1		9	32
F5	Full dummy test, belted dummy on rigid sled	Velocity 14 m/s	4	1		9	35
F6	Belted dummy 1 on rigid sled, no airbag	Velocity 12 m/s	3	1		9	37
F7	Belted dummy 2 on rigid sled, no airbag	Velocity 12 m/s	3	1		9	37
F8	Belted dummy 3 on rigid sled, no airbag	Velocity 12 m/s	3	1		9	37
F9	Belted dummy 1 on rigid sled, no airbag	Velocity 16 m/s	3	1		9	37
F10	Belted dummy 2 on rigid sled, no airbag	Velocity 16 m/s	3	1		9	37
F11	Belted dummy 3 on rigid sled, no airbag	Velocity 16 m/s	3	1		9	37

Table 3.12 Foot and Shoe tests

ID	Description	Conditions	#F	#P	#V	#A	#I
O5	Shoe impact test on front	Pres. motion 3.0 m/s		1	2	7	
O6	Shoe impact test on rear	Pres. motion 3.0 m/s		1	2	7	
O7	Shoe impact test on left heel	Pres. motion 1.0 m/s		1	2	7	
O8	Shoe impact test on left pad	Pres. motion 1.0 m/s		1	2	7	
O9	Shoe impact test on right heel	Pres. motion 1.0 m/s		1	2	7	
O10	Shoe impact test on right pad	Pres. motion 1.0 m/s		1	2	7	
O11	Left contour impact test on foot	Pres. motion 0.6 m/s		1	2	9	
O12	Left contour impact test on foot	Pres. motion 0.9 m/s		1	2	9	
O13	Right contour impact test on foot	Pres. motion 0.6 m/s		1	2	9	
O14	Right contour impact test on foot	Pres. motion 0.9 m/s		1	2	9	

## 3.2 Descriptions of the tests

This section gives descriptions of all the tests listed in the tables of the previous section. It will describe how the experiment was performed. If possible, pictures are added for greater clarity. The validation set is divided into the aforementioned categories. Test information can easily be found using the unique test ID throughout the complete report.

### 3.2.1 Full tests

- F1** This is a frontal sled test with an unbelted dummy in the driver position. The soft seat has a padded headrest and the dummy is restrained by the knee-bolster. Some parts of the vehicle interior are present, such as a steering wheel with an airbag, a windshield, a roof, and a dashboard. The sled has an initial velocity of 14 m/s.
- F2** This is a frontal sled test with an unbelted dummy. The dummy is seated at the passenger location. The soft seat has a padded headrest and the dummy is restrained by the knee-bolster. Some parts of the vehicle interior are present, such as a dashboard with an airbag, a windshield, and a roof. The sled has an initial velocity of 14 m/s.
- F3** This is a full dummy frontal impact test in USNCAP condition. The vehicle crashes head-on into a rigid concrete barrier at 16 m/s. The results are those of the driver.
- F4** This is a full dummy frontal impact test in USNCAP condition. The vehicle crashes head-on into a rigid concrete barrier at 16 m/s. The results are those of the passenger.
- F5** This test consists of a frontal sled with a rigid seat with separate shoulder and lap belt. The rigid seat has a padded headrest and foot plane mounted on a rigid sled. For this test set-up a slightly modified ECE-16 sled is used. To create a more realistic seating position of the dummy a wooden foot plate, thickness 20 mm, was introduced. To reduce foot/lower leg movement, a foot stop plate was introduced. The sled had an initial velocity of 14 m/s and reached a peak deceleration of 20g. Figure 3.1 (l) shows the experiment before the test. Figure 3.1 (r) shows the experiment after the test.

Figure 3.2 shows the simulation test setup.

## 4 Rating of the validation set

This chapter shows the rating values calculated for the complete validation set presented in this report (204 experiments). The signals of all tests have been numerically rated in an automated process as described in Appendix A. The tables list the combined values of all tests, consisting of 3 values (3 criteria) for every signal:

- a value for the peak correlation
- for the timing of the peak
- and for the shape of the simulation curve compared to that of the experiment.

The number of signals available per test can be found in the tables presented in Chapter 3.

### 4.1 Overall test results

In this section the rating results are presented in tables. The first four tables list the overall rating results for the dummy model. The first three give the score per rating criterion for the total dummy validation test set, followed by those for each test group; the fourth table gives the combined score (combining the scores from all three rating criteria) for the total test set followed by those for each test group. In these tables, the second column shows the weight factor that has been applied to the score of each test group for calculating the total scores. These test group weight factors are calculated as the ratio of the number of tests within the test group and the number of tests in the total dummy validation test set. In this way the sum of the test group weight factors is always 1.0. In the third column of the tables, the scores are given in percentages, with 100% indicating a perfect match with the experimental data.

After these first four tables, additional tables present the combined rating results of the individual tests in each test group. In each test group, all the tests (referred to by their test ID) are given the same test weight factor. The test weight factors are calculated as the inverse of the number of tests in the test group to which it belongs. In this way the sum of the test weight factors in a test group is always 1.0. Using the combination of test weight factors and test group weight factors, the score from each individual test contributes equally to the total score for the complete dummy validation test set.

Table 4.1 Rating results for the dummy model using the Peak criterion only

Group	Weight	Model	M2
Total		67.0%	74.7%
Full dummy tests	0.1330	69.3%	69.1%
Head tests	0.0148	19.2%	93.5%
Neck tests	0.1576	73.1%	79.2%
Thorax tests	0.2167	77.2%	78.7%
Lumbar Spine tests	0.0936	78.6%	78.6%
Pelvis tests	0.0443	72.4%	80.3%
Abdomen_pelvis tests	0.0345	41.9%	86.6%
Hip tests	0.0098	85.4%	85.3%
Leg tests	0.1576	60.3%	65.7%
Knee tests	0.0296	88.4%	91.3%
Tibia tests	0.0394	58.0%	74.6%
Foot and Shoe tests	0.0690	57.7%	69.6%

## 5 Comparison of results

This chapter shows results that are obtained directly from the experiments and simulations. Range plots are shown in the first section. A rangeplot provides information on the range in which the model has been evaluated, for each signal separately. By adding lines indicating the level of correlation, the range plots also provide information about the quality of the prediction of a certain signal.

The last section of this chapter contains information about the runtimes of the simulations. This gives the user an impression of what can be expected when running their own applications.

Time history plots of all signals are given in Appendix B. With these the engineer can visually judge the quality of the simulation results. It also helps to interpret the rating results presented earlier in this report, since the rating value can now be compared with the visual information from the curves. For this purpose, the rating values are printed below each curve.

For tests used to develop this model that have been conducted by customer, the curves are not printed because of confidentiality reasons. The information from these confidential tests is printed in the rangeplots as a single dot for each test (peak levels only) and the signals are included in the calculation of the rating as well.

### 5.1 Range plots

In this section, all rangeplots are presented. The range plots show the results of a particular signal over different tests. The peak value of the signal during simulation is represented by a point in the graph. The horizontal location of the point is proportional to the experimental test signal peak. In general this corresponds to the test severity. The vertical position is proportional to the simulation peak results. If the simulation reproduces the signals of the experiment exactly, the point is on the 100% line which is the line at 45 degrees, printed with a solid line type in the graphs. If the point with a positive value is below this line, the simulation has a lower peak than the experiment, which indicates an underprediction of the simulation. When it is above the line then the simulation over-predicts. Two additional lines are drawn in each plot. If the point is within the cone defined by the dotted lines, the peak score is above 80%.

Each result in the rangeplots is shown using a numbered marker. Table 1.1 in the Introduction chapter lists all markers used in this report.

The rangeplots have been divided over three sections. In the first section, the rangeplots are presented that refer to signals measured with the standard sensors in the dummy.

The second section adds the non-standard sensor signals (also dummy signals).

The third section adds the signals that refer to environment (non-dummy) measurements, like belt forces, impactor signals, etc.

#### 5.1.1 Dummy signals

This section shows the range plots derived from the standard sensor signals of the dummy. The plots are arranged top-down: from the head to the feet of the dummy.

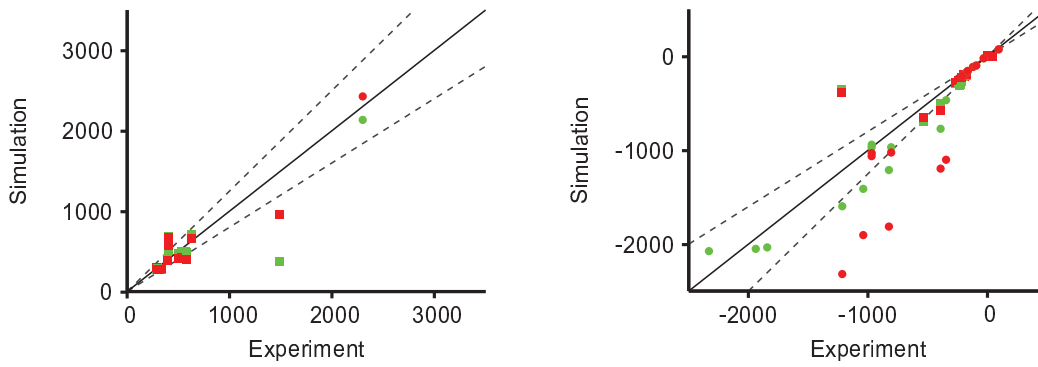


Figure 5.1 Rangeplot of signal Head\_AccR (left); Rangeplot of signal Head\_AccX (right)

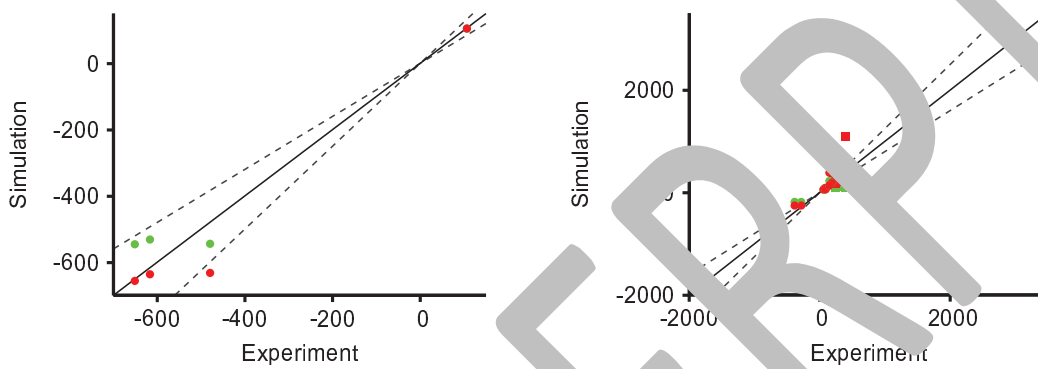


Figure 5.2 Rangeplot of signal Head\_AccY (left); Rangeplot of signal Head\_AccZ (right)

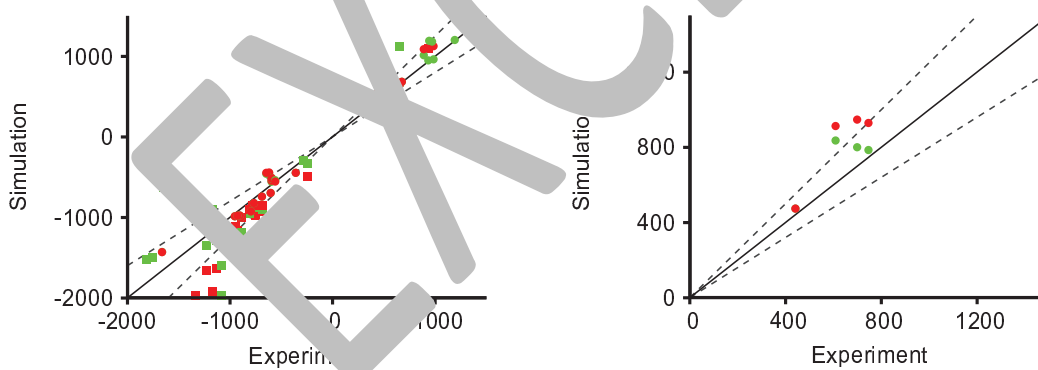


Figure 5.3 Rangeplot of signal NeckUp\_FrcX (left); Rangeplot of signal NeckUp\_FrcY (right)



## B Signal results

In this Appendix the signals of all the tests are presented. Signals that are missing have been removed for reasons of confidentiality.

### B.1 Signals of Full tests

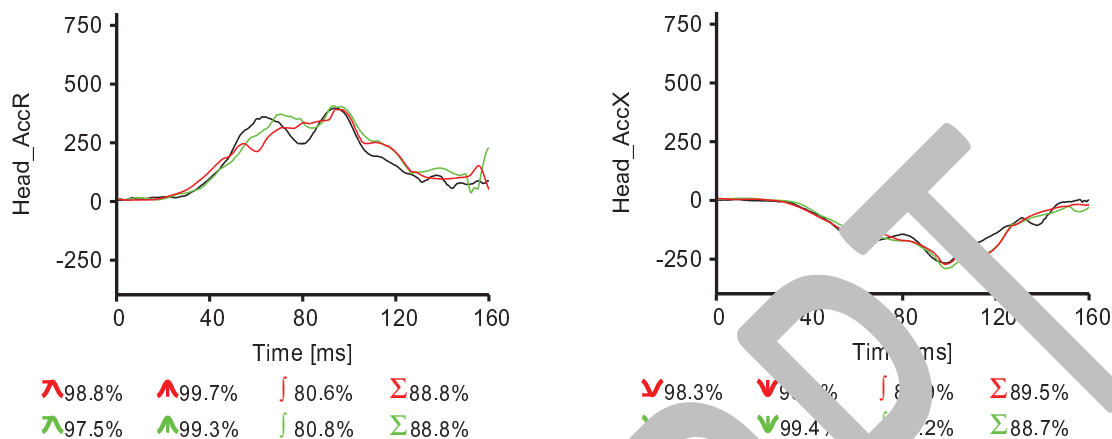


Figure B.1 Test F5 signal Head\_AccR (l); Test F5 signal Head\_AccX (r)

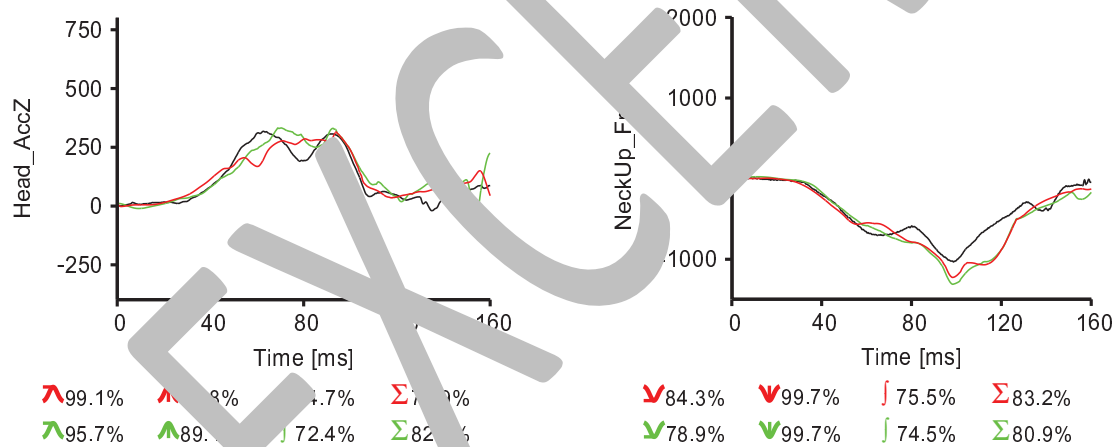


Figure B.2 Test F5 signal Head\_AccZ (l); Test F5 signal NeckUp\_FrcX (r)

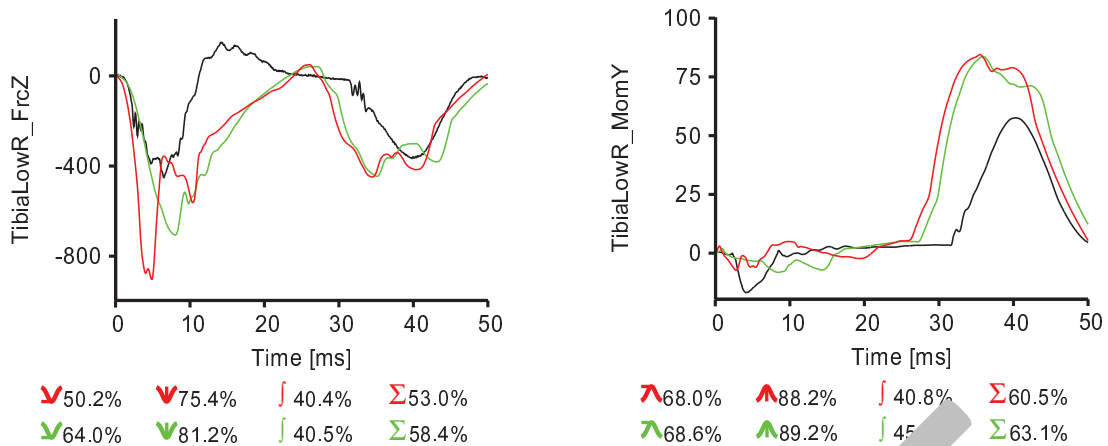


Figure B.669 Test O3 signal TibiaLowR\_FrcZ (l); Test O3 signal TibiaLowR\_MomY (r)

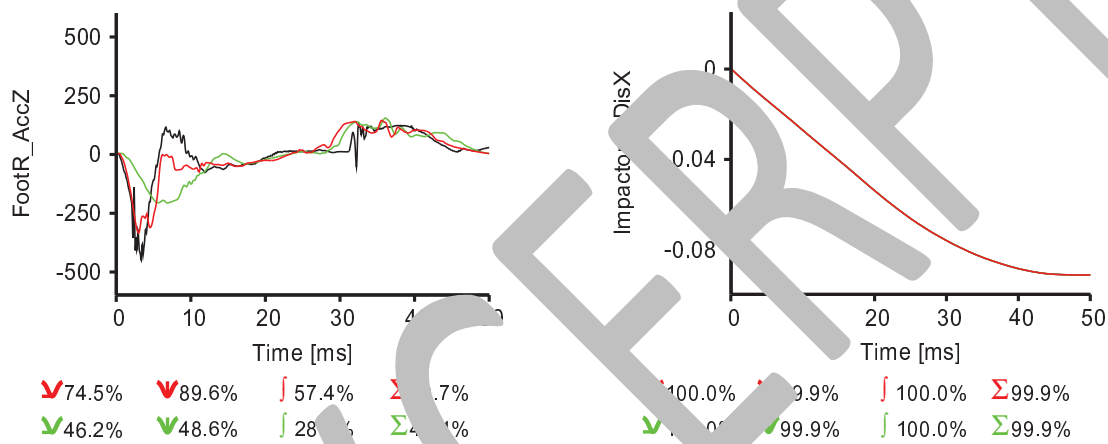


Figure B.670 Test O3 signal FootR\_AccZ (l); Test O3 signal Impactor1\_DisX (r)

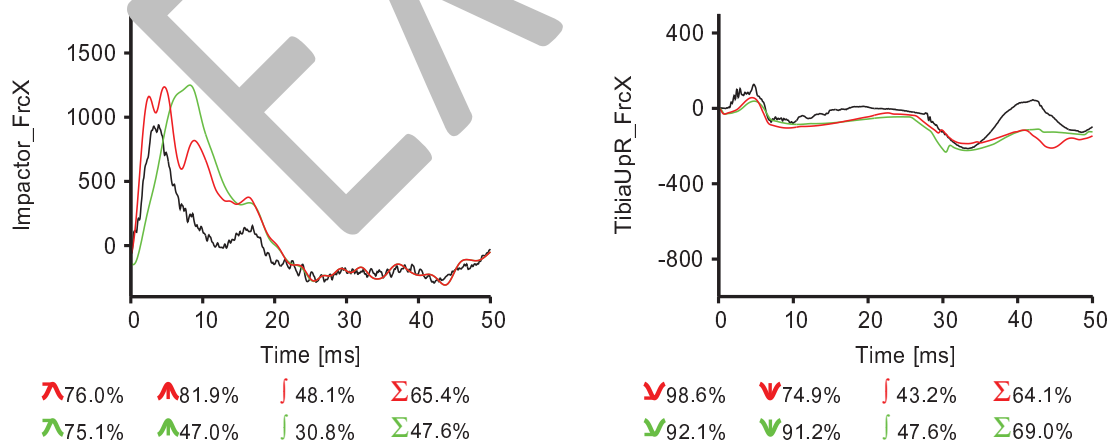


Figure B.671 Test O3 signal Impactor\_FrcX (l); Test O4 signal TibiaUpR\_FrcX (r)