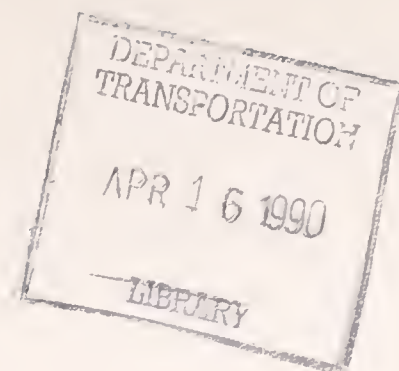


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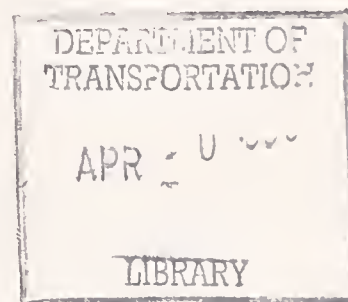
U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**



DOT HS 807 517
Final Report

September 1988

Comparison of Human Volunteer and Cadaver Head-Neck Response in Frontal Flexion



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16. Abstract The study compared post-mortem human subject (PMHS) tests conducted at the University of Heidelberg with volunteers conducted by the Naval Biodynamics Laboratory (NBDL) in New Orleans. Two PMHS test series similar to the volunteer frontal impacts were carried out. One having an impact severity identical to the most severe human volunteer tests, the second series with higher exposure levels. As a result of the compared collectives in regard to the injury severity one can determine that the volunteers as well as the PMHS, with some exceptions, suffered minor spinal column injuries. The film analysis shows that the head rotations are larger for the PMHS than for the volunteer tests. Vertical displacements and rotations of T1 are also larger in the PMHS tests than in the volunteer tests. The partly different kinematics and loadings behavior of the test subjects can be obviously explained by differences of muscular tensions in the PMHS and the volunteer test groups.				13. Type of Report and Period Covered Final 10/86 ... 5/87	
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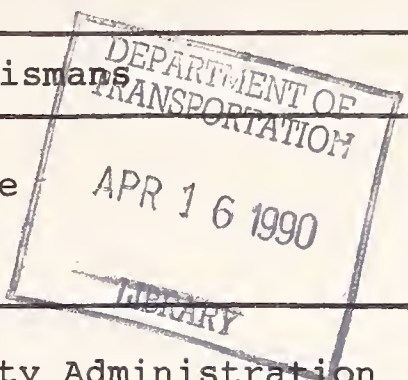


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TECHNICAL SUMMARY

CONTRACTOR	Prof.Dr.med.Gg.Schmidt, Institute of Forensic Medicine, University of Heidelberg	CONTRACT NUMBER	DTNH 22-83-C67019
REPORT TITLE	Comparison of Human Volunteer and Cadaver Head-Neck Response in Frontal Flexion	REPORT DATE	September 1988
REPORT AUTHOR(S)	D.Kallieris, R.Mattern, J. Wismans		

Investigations comparing dynamics and kinematics in volunteers and post mortem human subjects (PMHS) at similar impact conditions are rare, although such results are of elementary importance in order to estimate the suitability of PMHS as injury indicators in crash tests. Concerning this point of view, a report on twelve experimental frontal collisions was made in which PMHS in the age range of 24 to 61 years were loaded and restrained by an eighty (80) mm broad double shoulder-lap-step-belt. The impact velocity amounted 60 km/h, the mean sled decelerations were at 11 g and 15 g. The comparing collective of nine volunteers in the age range 18 to 22 years was investigated by a mean deceleration of 11 g at the same test conditions in the Naval Biodynamics Laboratory in New Orleans. Photo targets were mounted to the head as well as T1 of the PMHS; the collision phase was documented by a camera laterally mounted on the sled with a frame rate of 1000 pic/sec.

Head accelerations were measured tri-axially at the top of the skull, at the clivus and the 1st thoracic vertebra. In order to simulate the muscle tonus of the volunteers, formaldehyde was injected into the neck muscles.

The film analysis shows that the head rotations are larger for the PMHS than for the volunteer tests. Vertical displacements and rotations of T1 are also larger in the PMHS tests than in the volunteer tests.

The evaluated mean resultant accelerations at the clivus of the PMHS amounted 33 g to 45 g; the corresponding values at the 1st thoracic vertebra were between 23 and 31 g. The evaluated resultant C.G. head acceleration of volunteers and PMHS agrees very well, the mean resultant acceleration at T1 is higher in the volunteers than in the PMHS.

In the PMHS as well as in the volunteers no thoracic or abdominal injuries occurred at the above mentioned loads. The volunteer test subjects complained of pains in the neck after these loadings. In radiological investigations no morphological injury findings were observed. No spine injuries occurred in three of the twelve conducted PMHS tests; in seven cases strains of intervertebral discs, lacerations of the ligamentum flavum or strains in the vertebral joints have been observed. Two times a fracture in the front edge of the T2 vertebra was found, one time combined with a laceration of the ligamentum flavum at the same segment.

(Continue on additional pages)

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INTRODUCTION

The Naval Biodynamics Laboratory (NBDL) in New Orleans has conducted a large number of human volunteer tests to study omni-directional head-neck response in an impact situation. A detailed description of the NBDL instrumentation and test methods is provided by Ewing et al. (1973, 1978). A large number of the NBDL tests conducted between 1981 and 1985 have been analysed in order to develop performance requirements for a mechanical neck for crash dummies. Detailed results of these analyses have been presented by Wismans et al. (1983, 1984, 1986). It was shown that the volunteer relative head motion can be described quite well by a simple two-point analog system.

SCOPE

The purpose of this study is to extend this analysis to post-mortem human subject (PMHS) tests conducted at the University of Heidelberg. These subjects have been exposed to frontal impacts using a similar sled seat and restraint system as in the NBDL human volunteer tests. Results will be compared with a representative set of nine tests out of the most severe frontal human volunteer tests conducted at NBDL. In these NBDL tests five different subjects were exposed to a 15 g peak sled acceleration. The compared volunteer and PMHS tests are given in the matrix table 1.

SUBJECT	n	AGE (years)	IMP. VELOC. (km/h)	MEAN DECEL.
volunteer	9	18-22	60	11
PMHS	9	24-61	60	11
PMHS	3	27-50	60	15

Tabl. 1: Matrix of the compared volunteer and post-mortem human subject tests

HEIDELBERG TESTS

For the tests twelve post-mortem human subjects (PMHS) were used, in the age range between 24 and 61 years. Table 2 summarizes the most important anthropometric data of the subjects, the detailed data are reported in appendix A.

TEST PROCEDURE

The post-mortem human subject tests were conducted on the decelerator of the Institute of Forensic Medicine of the University of Heidelberg. The experimental set-up was similar to the frontal NBDL volunteer tests. The subjects were placed on a 90 degree rigid seat and restrained by shoulder straps, a lap belt and inverted V-pelvic strap tied to the lap belt (Fig. 1). The arms were restrained by an additional belt at the mamillar level to prevent flailing. The impact velocity amounted 60 km/h, the mean sled deceleration 11 g and 15 g (Tabl. 1,2).

PRETEST PREPARATION OF POST-MORTEM HUMAN SUBJECTS

In an attempt to simulate the muscle tone of living people 100 ml 10 % solution of formaldehyde was injected in the rear and side muscles of the neck of each post-mortem human subject (PMHS). The time between the injection and the test amounted, in most cases, to more than 20 hours. By that it was attained that the contraction condition of the muscular system in the neck area was controlled in all tests. Fluctuations as they usually occur in the condition of rigor mortis, were reduced because of this measure. This means, that in the cases with a relaxed rigor mortis a contraction condition has been established which can be compared with a medium strong muscular tension in a living person. In a fully marked rigor mortis an additional contraction by means of formaldehyde injection could not be obtained. The fully marked rigor mortis corresponds to a very strong muscular tension in a living person.

Run No.	imp. veloc. (km/h)	medium sled decel. (g)	Sex	Age (years)	Body weight (kg)	Body length (cm)	Sitting height (cm)	Head length (cm)	Head breath (cm)	Head height (cm)	AIS spine
8614*	59	11	male	50	80	176	96	25	20	17	0
8615*	59	12	male	50	80	176	96	25	20	17	0
8616	59	11	male	51	66	170	92	25	19	17	1
8618	59	11	female	61	58	155	84	22	18	16	1
8620	59	11	female	51	78	165	91	21	18	15	2
8621	59	11	female	46	72	166	91	22	18	15	0
8622	59	11	male	37	80	182	95	23	19	15	1
8701	60	11	female	24	74	168	89	21	18	15	1
8703	60	11	male	59	66	154	85	25	19	15	1
8705	60	11	male	38	71	175	92	22	19	17	1
8706	59	15	male	50	72	172	91	23	19	16	1
8709	61	16	male	27	74	170	97	25	20	15	0
8710	61	16	female	43	53	175	90	22	19	14	2
* the same subject											

Tabl. 2: Test conditions, subject anthropometry and post test AIS values

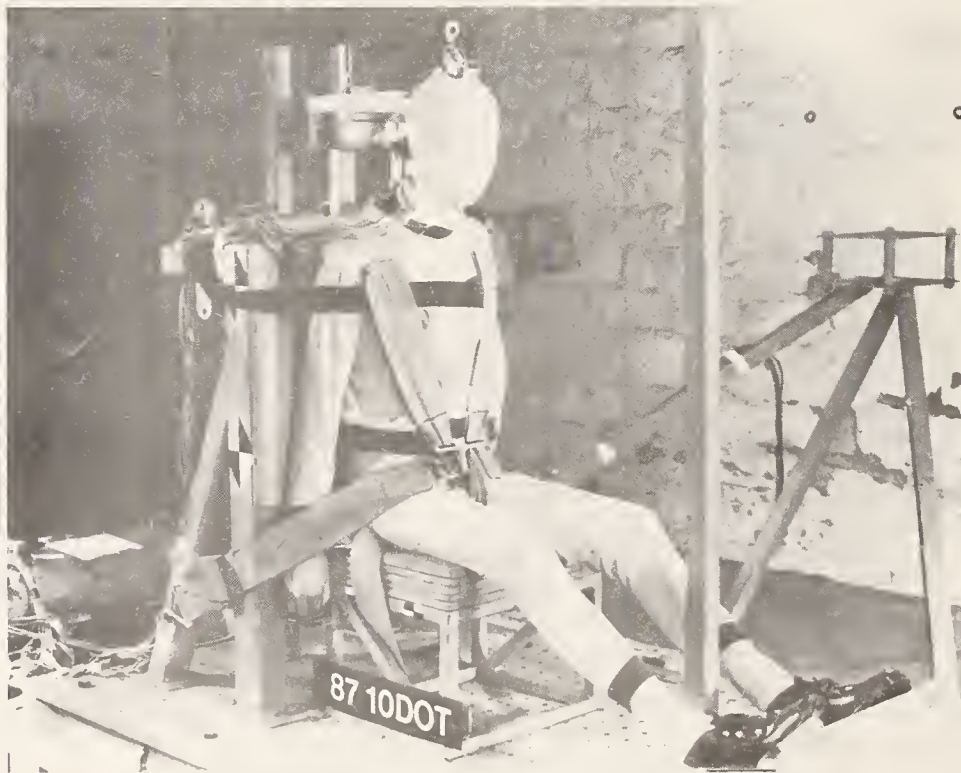
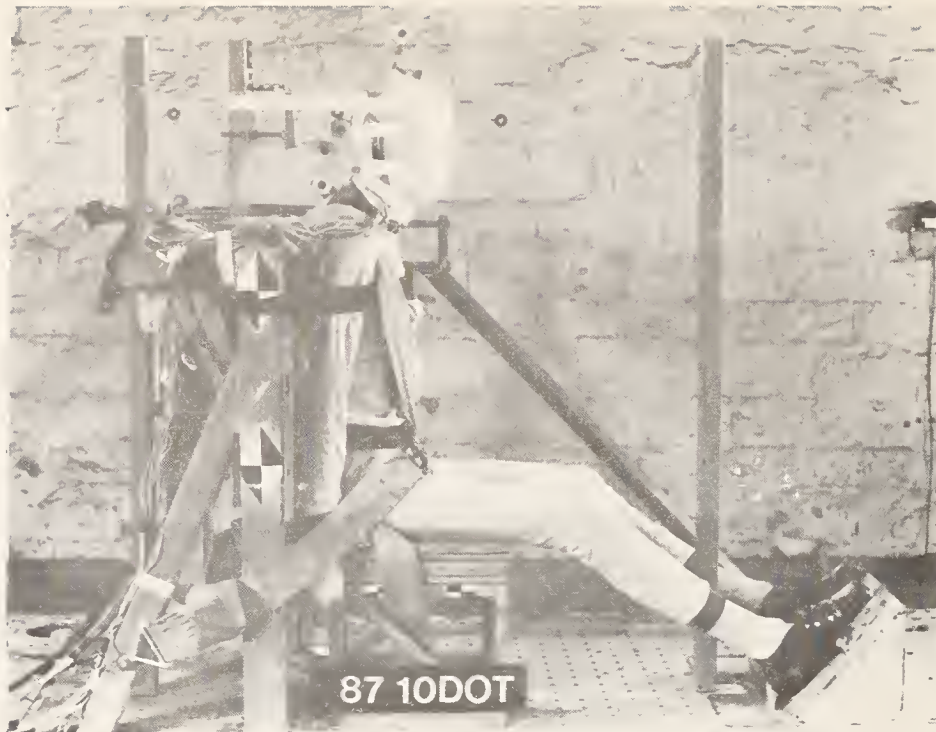


Fig. 1: Test set-up for PMHS-tests (initial conditions)

The anatomical landmarks defining the frankfurt plane, infraorbital notches and auditory meati, were marked with small lead balls. The position of these landmarks and positions of the optical targets and instrumentation were documented by anterior-posterior and lateral x-rays (Fig. 2).

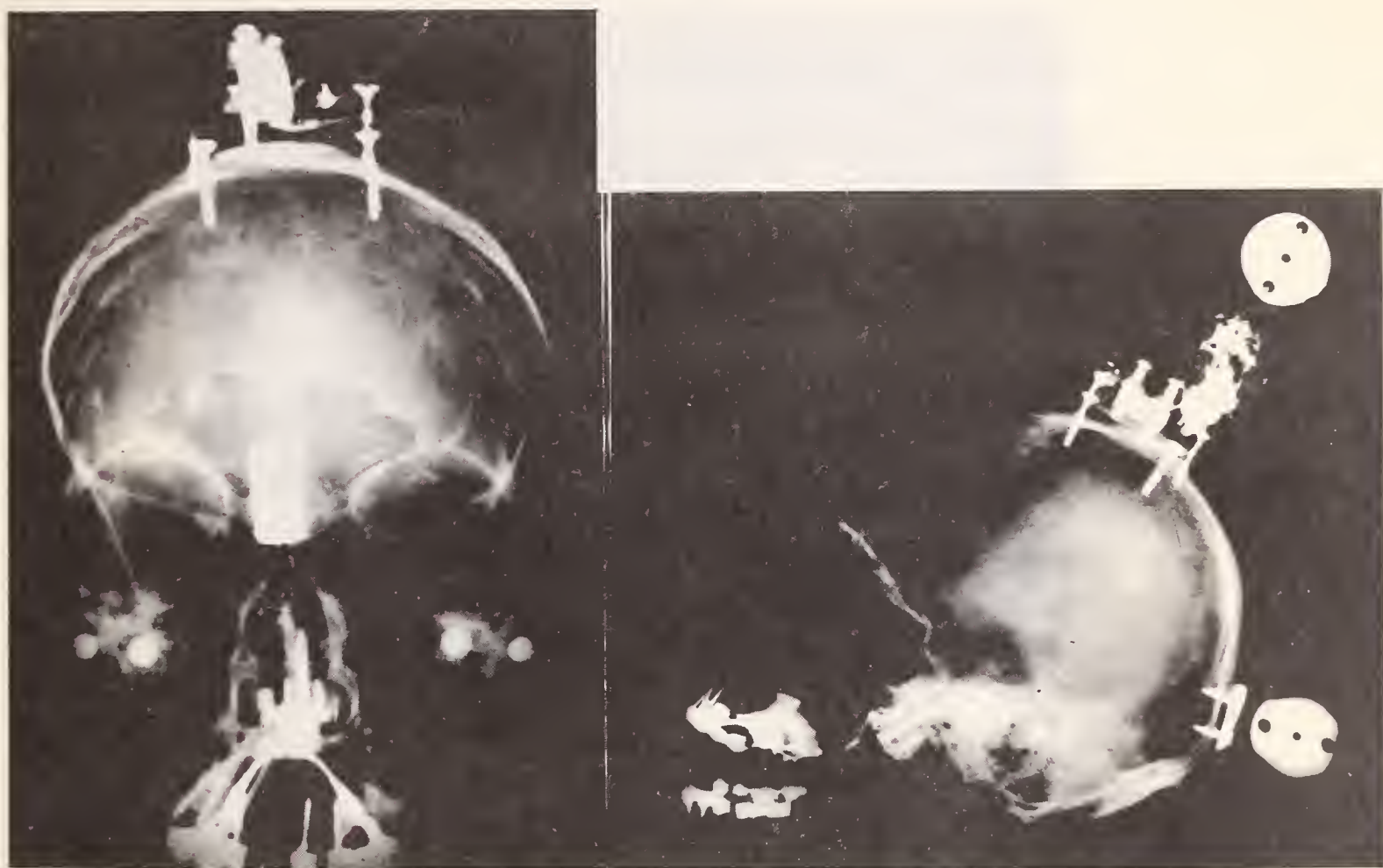


Fig. 2: Anterior-posterior and lateral x-rays with instrumentation and lead balls at the anatomical landmarks.

INSTRUMENTATION

The position of head and the first thoracic vertebral body (T1) were registered by a sled mounted high speed camera running at 1000 frames/second, assumed to be parallel to the plane of motion. Two photo targets are mounted to the head as well as T1 (Fig. 3). The positions of the head and T1 anatomical coordinate systems were related to these targets by two dimensional x-ray analysis. The distances bet-

ween the photo targets at the head among one another and head - T1 and the distances between the sled fixed points were measured in sitting position prior to the test, detailed information for each case is given in appendix B.

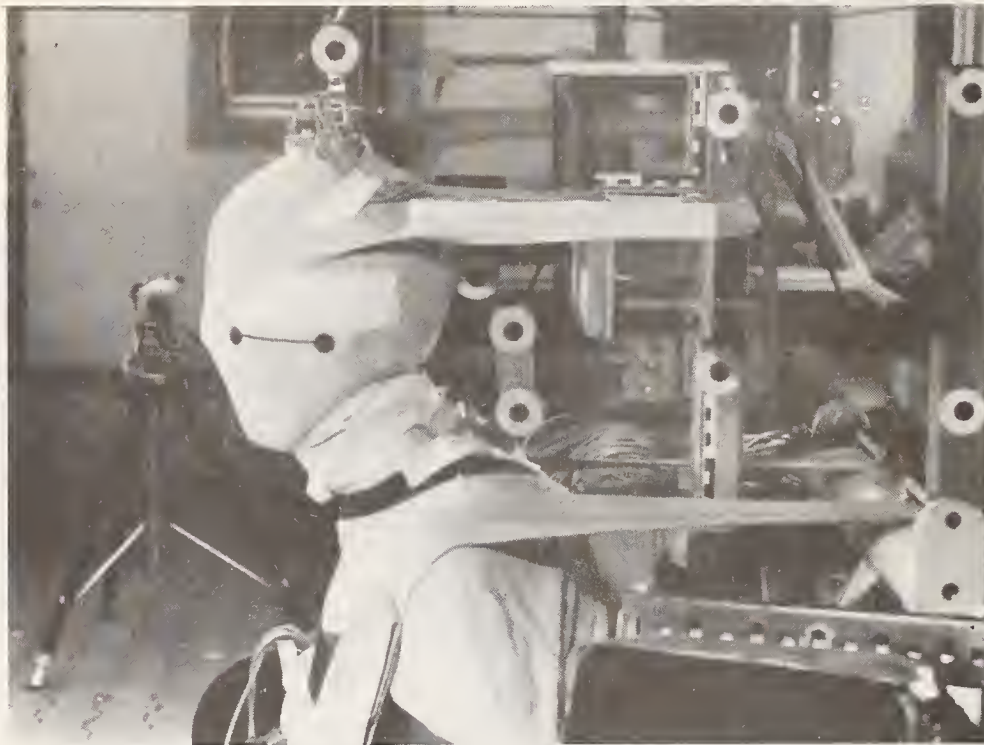


Fig. 3: Photo targets mounted to the head and the T1.

Sixteen channels of time-history data were recorded for each test. The instrumentation included a nine-acclerometer array as described by Padgaonkar (1976), screwed to the top of the skull (Fig. 4), a tri-axial accelerometer unit screwed at the clivus (Fig. 2) and a tri-axial accelerometer unit screwed to T1. All accelerometers used are ENDEVCO 2264-2000. The mass of the head instrumentation is about 0,165 kg. The orientation of accelerometers in relation to the anatomical landmarks were obtained from lateral and anterior-posterior x-rays.

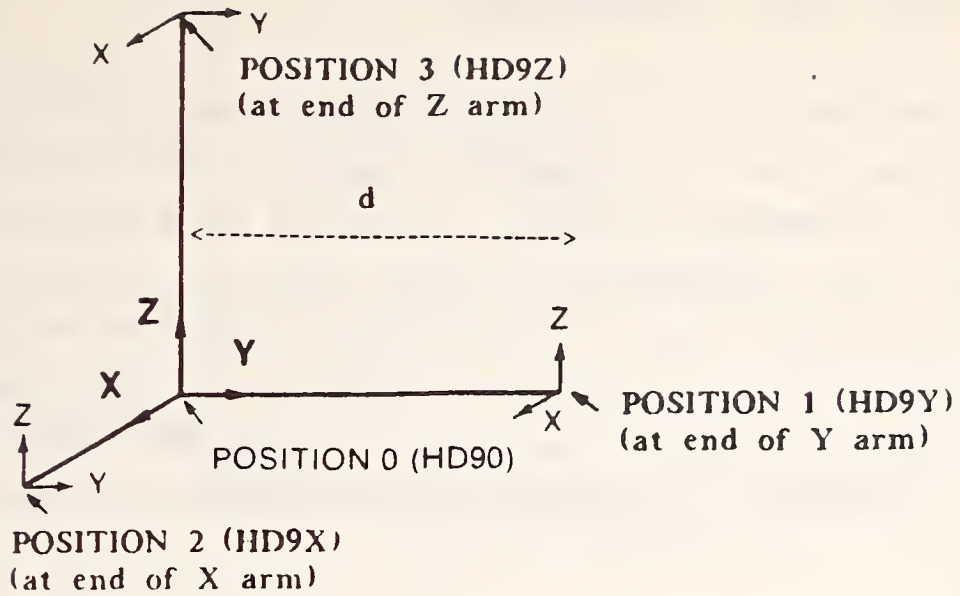


Fig. 4: Nine accelerometer array

POST-TEST PROCEDURE OF THE POST-MORTEM HUMAN SUBJECTS

The volume of the PMHS head was measured by submersion. A fully autopsy with a detailed investigation of the vertebral column has been performed after each test, as described by Mattern (1980). The injury severity of observed lesions was scaled in accordance with AIS 1980 (Tabl. 2). Injuries not separately mentioned in the AIS vocabulary were scaled by analog application of the AIS criteria. Injuries in the PMHS were diagnosed as acute strain if hemorrhages occurred in the deep spinal column muscular system between the muscle bundles or in the region of the ligamental system, as well as in the vertebral joints and discs. Such cases were estimated with AIS 1. Macroscopically visible cuttings of above mentioned tissues did not occur in the investigated cases. Lacerations of ligaments, of intervertebral disc tissue and tear drop fractures of the vertebral bodies have been estimated with AIS 2.

DATA ACQUISITION - EVALUATION

The measuring data were recorded by using a multiplexed FM recorder. For the Heidelberg evaluations the data were filtered according to SAE J 211 a and were then digitized, acceleration-time-histories were plotted. On the other hand we provided TNO the unfiltered digitized data and high speed films for further evaluations. The signals evaluated by TNO were sampled at 10 kHz and were filtered with a low pass 100 Hz 4th order Butterworth digital filter.

TEST RESULTS

MEASURING DATA - FILM ANALYSIS

Five PMHS tests have been evaluated in detail by TNO and the results were compared with the results of nine (9) NBDL volunteer tests; a combined paper of TNO, the Netherlands and the University of Heidelberg was presented at the 31th Stapp Car Crash Conference (appendix C). Additional evaluations of the measuring data of the PMHS tests were performed at the University of Heidelberg. Fig. 5 shows the mean and standard deviation-time-histories of the sled deceleration for the two test groups. The maximum mean values amount for the lower severity group 14,8 g and for the more severe test group 22,4 g. The duration of the more severe test group is smaller than the one of the lower severity group.

In the same kind the resultant accelerations at the head (9 accelerometer array, clivus) have been illustrated as well as the 1th thoracic vertebra for each PMHS test group in the Fig. 6-10.

Generally, an increase of the maximum mean values of the resultant accelerations at the head and the 1st thoracic vertebra was observed according to the impact severity; except the resultant acceleration head 3 (Fig. 4) in x-, and

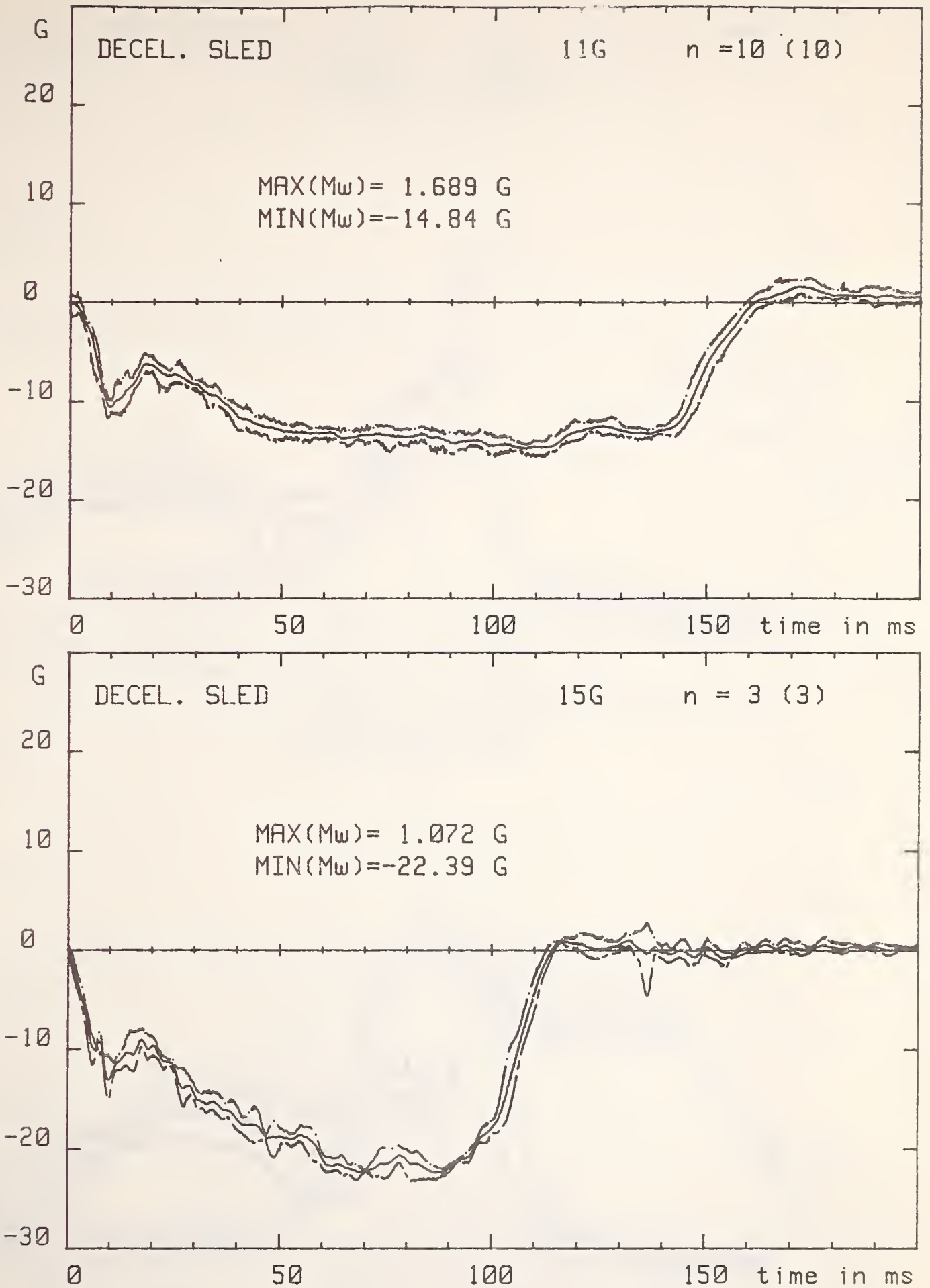


Fig. 5: Deceleration-time-histories, mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

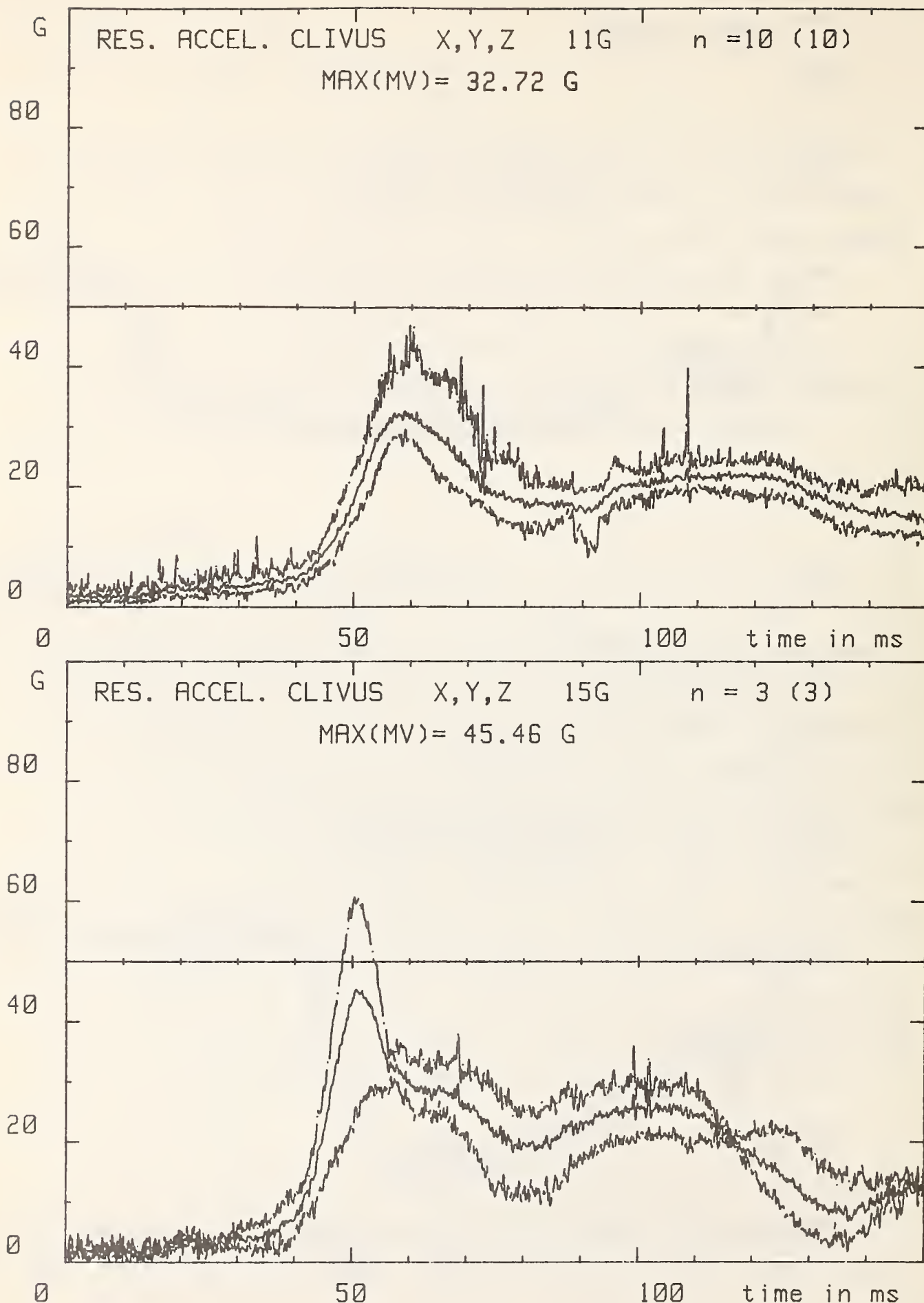


Fig. 6: Acceleration-time-histories of the resultant acceleration at the clivus; mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

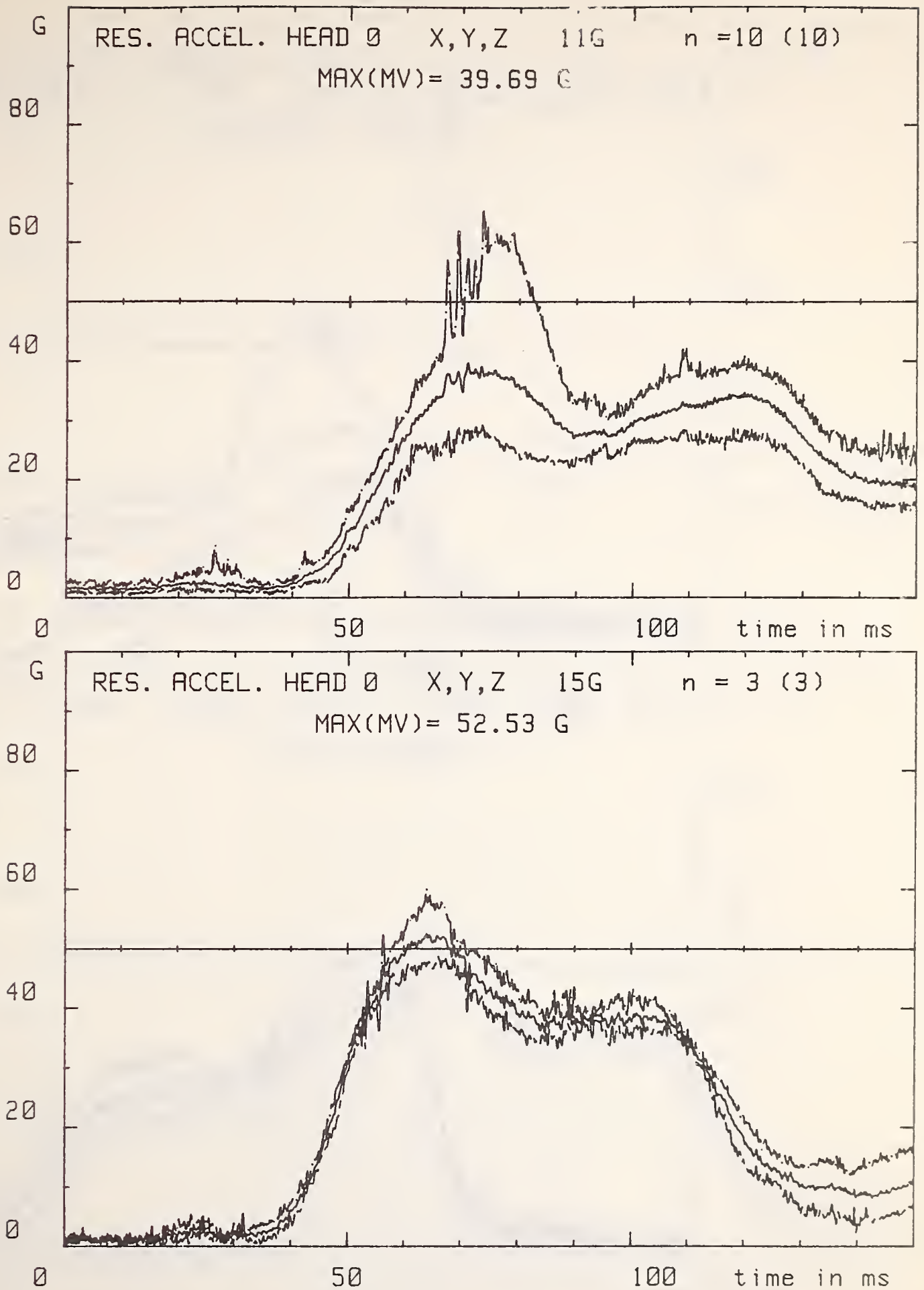


Fig. 7: Acceleration-time-histories of the resultant acceleration at the top of the skull (head 0, Fig. 4); mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

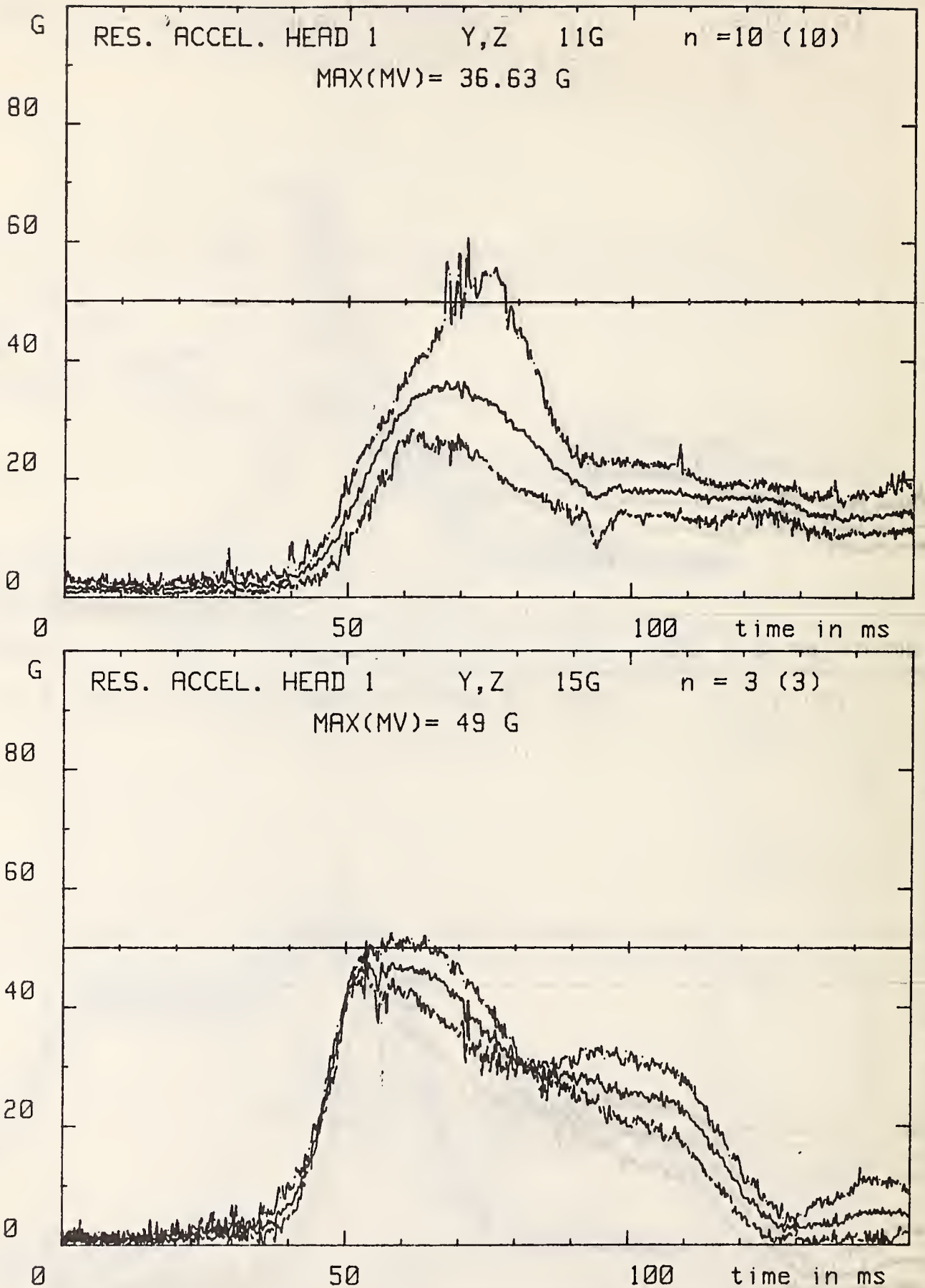


Fig. 8: Acceleration-time-histories of the resultant acceleration at the top of the skull (head 1, Fig. 4); mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

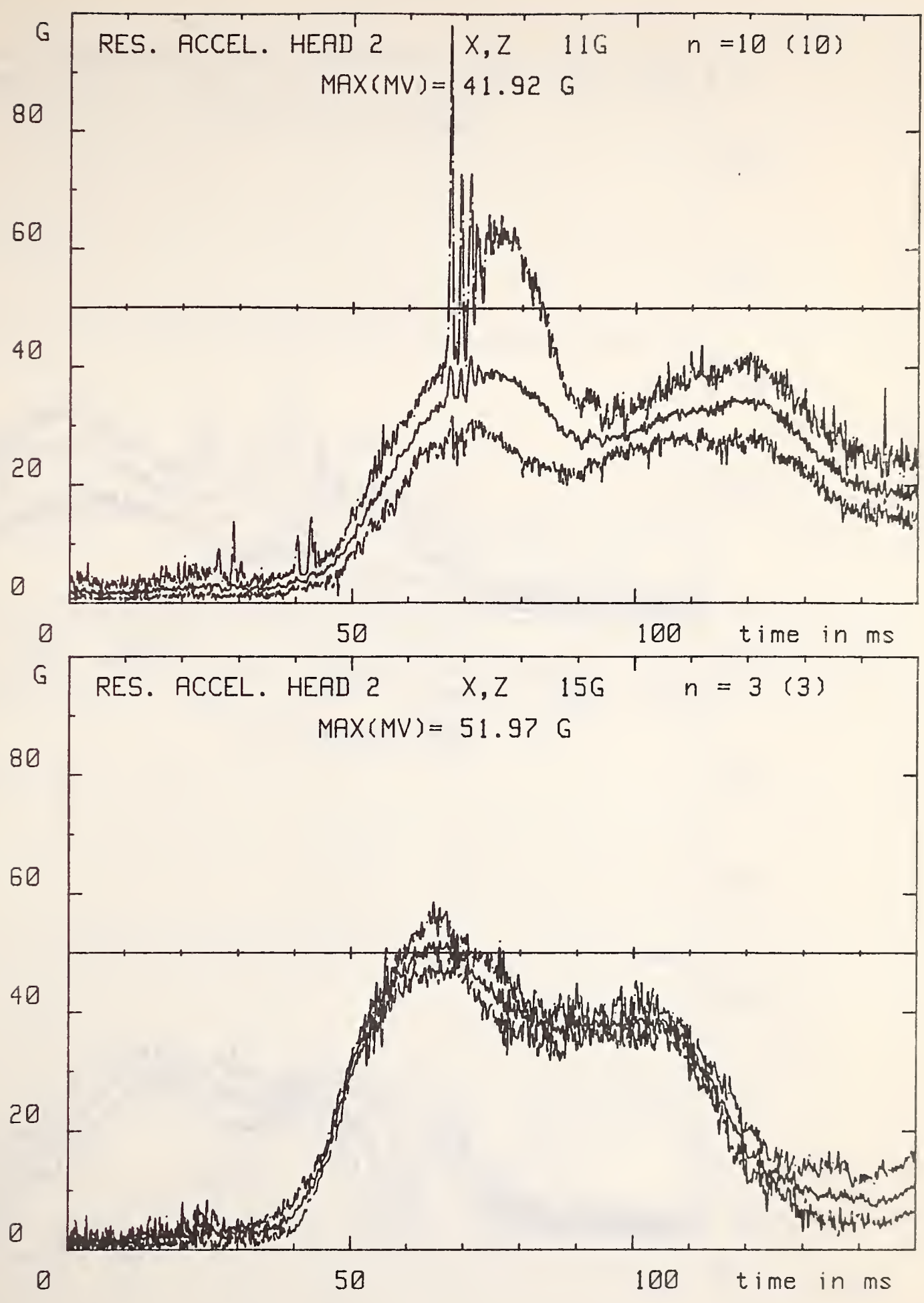


Fig. 9: Acceleration-time-histories of the resultant acceleration at the top of the skull (head 2, Fig. 4); mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

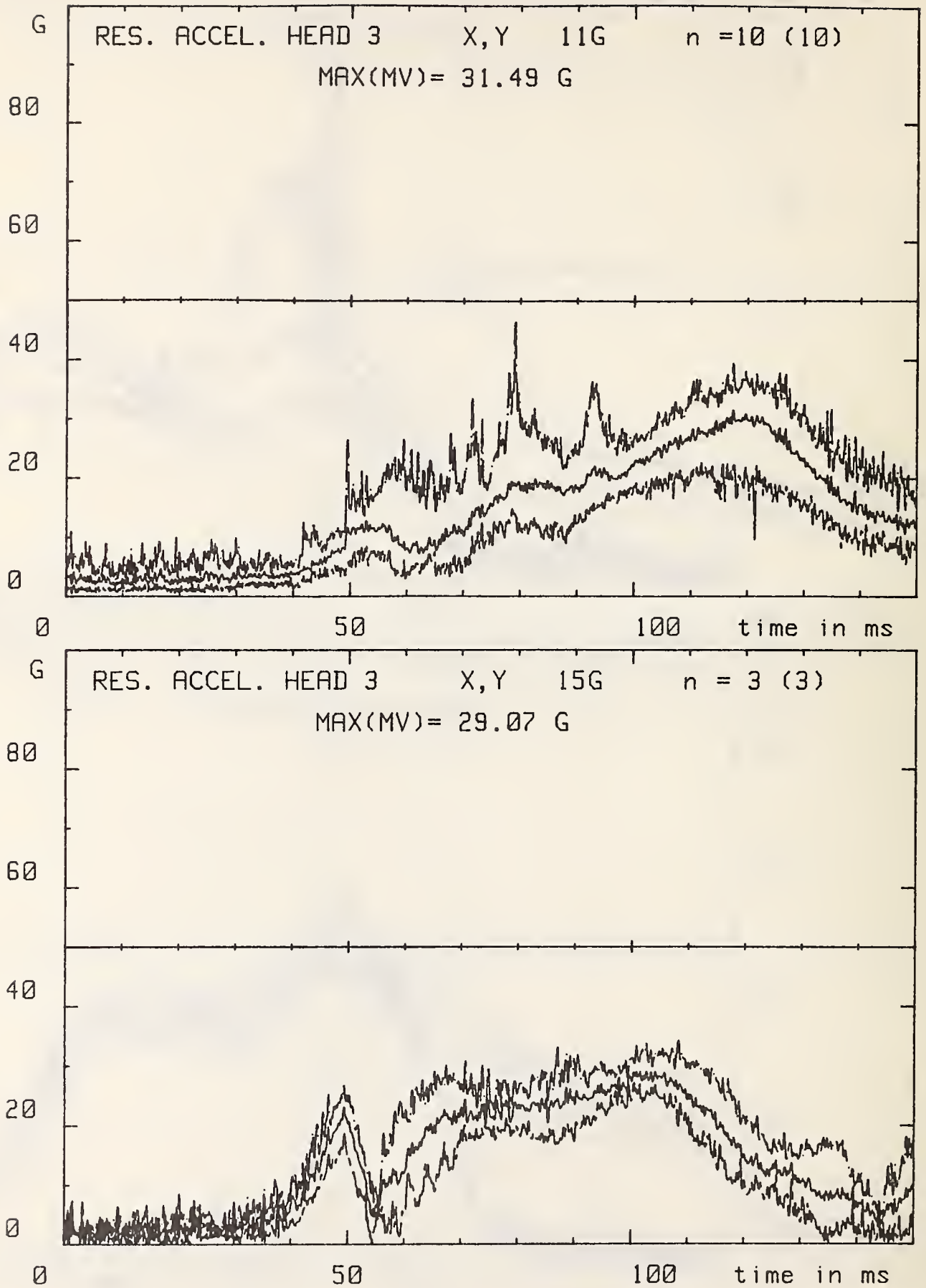


Fig.10: Acceleration-time-histories of the resultant acceleration at the top of the skull (head 3, Fig. 4); mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

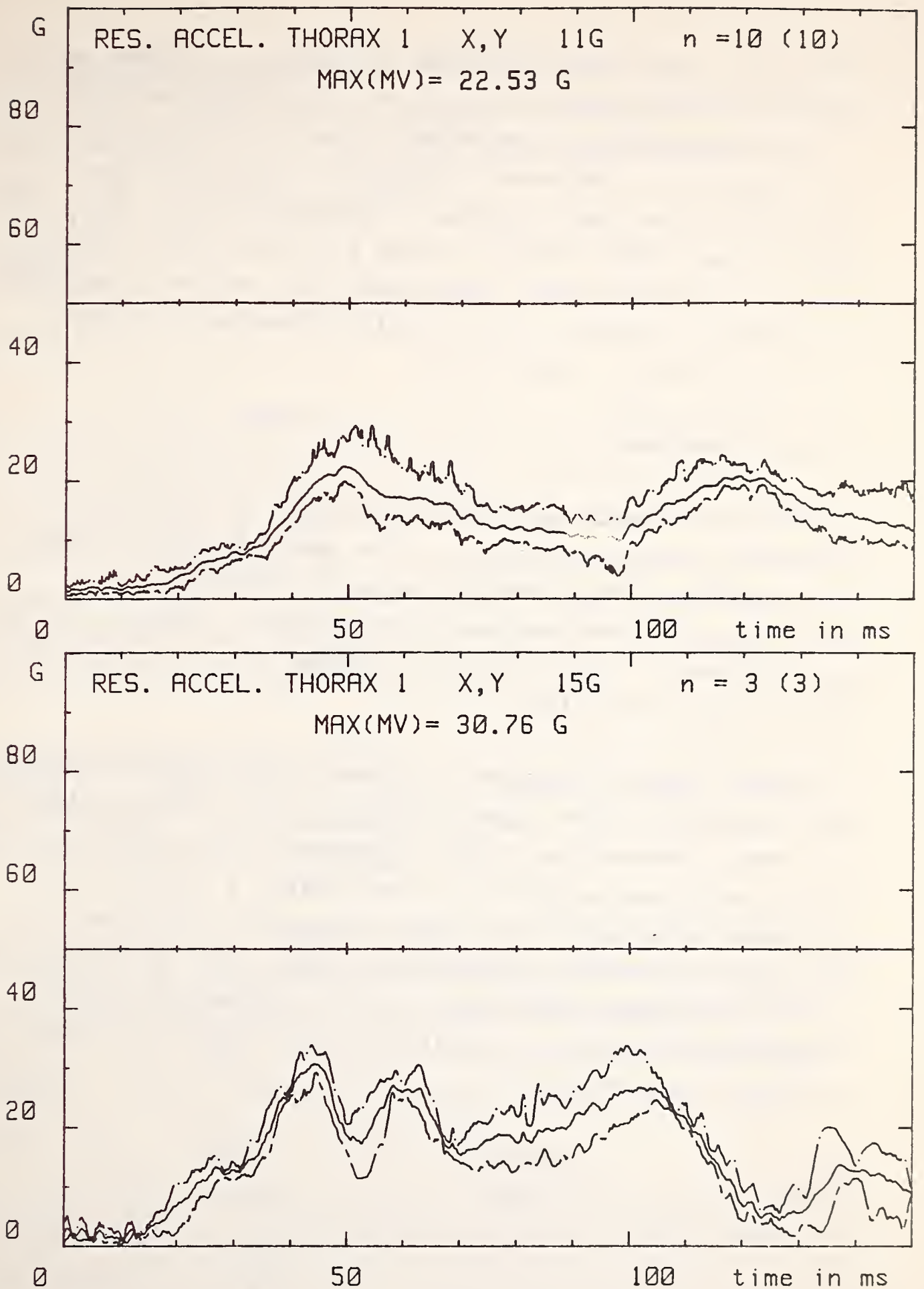


Fig.11: Acceleration-time-histories of the resultant acceleration at Th1; mean value and standard deviation of the two groups of the PMHS tests. Impact velocity 60 km/h, mean sled deceleration 11 g and 15 g

y-direction. The mean resultant acceleration maxima were reached in the time 40 ms to 80 ms after the crash and are also dependent of the impact severity, except of the head location 3. The mean acceleration maxima of the resultant of the head location 3 occurred 120 ms after the crash in the lower severity group and 105 ms after the crash in the more severe test group. All values according to measuring location and measuring direction for each test are listed in appendix E.

MEDICAL FINDINGS

In the PMHS as well as in the volunteers no thoracic- or abdominal injuries occurred in the above mentioned loads. The volunteers complained of pains in the neck. In radiological investigations no morphologic injury findings were observed. Therefore, the injuries of the volunteers can be rated with AIS 1.

No spine injuries occurred in three of the twelve conducted PMHS tests. In seven cases strains in the intervertebral discs and small lacerations of the ligamenta flava and within the joints have been observed. In two tests, a severity of AIS 2 was determined: the first caused by a fracture in the upper front edge of the T2 vertebra (Run No. 8620), the second caused by a laceration of the ligamentum flavum (T2/T3 and fracture of the lower front edge of T2 (Run No. 8710; Tabl. 2,3).

AIS	VOLUNTEER		PMHS	
	11 g		11 g	15 g
0			2	1
1	9		6	1
2			1 *	1 **

Tabl. 3: Distribution of the Injury Severity according AIS 80 for the volunteer and the two PMHS test groups. *: 51 years; **: 43 years

The PMHS suffered minor (AIS 1) and moderate (AIS 2) injuries. AIS 2 injuries were observed in each a test with an impact severity of 11 g and 15 g and concerned test subjects of 51 years and 43 years.

Spinal column injuries for each test are reported in detail in appendix E.

DISCUSSION

As a result of the compared collectives in regard to the injury severity one can determine that the volunteers as well as the PMHS, with some exceptions, suffered minor spinal column injuries. The cervical spine injuries observed in the detail investigation of the vertebral column of the PMHS cannot be proved in conventional x-rays. Therefore, PMHS are suitable test subjects in order to determine the injury severity by this kind of loading.

The film analysis shows (appendix C) that the head rotations are larger for the PMHS than for the volunteer tests. Vertical displacements and rotations of T1 are also larger in the PMHS tests than in the volunteer tests.

The partly different kinematic behavior of the test subjects can be obviously explained by differences of muscular tensions. The volunteers expected the crash and their neck and torso muscles were extremely contracted in order to avoid injuries or perhaps, because they were afraid; furthermore, the test subjects were young, well-trained men.

Due to the formaldehyde injection in the rear and side muscles of the PMHS neck, a muscle tension occurred in this area like a full-marked rigor mortis.

It is doubtful, if in a real accident situation the same extreme muscle contraction appears as in the volunteer tests.

REFERENCES

1. Ewing CL, Thomas DJ, Lustick L, Williams GG, Muzzy III WH, Becker EB, Jessop ME (1978) "Dynamic Response of Human Primate Head and Neck to +Gy Impact Accelerations". Report DOT HS-803 058
2. Ewing CL, Thomas DJ, Lustick L (1978) "Multiaxis Dynamic Response of the Human Head and Neck to Impact acceleration". Aerospace Medical Panel's Specialist's meeting. Paris, AGARD Conference Proceedings no 153. North Atlantic Treaty Organization. Advisory Group for Aerospace Research Development.
3. Ewing CL, Thomas DJ (1973) "Human Head and Neck Response to Impact Acceleration". NAMRL Monograph 21. Naval Aerospace Medical Research Laboratory, Pensacola, Florida,, 32512
4. Ewing CL, Thomas DJ (1973) "Torque versus Angular Displacement Response Proceedings of the 17th Stapp Car Crash Conference.
5. Wismans J, Spenny CH (1983) "Performance Requirements for Mechanical Necks in Lateral Flexion". In: Proceedings of the 27th Stapp car Crash Conference. SAE Paper no. 831613
6. Wismans J, Spenny CH (1984) "Head-Neck Response in Frontal Flexion". In: Proceedings of the 28th Stapp Car Crash Conference. SAE Paper no. 841666
7. Wismans J (1986) "Preliminary Development Head-Neck Simulator". Vol. 1: Analysis of Human Volunteer Tests. Report no. DOT HS 807034. Vehicle Research and Test Center, NHTSA
8. Wismans J, v. Ooerschot H, Woltring HJ (1986) "Omni-Directional Human Head-Neck Response". In: P-189, 30th Stapp Car Crash Conference Proceedings, Paper 861983
9. Padgaonkar AJ, Krieger KW, King AI (1976) "Measurements of Angular Acceleration of a Rigid Body using Linear Accelerometers. Journal of Applied Mechanics.
10. Mattern R (1980) Wirbelsäulenverletzungen angegurteter Fahrzeuginsassen bei Frontalkollisionen. Habilitationsschrift für das Fach Rechtsmedizin, Institut für Rechtsmedizin der Universität Heidelberg, Heidelberg
11. "The Abbreviated Injury Scale" 1980 Revision, American Association for Automotive Medicine, Morton Grove, IL 60053

APPENDIX A: ANTHROPOMETRIC DATA

University of Heidelberg

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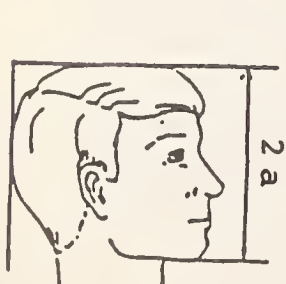
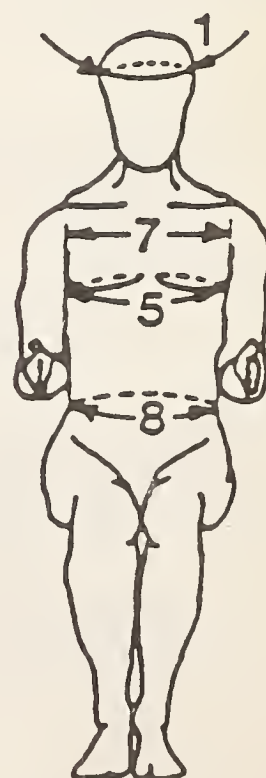
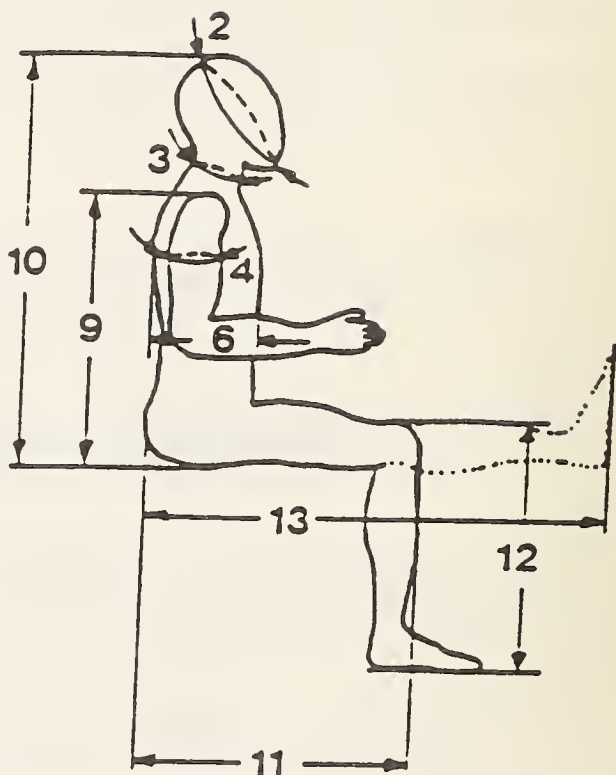
Run No. 8614, 8615 DOT

Anthropometric Data

Body weight 80 kg

Body length 176 cm

- 1. Hat size cm 61
- 2. Occip.-chin.circumfer..... cm 75
- 2a. Head length cm 24,5
- 2b. Head breadth cm 19,7
- 2c. Head height cm 17,1
- 3. Neck circumfer. cm 42
- 4. Upper arm circumfer. cm 30
- 5. Chest circumfer. cm 100
- 6. Chest height..... cm 24
- 7. Chest width cm 35
- 8. Abdomen circumfer. cm 91
- 9. Buttocks - shoulder cm 68
- 10. Seat height cm 96
- 11. Pelvis - knee cm 56
- 12. Sole of foot - knee cm 56
- 13. Pelvis - heal cm 98



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Institute of Forensic Medicine

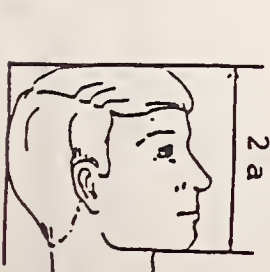
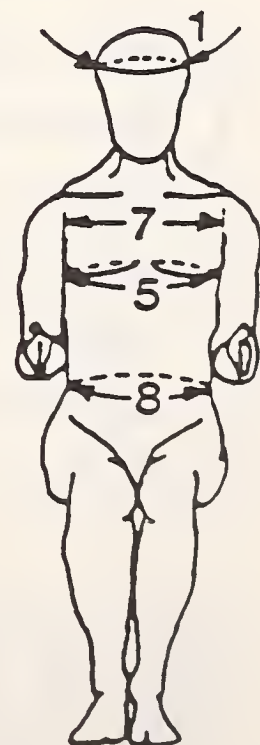
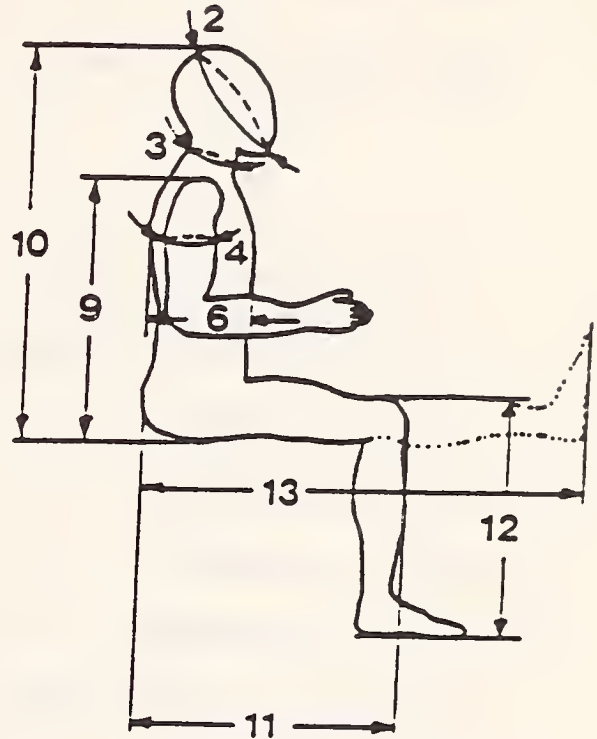
Run No. .86.20.DOT....

Anthropometric Data

Body weight .78
..... kg

Body length 165
..... cm

- 1. Hat size 55 cm
- 2. Occip.-chin.circumfer. 65 cm
- 2a. Head length 21 cm
- 2b. Head breadth 18,2 cm
- 2c. Head height 15,3 cm
- 3. Neck circumfer. 41 cm
- 4. Upper arm circumfer. 28 cm
- 5. Chest circumfer. 96 cm
- 6. Chest height..... 23 cm
- 7. Chest width 31 cm
- 8. Abdomen circumfer. 85 cm
- 9. Buttocks - shoulder ..72... cm
- 10. Seat height 91 cm
- 11. Pelvis - knee 48 cm
- 12. Sole of foot - knee ..57... cm
- 13. Pelvis - heal 92 cm



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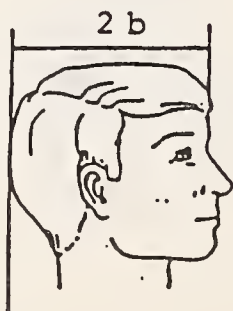
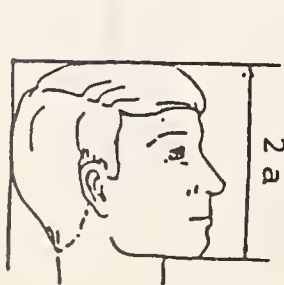
Run No. 86 21 DOT

Anthropometric Data

Body weight 72 kg

Body length 166 cm

- 1. Hat size 55 cm
- 2. Occip.-chin.circumfer. 65 cm
- 2a. Head length 22 cm
- 2b. Head breadth 18 cm
- 2c. Head height 15,3 cm
- 3. Neck circumfer. 39 cm
- 4. Upper arm circumfer. 28 cm
- 5. Chest circumfer. 100 cm
- 6. Chest height 22 cm
- 7. Chest width 33 cm
- 8. Abdomen circumfer. 87 cm
- 9. Buttocks - shoulder 68 cm
- 10. Seat height 91 cm
- 11. Pelvis - knee 56 cm
- 12. Sole of foot - knee 51 cm
- 13. Pelvis - heal 95 cm



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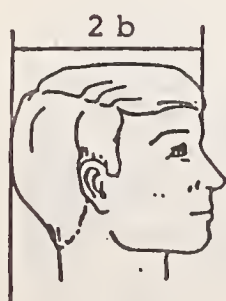
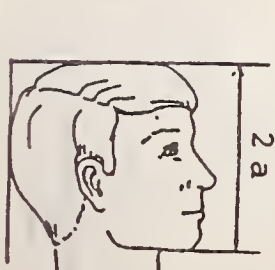
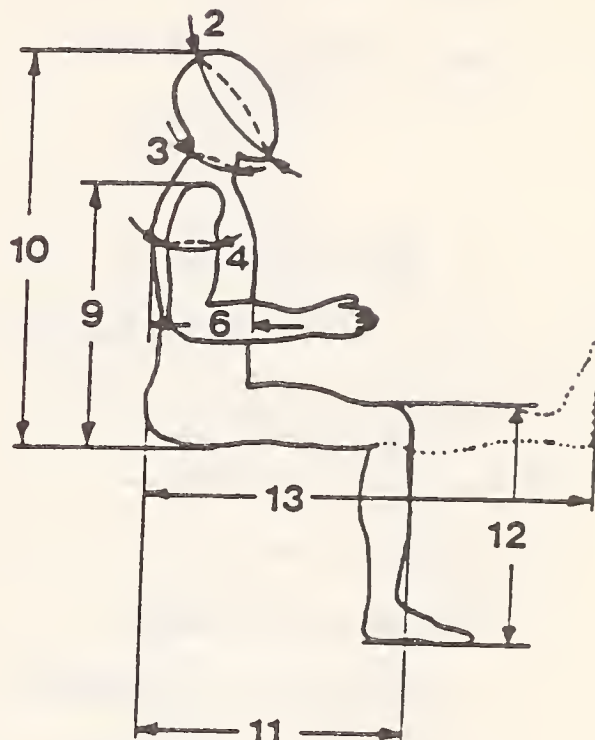
Run No. .86.22.DOT.....

Anthropometric Data

Body weight 80 kg

Body length 182 cm

- 1. Hat size 57 cm
- 2. Occip.-chin.circumfer.... 68 cm
- 2a. Head length 23 cm
- 2b. Head breadth 19 cm
- 2c. Head height 14,5 cm
- 3. Neck circumfer. 38 cm
- 4. Upper arm circumfer. 33 cm
- 5. Chest circumfer. 94 cm
- 6. Chest height..... 25 cm
- 7. Chest width 29 cm
- 8. Abdomen circumfer. 85 cm
- 9. Buttocks - shoulder 73 cm
- 10. Seat height 95 cm
- 11. Pelvis - knee 60 cm
- 12. Sole of foot - knee 56 cm
- 13. Pelvis - heal 103 cm



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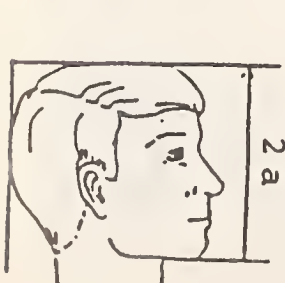
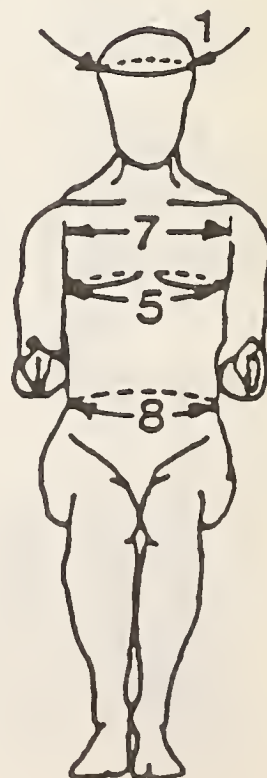
Run No. 8701 DOT

Anthropometric Data

Body weight 74 kg

Body length 168 cm

- 1. Hat size 54 cm
- 2. Occip.-chin.circumfer. 65 cm
- 2a. Head length 21 cm
- 2b. Head breadth 17,8 cm
- 2c. Head height 15,2 cm
- 3. Neck circumfer. 34 cm
- 4. Upper arm circumfer. . 32 cm
- 5. Chest circumfer. 91 cm
- 6. Chest height..... 21 cm
- 7. Chest width 31 cm
- 8. Abdomen circumfer. 93 cm
- 9. Buttocks - shoulder ... 64 cm
- 10. Seat height 89 cm
- 11. Pelvis - knee 55 cm
- 12. Sole of foot - knee ... 51 cm
- 13. Pelvis - heal 95 cm



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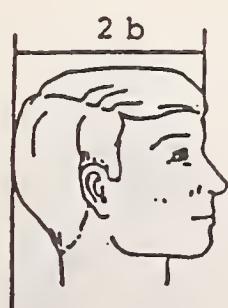
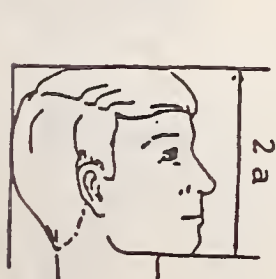
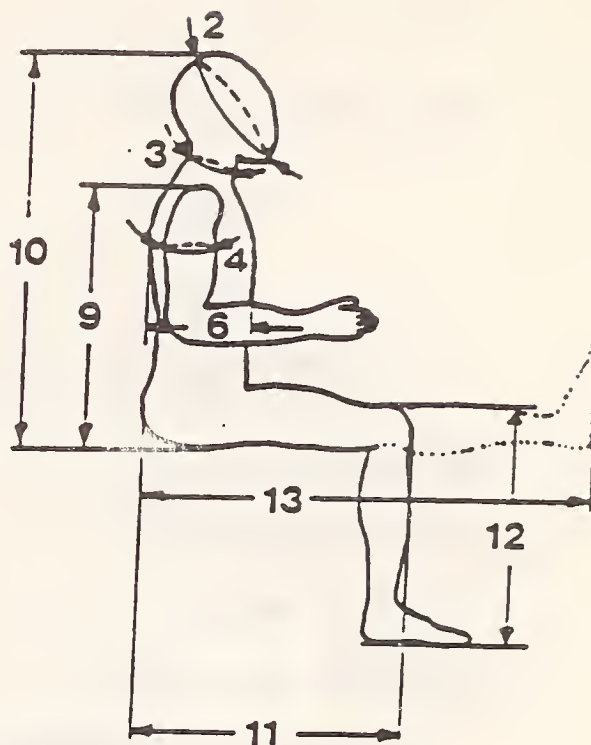
Run No. .8703 DOT.....

Anthropometric Data

Body weight ..66. kg

Body length .154. cm

- 1. Hat size55. cm
- 2. Occip.-chin.circumfer.65. cm
- 2a. Head length24,5cm
- 2b. Head breadth19,0cm
- 2c. Head height15,0cm
- 3. Neck circumfer.42. cm
- 4. Upper arm circumfer. .30. cm
- 5. Chest circumfer.101. cm
- 6. Chest height.....27. cm
- 7. Chest width33. cm
- 8. Abdomen circumfer. ...94. cm
- 9. Buttocks - shoulder ..61. cm
- 10. Seat height85. cm
- 11. Pelvis - knee51. cm
- 12. Sole of foot - knee 46 cm
- 13. Pelvis - heal 88 cm



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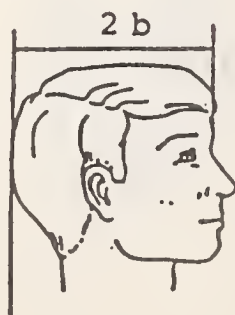
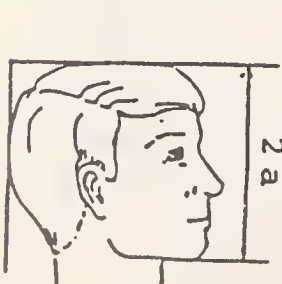
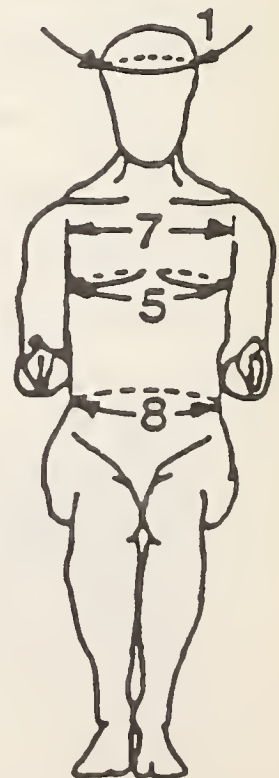
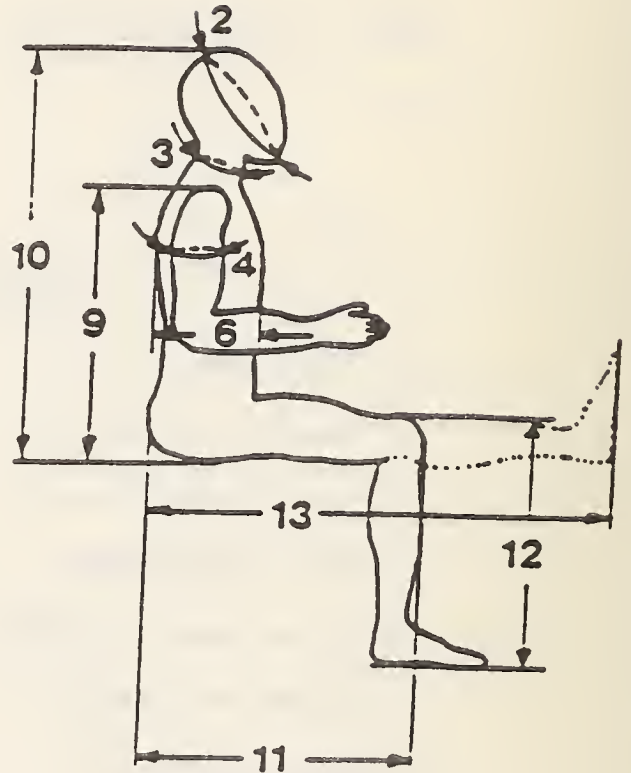
Run No. 8705 DOT.....

Anthropometric Data

Body weight 71 kg

Body length 175 cm

- 1. Hat size 59 cm
- 2. Occip.-chin.circumfer. 68 cm
- 2a. Head length 22 cm
- 2b. Head breadth 19,1 cm
- 2c. Head height 16,8 cm
- 3. Neck circumfer. 45 cm
- 4. Upper arm circumfer. ... 31 cm
- 5. Chest circumfer. 89 cm
- 6. Chest height..... 21 cm
- 7. Chest width 33 cm
- 8. Abdomen circumfer. ... 78,5 cm
- 9. Buttocks - shoulder ... 70 cm
- 10. Seat height 92 cm
- 11. Pelvis - knee 57 cm
- 12. Sole of foot - knee ... 52 cm
- 13. Pelvis - heal 75 cm



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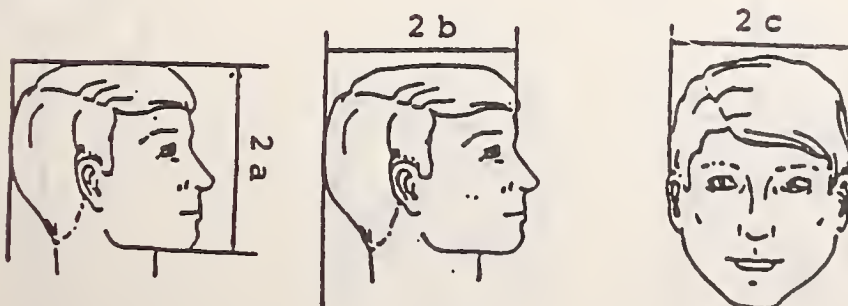
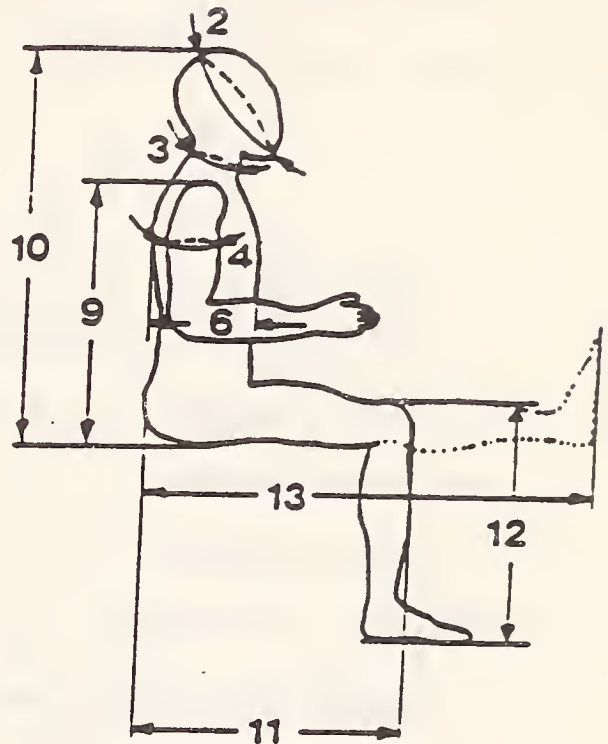
Run No. 8706 DOT

Anthropometric Data

Body weight 72 kg

Body length 172 cm

- 1. Hat size 59 cm
- 2. Occip.-chin.circumfer. 69 cm
- 2a. Head length 23 cm
- 2b. Head breadth 19 cm
- 2c. Head height 16 cm
- 3. Neck circumfer. 43 cm
- 4. Upper arm circumfer. 30 cm
- 5. Chest circumfer. 100 cm
- 6. Chest height..... 25 cm
- 7. Chest width 30 cm
- 8. Abdomen circumfer. 88 cm
- 9. Buttocks - shoulder 68 cm
- 10. Seat height 91 cm
- 11. Pelvis - knee 59 cm
- 12. Sole of foot - knee ... 51 cm
- 13. Pelvis - heel 95 cm

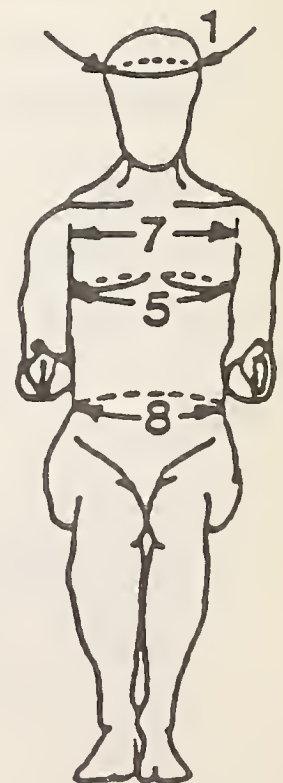
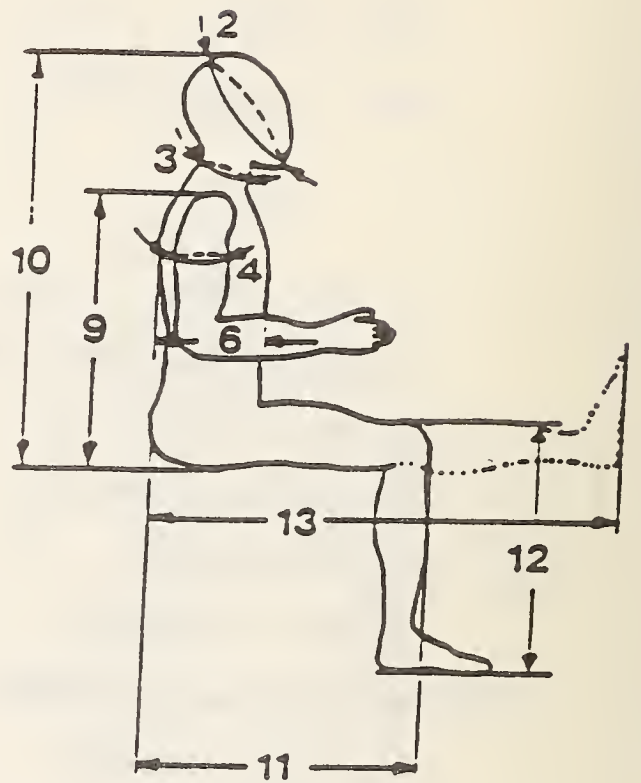


Anthropometric Data

Body weight kg

Body length cm

- 1. Hat size 58 cm
- 2. Occip.-chin.circumfer.... 67 cm
- 2a. Head length 25,0 cm
- 2b. Head breadth 19,6 cm
- 2c. Head height 14,7 cm
- 3. Neck circumfer. 39 cm
- 4. Upper arm circumfer. 33 cm
- 5. Chest circumfer. 92 cm
- 6. Chest height..... 21 cm
- 7. Chest width 33 cm
- 8. Abdomen circumfer. 88 cm
- 9. Buttocks - shoulder 70 cm
- 10. Seat height 97 cm
- 11. Pelvis - knee 58 cm
- 12. Sole of foot - knee 53 cm
- 13. Pelvis - heel 100 cm



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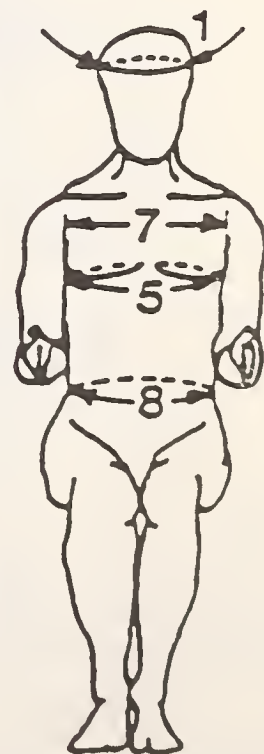
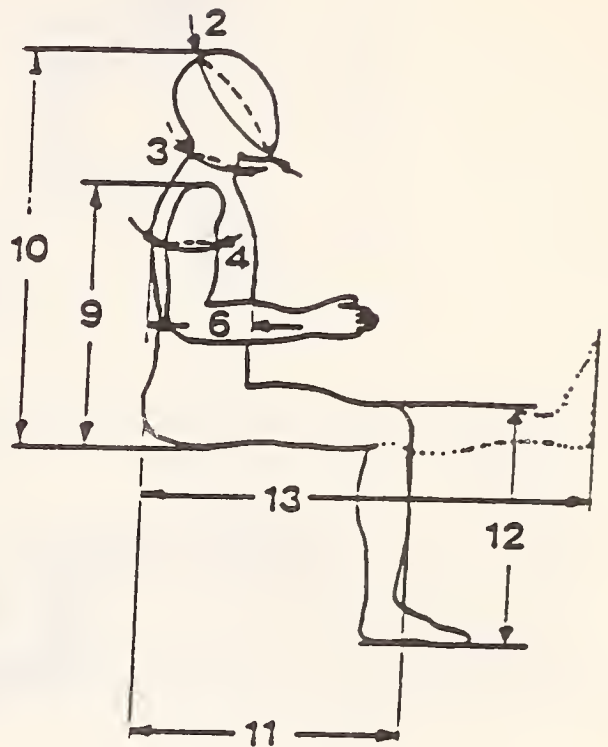
Run No. 8710 DOT.....

Anthropometric Data

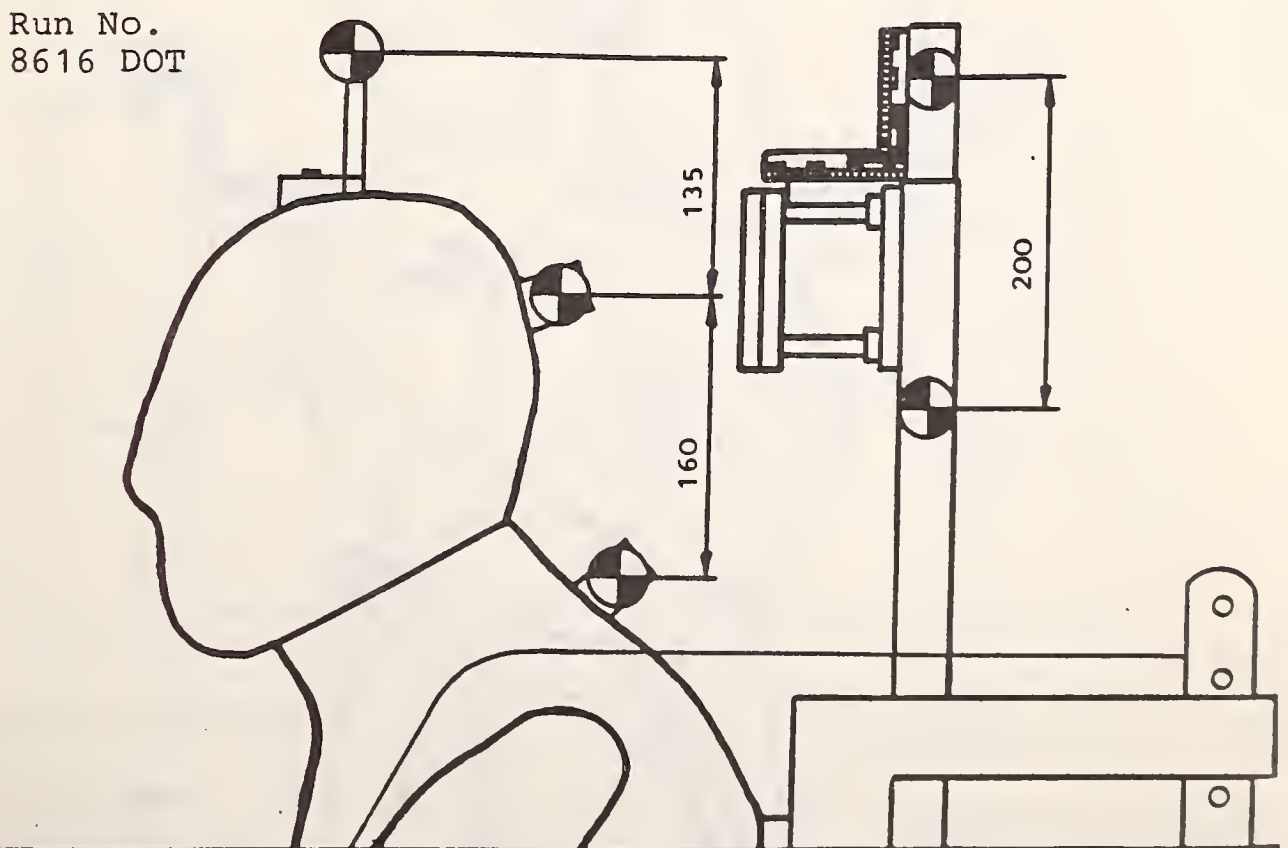
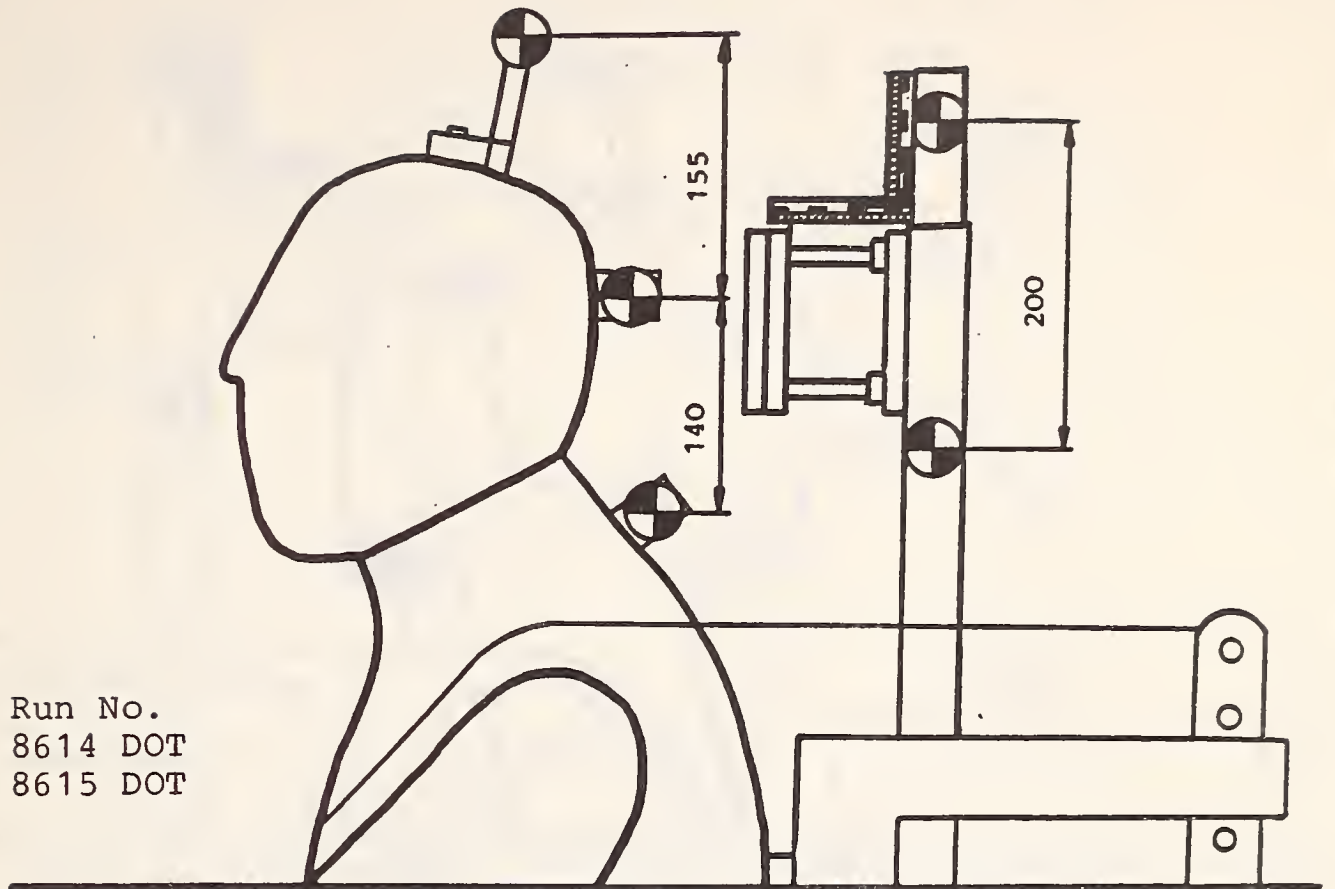
Body weight ...53 kg

Body length cm

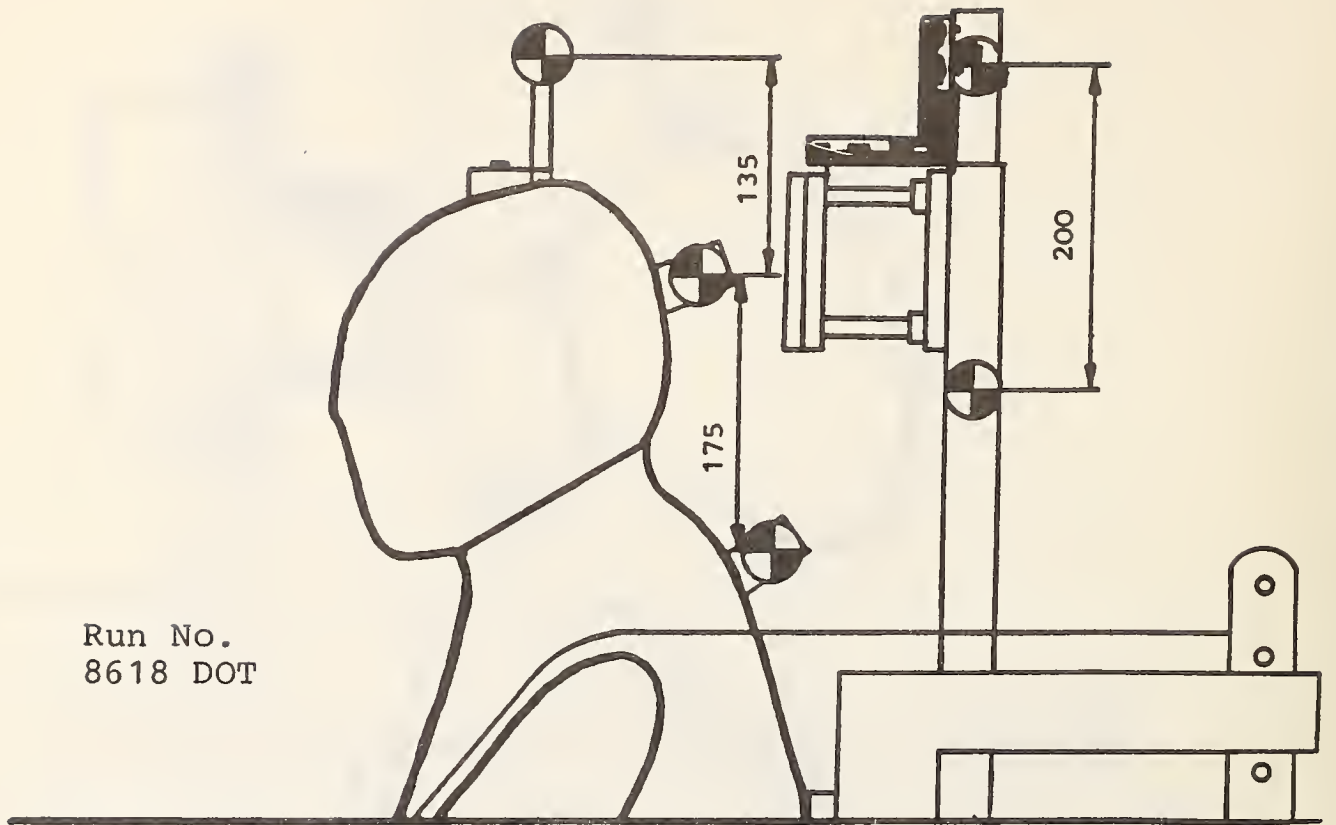
- 1. Hat size 53 cm
- 2. Occip.-chin.circumfer. 65 cm
- 2a. Head length 21,6 cm
- 2b. Head breadth 18,6 cm
- 2c. Head height 13,8 cm
- 3. Neck circumfer. 33 cm
- 4. Upper arm circumfer. ... 22 cm
- 5. Chest circumfer. 91 cm
- 6. Chest height..... 20 cm
- 7. Chest width 28 cm
- 8. Abdomen circumfer. 65 cm
- 9. Buttocks - shoulder 67 cm
- 10. Seat height 90 cm
- 11. Pelvis - knee 57 cm
- 12. Sole of foot - knee 55 cm
- 13. Pelvis - heel 104 cm



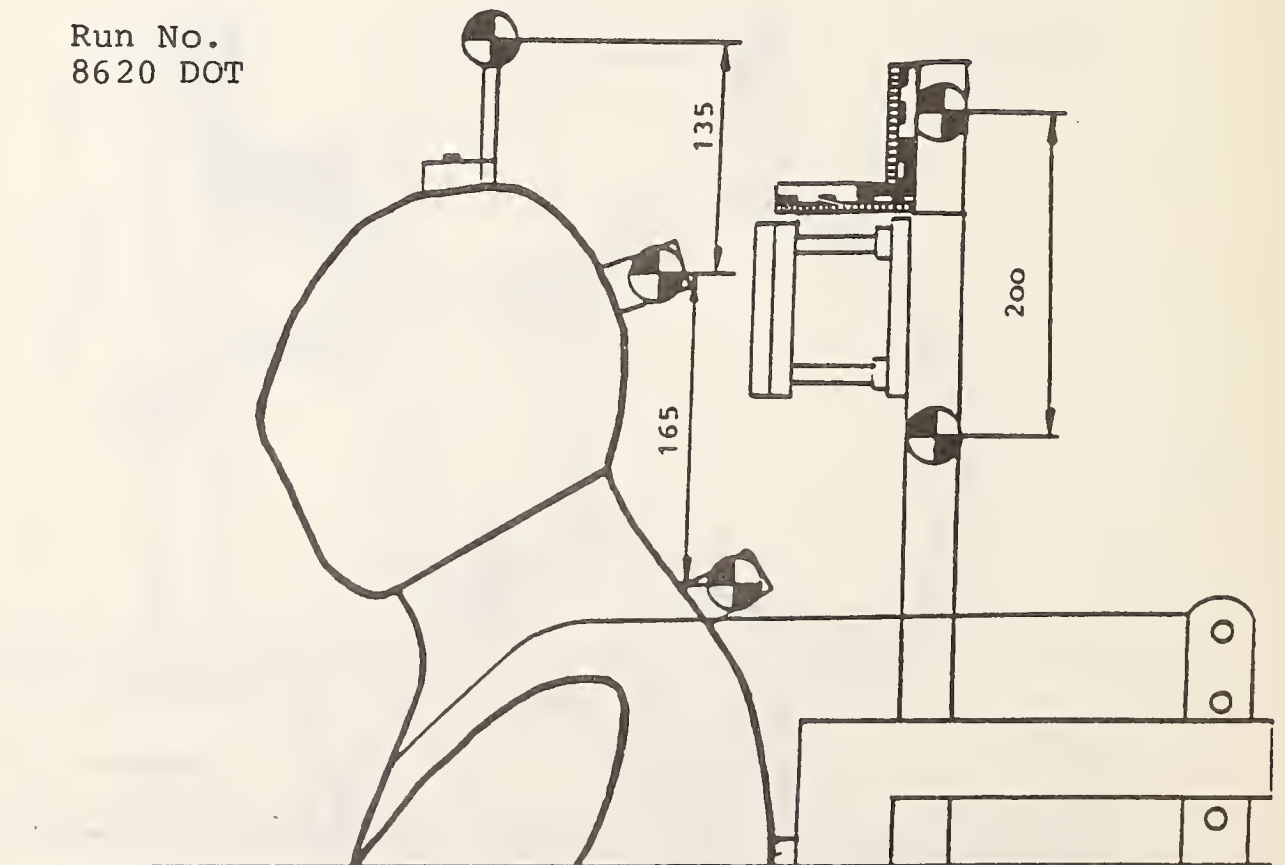
APPENDIX B: DISTANCES BETWEEN THE PHOTO TARGETS
AT THE HEAD; THE TH1 AND THE SLED FIXED
POINTS; ALL DISTANCES IN MILLIMETERS



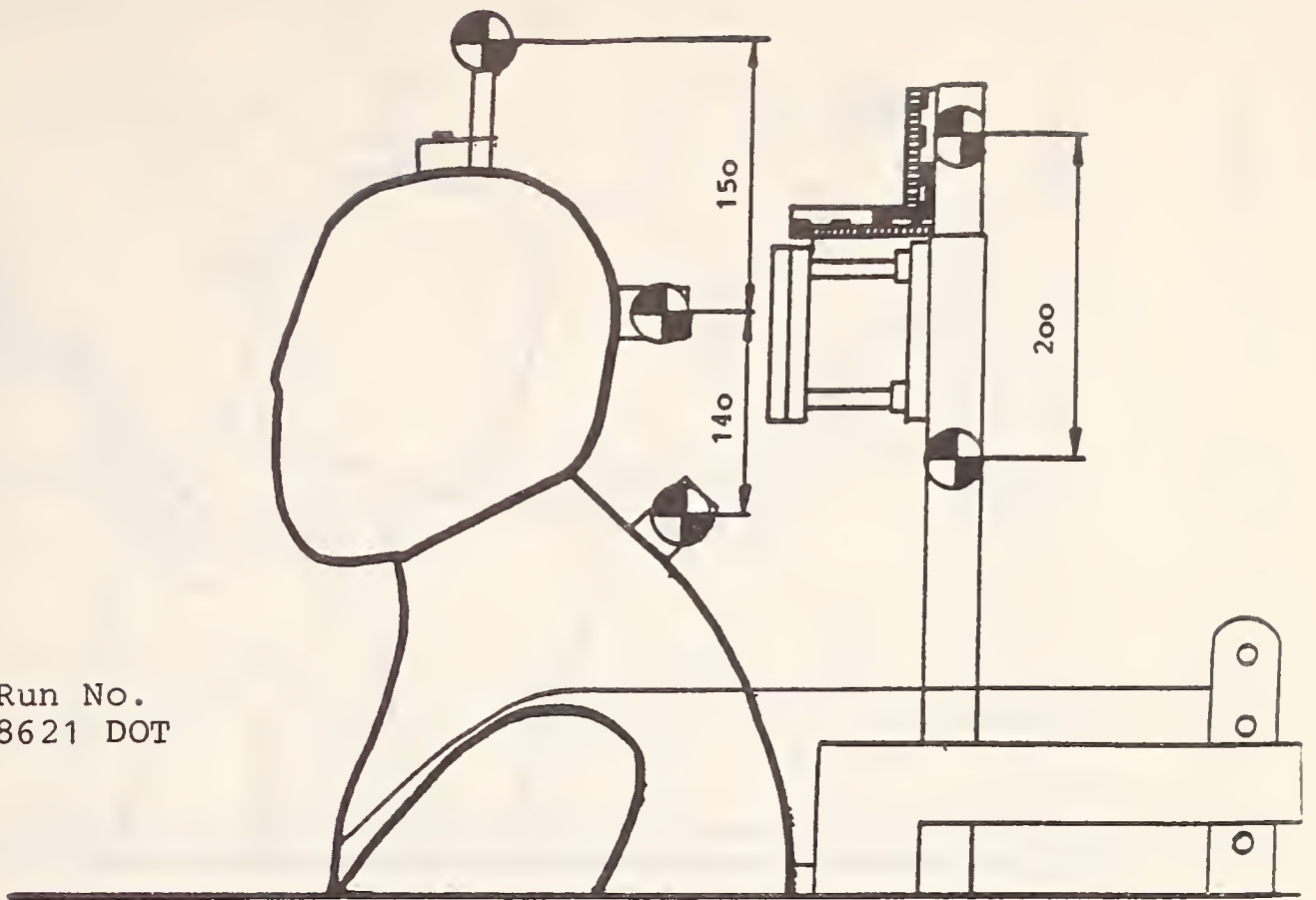
Run No.
8618 DOT



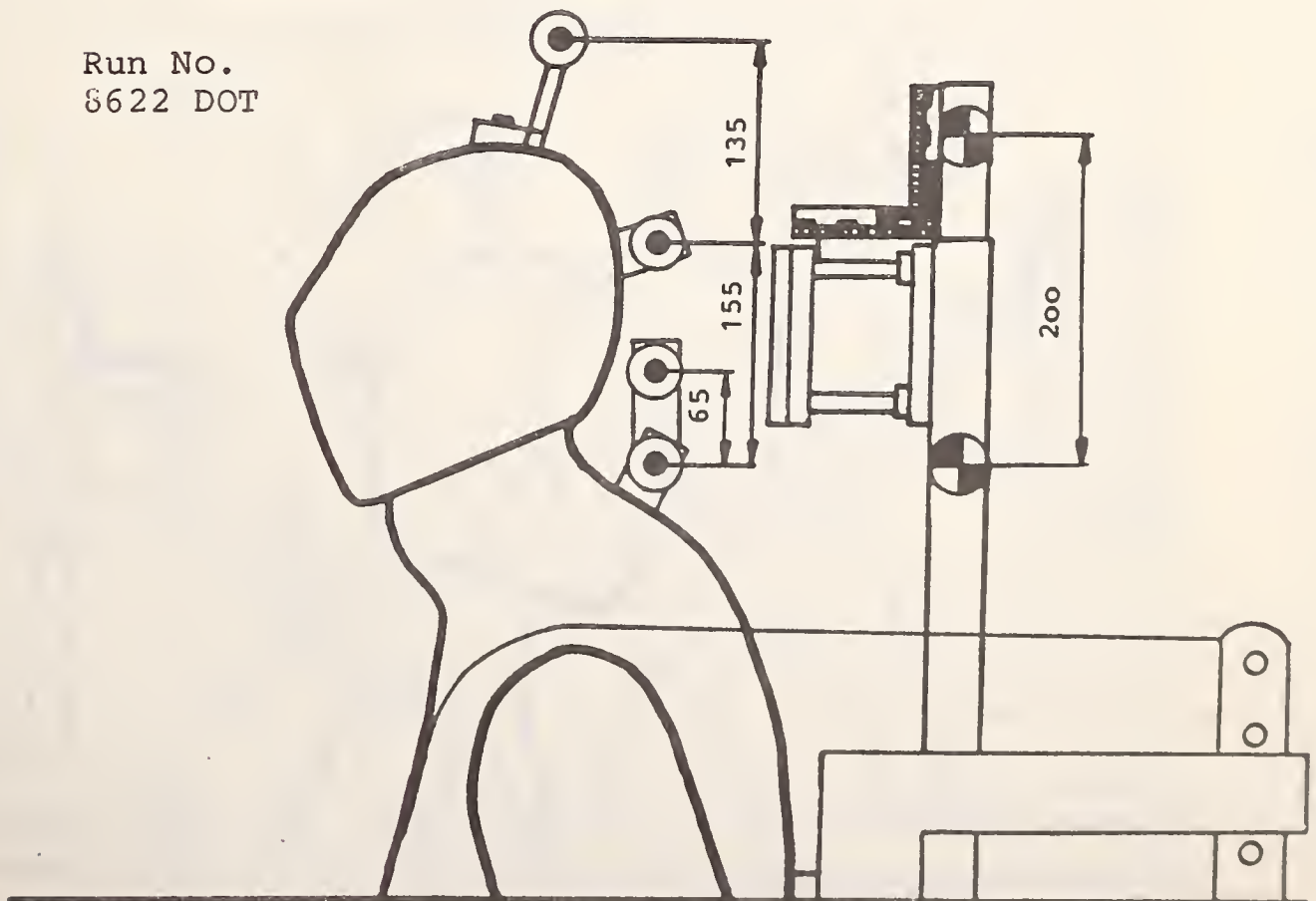
Run No.
8620 DOT

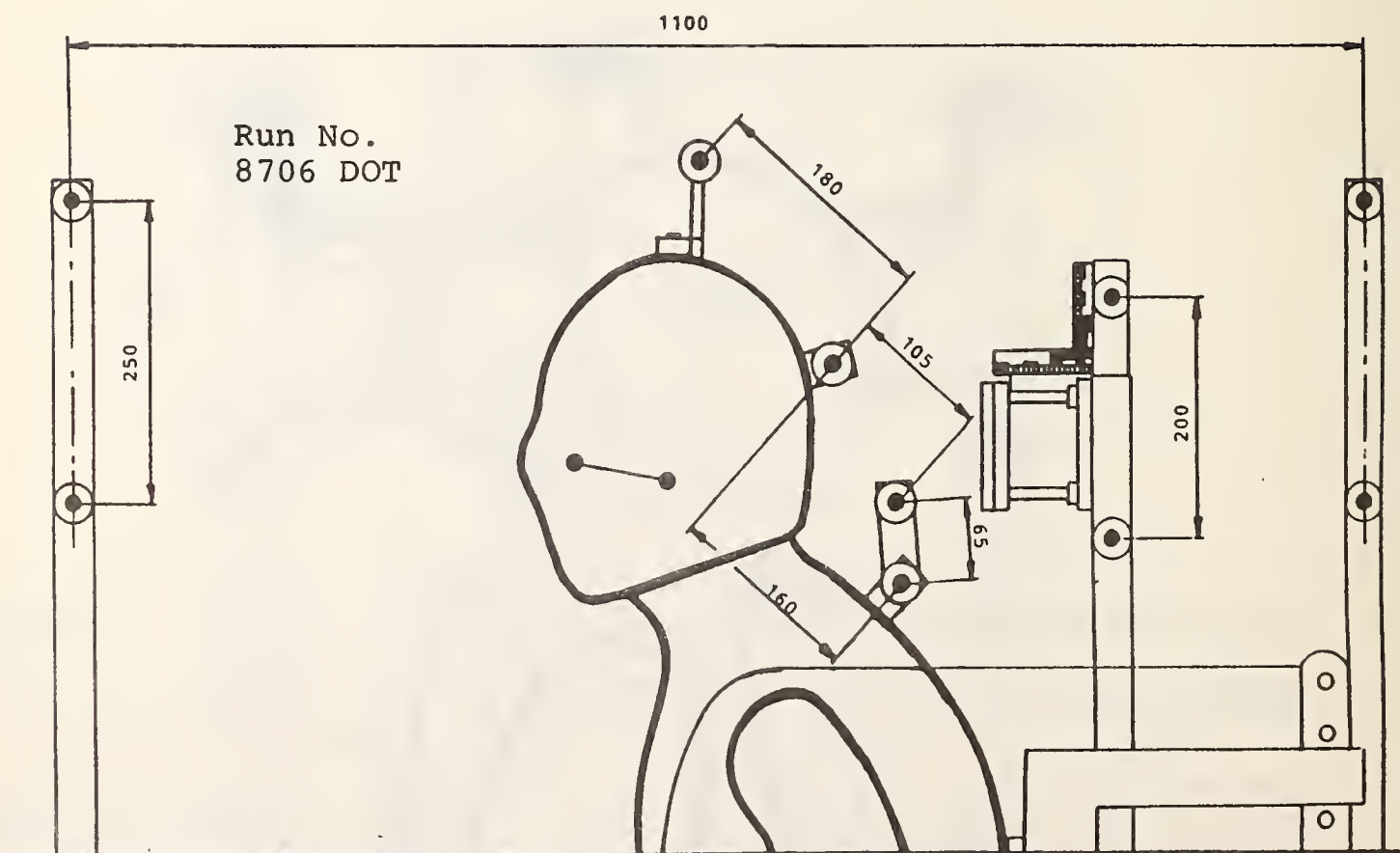
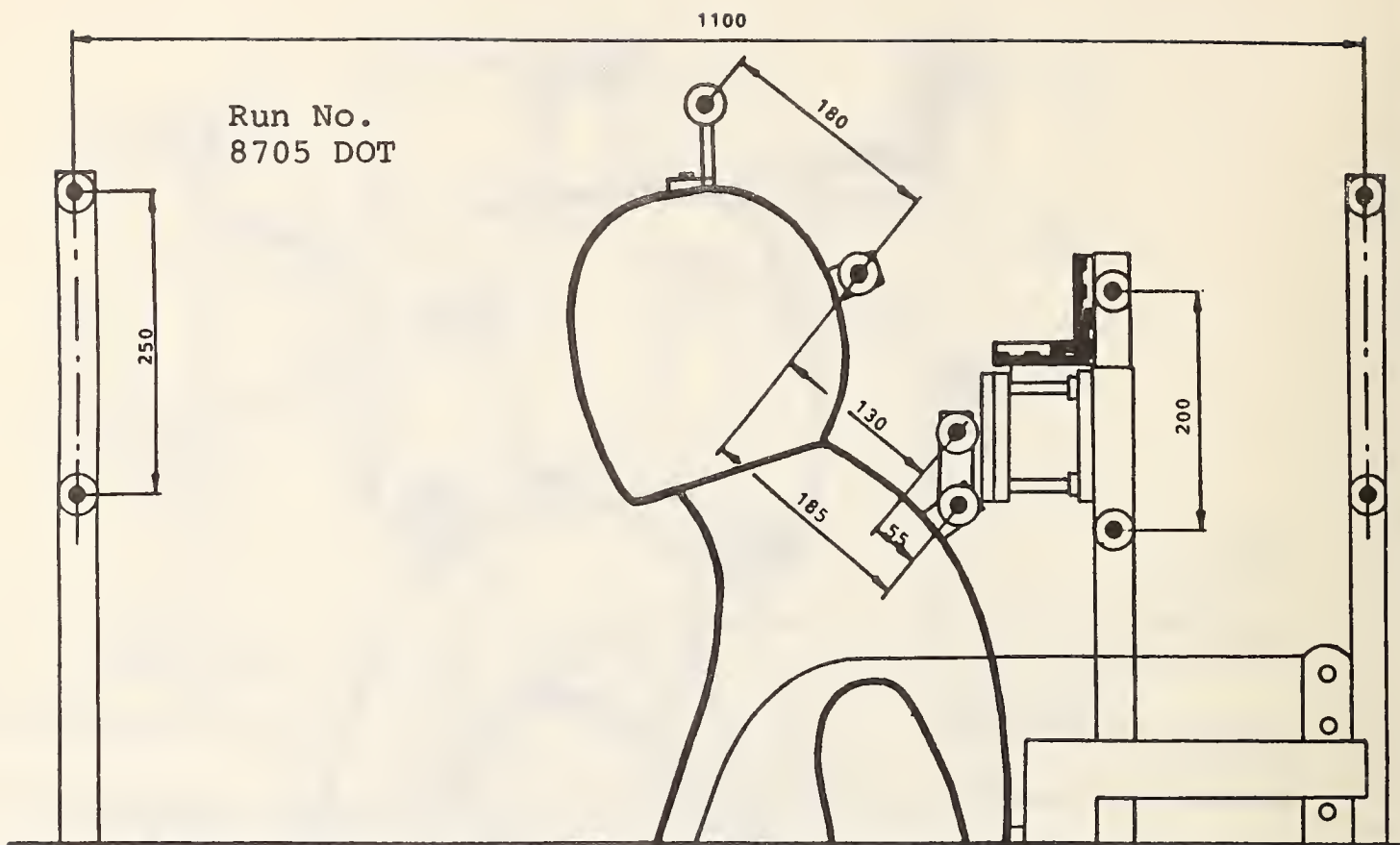


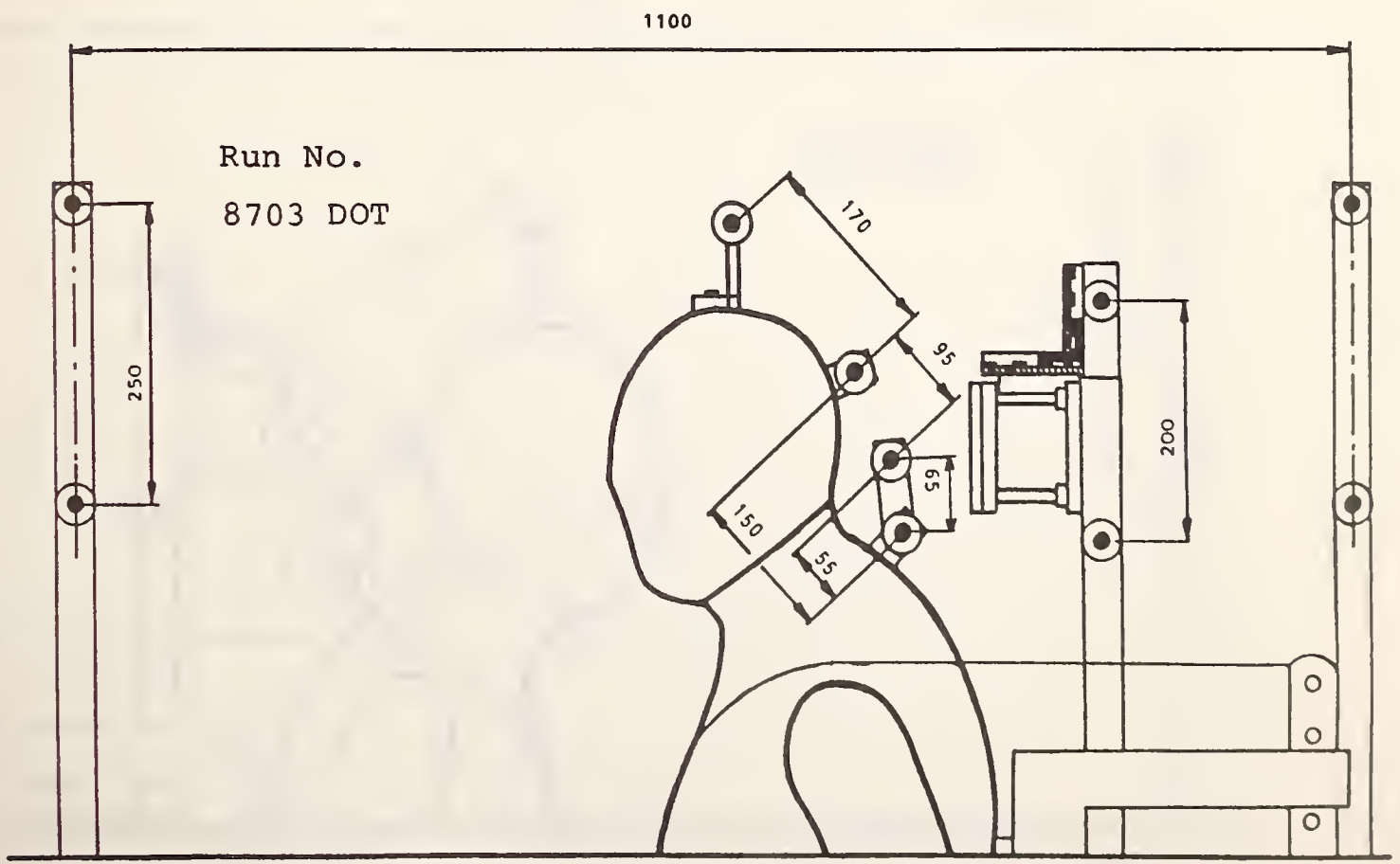
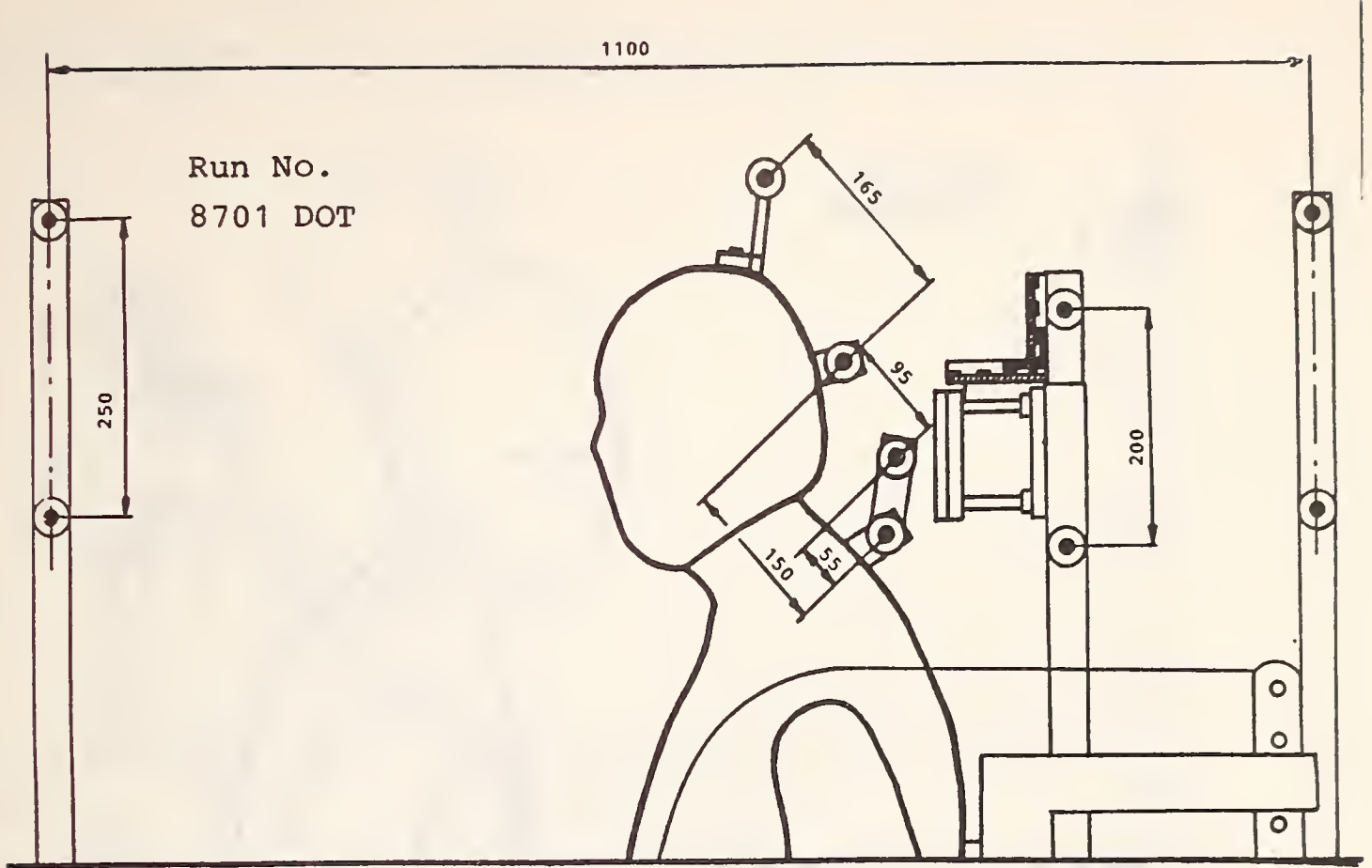
Run No.
8621 DOT

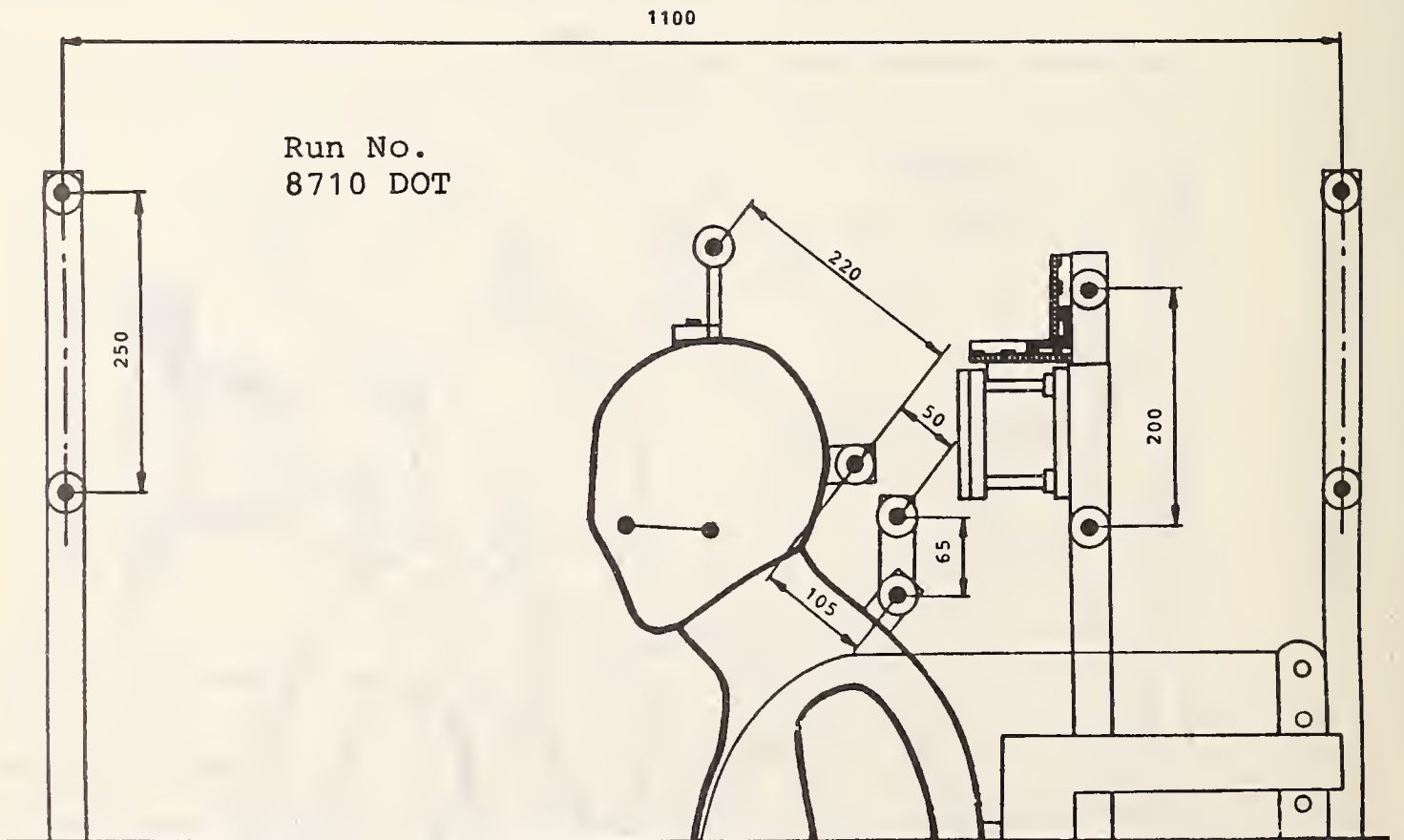
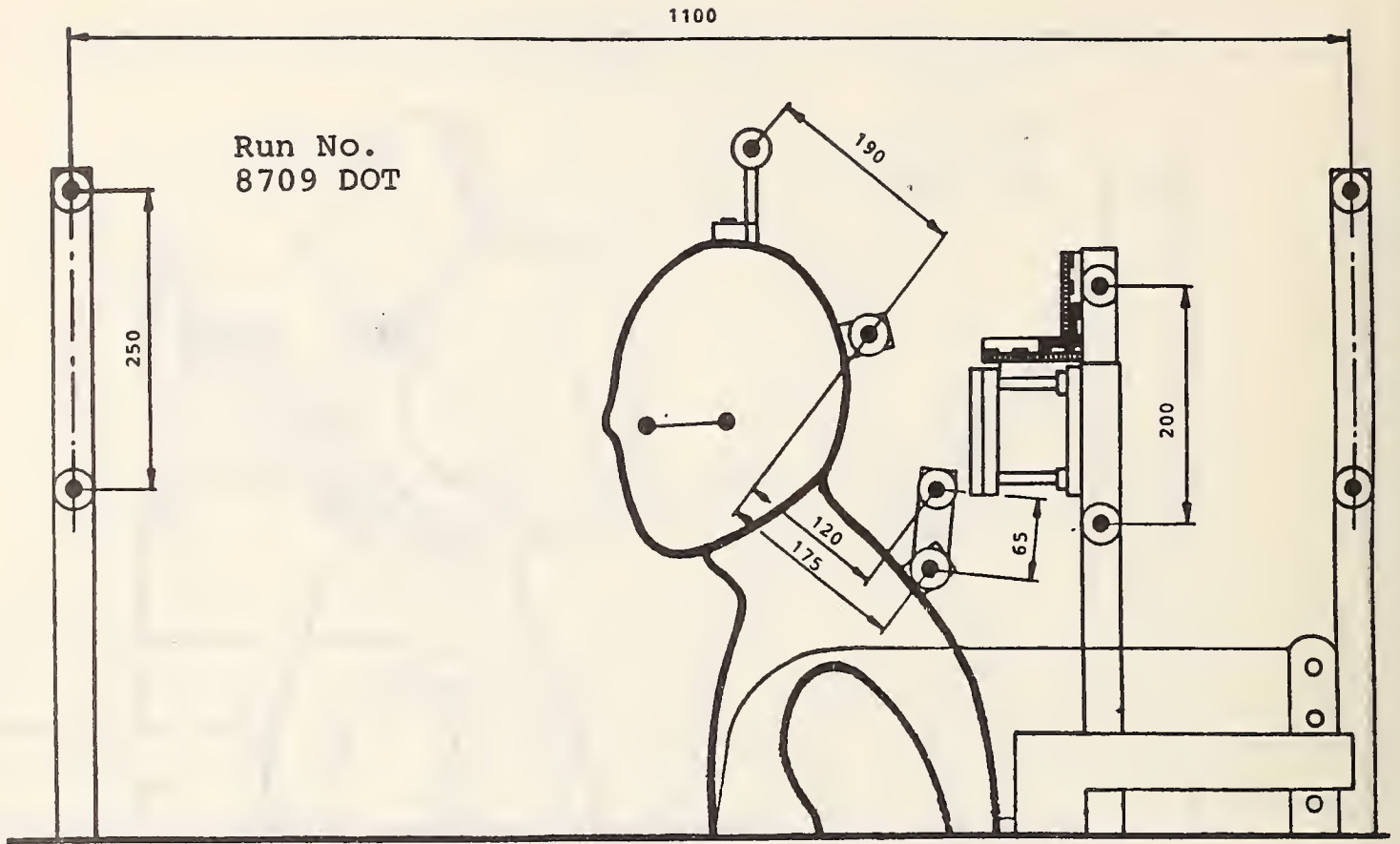


Run No.
8622 DOT









APPENDIX C: MEASURING DATA FOR EACH POST-MORTEM
HUMAN SUBJECT TEST

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : SLED

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	2.6447	173.4	2.3602	15.211	99.3	14.526
8703	59.405	11	3.1839	173.2	2.902	15.211	90.5	14.641
8701	59.504	11	2.1442	168.3	1.8896	15.279	86.9	14.771
8622	59.016	11	2.3683	188.4	2.1143	16.056	111.2	15.802
8621	59.504	11	1.7053	199.3	1.4529	14.79	116.3	14.534
8620	58.537	11	2.067	171.8	1.7287	16.452	98	15.944
8618	59.016	11	2.7963	166.4	2.5424	15.123	105	14.869
8616	59.016	11	3.0523	169.6	2.39	15.024	105.3	14.834
8615	58.537	11	2.195	169.7	2.0998	15.455	75.3	15.265
8614	59.016	11	1.677	178.6	1.677	16.045	109.5	15.666

11	G	MV : 59.105	km/h	n : 10				
MEAN VALUE :			2.3835	176	2.1157	15.465	99.7	15.125
MAX. VALUE :			3.1839	199.3	2.902	16.452	116.3	15.944
MIN. VALUE :			1.677	166.4	1.4529	14.79	75.3	14.534

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	2.2982	136.1	1.9168	23.26	81.1	23.068
8709	60.5	15	1.0993	133.6	.71894	22.49	71.2	22.205
8706	59.504	15	1.9077	120.8	1.6233	23.032	74.5	22.746

15	G	MV : 60.34	km/h	n : 3				
MEAN VALUE :			1.7684	130	1.4197	22.927	75.6	22.673
MAX. VALUE :			2.2982	136.1	1.9168	23.26	81.1	23.068
MIN. VALUE :			1.0993	120.8	.71894	22.49	71.2	22.205

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : CLIVUS X

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		3.5627	10.9	1.253	20.758	56.1	18.995
8703	59.405	11		6.9605	232.9	2.3471	22.572	53.2	21.691
8701	59.504	11		16.097	226.4	5.9448	28.396	55.6	25.812
8622	59.016	11		6.4148	232.8	1.6569	36.808	63.3	33.386
8621	59.504	11		3.4512	0	2.3289	18.118	56.5	15.273
8620	58.537	11		4.3547	27.4	2.4007	27.087	53.5	25.963
8618	59.016	11		5.4773	234.2	3.744	18.832	56	18.538
8616	59.016	11		6.6036	235.4	.67813	23.663	60	22.328
8615	58.537	11		7.373	81.5	7.373	34.416	70.2	30.397
8614	59.016	11		4.6305	82.3	2.3219	21.373	70.3	19.368

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				6.4925	136	3.0048	25.202	59.5	23.175
MAX. VALUE :				16.097	235.4	7.373	36.808	70.3	33.386
MIN. VALUE :				3.4512	10.9	.67813	18.118	53.2	15.273

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		3.6814	231.5	1.9514	39.979	47.1	36.776
8709	60.5	15		4.027	0	2.9617	39.35	49.6	35.439
8706	59.504	15		3.6707	166.1	2.2233	41.833	50.9	36.542

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				3.793	133	2.3788	40.387	49.2	36.252
MAX. VALUE :				4.027	231.5	2.9617	41.833	50.9	36.776
MIN. VALUE :				3.6707	166.1	1.9514	39.35	47.1	35.439

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
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 BIOMECHANICS GROUP

MES. LOCATION : CLIVUS Y

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	3.0706	45.5	2.5396	2.8632	89.1	1.8712
8703	59.405	11	1.101	46.3	1.7362	6.4507	64.8	2.3923
8701	59.504	11	13.624	64.6	8.4237	6.0994	65.3	1.0464
8622	59.016	11	3.721	83.1	3.0322	7.4016	66.7	6.4032
8621	59.504	11	4.931	57.8	2.4003	5.2125	64.4	2.5177
8620	58.537	11	5.3733	43	2.6928	4.9607	194.1	3.5071
8618	59.016	11	3.0029	201.2	1.9173	4.5271	115.4	4.192
8616	59.016	11	3.9646	235.4	.6145	9.5835	58.7	8.8136
8615	58.537	11	8.4306	80.7	8.0438	12.559	70.4	8.334
8614	59.016	11	13.4	92.9	5.48	6.3685	51.1	3.4851

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			6.3619	95.1	3.688	6.6026	84	4.2563
MAX. VALUE :			13.624	235.4	8.4237	12.559	194.1	8.8136
MIN. VALUE :			3.0029	43	.6145	2.8632	51.1	1.0464

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	5.1096	74.7	4.4521	2.5164	53.5	1.8542
8709	60.5	15	2.8847	68.6	1.3493	10.862	49.5	9.9
8706	59.504	15	8.673	81.5	2.0355	8.4847	58.4	2.692

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			5.5558	74.9	2.6123	7.2877	53.8	4.8154
MAX. VALUE :			8.673	81.5	4.4521	10.862	58.4	9.9
MIN. VALUE :			2.8847	68.6	1.3493	2.5164	49.5	1.8542

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : CLIVUS Z

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		25.583	54.5	23.937	6.5382	202.9	2.0736
8703	59.405	11		24.654	59.5	23.998	15.049	207.6	.78614
8701	59.504	11		37.895	54.9	29.003	3.9034	28	1.7086
8622	59.016	11		31.203	64.8	30.199	7.1951	201.7	1.7776
8621	59.504	11		32.738	56.9	28.774	3.9208	225.6	1.4497
8620	58.537	11		36.393	108.1	21.798	4.2436	219.9	1.4234
8618	59.016	11		29.337	60	26.348	8.5374	213	2.0302
8616	59.016	11		26.669	65.3	25.541	6.4758	196.2	2.4924
8615	58.537	11		46.136	70.6	35.215	8.1551	37.7	1.8936
8614	59.016	11		36.928	71.5	29.984	8.3741	208.8	1.5597

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				32.754	66.6	27.48	7.2393	174	1.7195
MAX. VALUE :				46.136	108.1	35.215	15.049	225.6	2.4924
MIN. VALUE :				24.654	54.5	21.798	3.9034	28	.78614

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		37.691	48.9	31.636	9.1486	161.1	7.9559
8709	60.5	15		46.944	51	44.331	7.8184	166.1	6.1904
8706	59.504	15		32.339	62.8	29.725	12.105	140.5	10.944

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				38.991	54.2	35.231	9.6907	156	8.3634
MAX. VALUE :				46.944	62.8	44.331	12.105	166.1	10.944
MIN. VALUE :				32.339	48.9	29.725	7.8184	140.5	6.1904

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. CLIVUS X,Y,Z

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	30.176	55.2	30.176	0	0	0
8703	59.405	11	30.943	56.8	30.457	0	0	0
8701	59.504	11	47.428	56.2	40.59	0	0	0
8622	59.016	11	46.185	63.3	44.723	0	0	0
8621	59.504	11	35.834	56.9	32.127	0	0	0
8620	58.537	11	39.855	108.1	32.337	0	0	0
8618	59.016	11	30.813	60	30.615	0	0	0
8616	59.016	11	34.749	61.5	32.021	0	0	0
8615	58.537	11	52.001	70.6	43.029	0	0	0
8614	59.016	11	37.633	70.7	33.696	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			38.562	65.9	34.977	0	0	0
MAX. VALUE :			52.001	108.1	44.723	0	0	0
MIN. VALUE :			30.176	55.2	30.176	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	52.75	47.7	50.137	0	0	0
8709	60.5	15	59.068	50.3	56.392	0	0	0
8706	59.504	15	51.046	50.9	46.621	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			54.288	49.6	51.05	0	0	0
MAX. VALUE :			59.068	50.9	56.392	0	0	0
MIN. VALUE :			51.046	47.7	46.621	0	0	0

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : HEAD 0 X

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	2.4057	58.7	1.7493	19.625	88.2	17.487
8703	59.405	11	8.1108	50.5	5.644	26.938	101.7	26.283
8701	59.504	11	11.071	52.9	4.8439	37.365	120.4	36.702
8622	59.016	11	10.712	60	9.3936	34.169	124.3	32.855
8621	59.504	11	1.376	226.1	.54708	29.837	123.2	29.837
8620	58.537	11	6.24	48.5	5.5818	31.221	110.1	28.265
8618	59.016	11	6.3014	47.3	6.3014	35.694	115.5	35.358
8616	59.016	11	4.8149	55.4	3.8109	30.722	121.6	29.919
8615	58.537	11	15.119	59.7	14.109	33.416	80.5	29.997
8614	59.016	11	13.787	50.3	8.5157	27.762	93.1	25.75

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			7.9938	70.9	6.0497	30.675	108	29.245
MAX. VALUE :			15.119	226.1	14.109	37.365	124.3	36.702
MIN. VALUE :			1.376	47.3	.54708	19.625	80.5	17.487

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	14.033	43.7	13.041	23.472	100.3	23.308
8709	60.5	15	12.655	49.2	9.9929	26.568	94	25.577
8706	59.504	15	8.3923	49.7	7.3999	30.864	89.9	30.536

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			11.693	47.5	10.145	26.968	94.7	26.474
MAX. VALUE :			14.033	49.7	13.041	30.864	100.3	30.536
MIN. VALUE :			8.3923	43.7	7.3999	23.472	89.9	23.308

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : HEAD Ø Y

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	3.1791	182.8	3.04	5.1784	58.4	4.7601
8703	59.405	11	2.8983	208.7	1.5075	8.3127	67	6.9309
8701	59.504	11	7.818	105.4	5.843	4.7072	53.2	3.0251
8622	59.016	11	2.311	49.5	1.7528	4.9243	63.3	3.3959
8621	59.504	11	3.8283	52.9	3.4122	8.164	126.7	7.1854
8620	58.537	11	4.5104	125.8	4.0923	2.0245	186	1.3331
8618	59.016	11	9.4069	68.7	6.5993	1.9412	37.6	1.2136
8616	59.016	11	2.9396	54.2	1.3224	5.0939	126.7	4.7381
8615	58.537	11	12.095	77.5	9.2139	9.6277	60.4	6.7665
8614	59.016	11	7.2883	93.5	6.7495	8.8274	50	4.5405

11 G MV : 59.105 km/h n : 10

MEAN VALUE :	5.6275	102	4.3533	5.8801	82.9	4.3889
MAX. VALUE :	12.095	208.7	9.2139	9.6277	186	7.1854
MIN. VALUE :	2.311	49.5	1.3224	1.9412	37.6	1.2136

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	5.3286	76.7	5.0489	4.9184	168.9	4.2334
8709	60.5	15	2.6889	73.6	2.1234	5.1964	110.8	3.9318
8706	59.504	15	10.85	77.5	7.7913	3.4706	56.3	1.663

15 G MV : 60.34 km/h n : 3

MEAN VALUE :	6.2892	75.9	4.9879	4.5285	112	3.2761
MAX. VALUE :	10.85	77.5	7.7913	5.1964	168.9	4.2334
MIN. VALUE :	2.6889	73.6	2.1234	3.4706	56.3	1.663

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : HEAD 0 Z

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		3.1112	182.7	2.4297	32.836	58.4	27.644
8703	59.405	11		12.223	205.8	2.2348	40.746	68.4	38.176
8701	59.504	11		3.3293	0	2.2953	43.674	80.9	42.454
8622	59.016	11		6.726	205.5	1.3906	48.096	75.8	48.096
8621	59.504	11		2.6528	9.9	2.1394	29.864	59.5	28.652
8620	58.537	11		2.6012	222.3	1.7422	31.812	65.7	30.601
8618	59.016	11		6.6613	212.7	1.6228	41.333	67.3	38.702
8616	59.016	11		4.0502	197.2	1.2122	38.166	61.8	37.341
8615	58.537	11		9.0694	210.8	2.3195	72.798	75.6	71.972
8614	59.016	11		11.557	208.5	1.9466	59.688	71	46.446

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				6.1981	166	1.9333	43.901	68.4	41.008
MAX. VALUE :				12.223	222.3	2.4297	72.798	80.9	71.972
MIN. VALUE :				2.6012	9.9	1.2122	29.864	58.4	27.644

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		5.1771	158.4	4.4946	57.654	61	55.408
8709	60.5	15		7.6785	146.4	6.9871	48.569	70.6	47.011
8706	59.504	15		13.749	144.2	13.238	49.424	56.3	48.735

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				8.8682	150	8.2399	51.882	62.6	50.385
MAX. VALUE :				13.749	158.4	13.238	57.654	70.6	55.408
MIN. VALUE :				5.1771	144.2	4.4946	48.569	56.3	47.011

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : HEAD 1 Z

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	2.7103	182.7	1.7607	32.417	57.1	30.616
8703	59.405	11	13.399	205.9	1.7256	41.176	68.5	38.69
8701	59.504	11	5.3677	31	3.2302	40.481	74.4	40.206
8622	59.016	11	5.3535	205.4	1.6774	48.392	72.6	47.559
8621	59.504	11	2.6506	8	1.971	32.507	58.3	30.976
8620	58.537	11	2.3563	11.9	1.9495	31.642	65.7	30.812
8618	59.016	11	7.458	212.6	2.3322	39.992	62.3	39.992
8616	59.016	11	4.0846	197.2	2.7779	42.741	61.8	37.995
8615	58.537	11	7.3073	216.6	2.0285	70.09	69.3	65.472
8614	59.016	11	9.8147	208.4	2.5293	49.996	71	46.554

11 6 MV : 59.105 km/h n : 10

MEAN VALUE :	5.8502	148	2.1982	42.943	66.1	40.887
MAX. VALUE :	13.399	216.6	3.2302	70.09	74.4	65.472
MIN. VALUE :	2.3563	8	1.6774	31.642	57.1	30.616

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	8.6558	160.7	8.2475	52.463	55	51.354
8709	60.5	15	9.0206	165.7	7.0996	48.501	65.9	47.529
8706	59.504	15	12.859	141.2	11.369	50.971	53.6	48.768

15 6 MV : 60.34 km/h n : 3

MEAN VALUE :	10.178	156	8.9054	50.645	58.2	49.217
MAX. VALUE :	12.859	165.7	11.369	52.463	65.9	51.354
MIN. VALUE :	8.6558	141.2	7.0996	48.501	53.6	47.529

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
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 BIOMECHANICS GROUP

MES. LOCATION : HEAD 1 Y

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		5.0398	91.2	4.7144	7.2272	55.9	6.7347
8703	59.405	11		2.6675	0	2.1813	15.111	70.5	7.7628
8701	59.504	11		9.7692	81.8	6.6146	8.9876	135.1	6.9963
8622	59.016	11		4.4492	35.4	1.746	10.331	32.9	4.9211
8621	59.504	11		4.3274	52.9	2.5311	10.961	126	9.3126
8620	58.537	11		6.9418	92.5	5.3115	4.0068	175.5	2.6942
8618	59.016	11		9.3681	68.6	8.3375	3.3484	29.5	2.316
8616	59.016	11		4.5564	135.6	3.9483	5.9943	128.4	4.5729
8615	58.537	11		14.225	78.3	12.21	10.014	42.1	9.4061
8614	59.016	11		10.349	72.2	9.9398	8.6821	48.8	5.2027

11 G MV : 59.105 km/h n : 10

MEAN VALUE :		7.1693	70.8	5.7534	8.4663	84.5	5.9919
MAX. VALUE :		14.225	135.6	12.21	15.111	175.5	9.4061
MIN. VALUE :		2.6675	35.4	1.746	3.3484	29.5	2.316

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		9.2545	72.5	7.3021	6.3237	168.1	5.1922
8709	60.5	15		4.3566	80.6	3.8596	5.6052	109.7	5.2725
8706	59.504	15		9.267	88.9	8.455	7.3337	56.3	2.438

15 G MV : 60.34 km/h n : 3

MEAN VALUE :		7.626	80.7	6.5389	6.4209	111	4.3009
MAX. VALUE :		9.267	88.9	8.455	7.3337	168.1	5.2725
MIN. VALUE :		4.3566	72.5	3.8596	5.6052	56.3	2.438

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : HEAD 2 X

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		5.3743	51.7	3.7502	23.928	89.2	20.203
8703	59.405	11		8.7994	50.5	6.9098	27.214	105.2	26.614
8701	59.504	11		11.782	53	4.0266	37.572	113.4	36.34
8622	59.016	11		13.527	61.8	10.861	36.731	123.2	36.731
8621	59.504	11		4.5444	38.7	2.6387	29.961	115.7	29.961
8620	58.537	11		6.2242	45.6	6.2242	29.294	110.3	27.947
8618	59.016	11		5.1921	48.7	4.4361	37.849	119	37.232
8616	59.016	11		5.118	46.1	3.9027	33	122.5	30.854
8615	58.537	11		20.262	68.3	17.446	34.501	80.3	30.606
8614	59.016	11		12.669	52.1	10.753	28.425	93.1	26.988

11	G	MU :	59.105	km/h	n :	10			
MEAN VALUE :			9.3492		51.6	7.0948	31.847	107	30.348
MAX. VALUE :			20.262		68.3	17.446	37.849	123.2	37.232
MIN. VALUE :			4.5444		38.7	2.6387	23.928	80.3	20.203

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		13.057	43.7	11.448	25.227	98.4	24.475
8709	60.5	15		16.141	49.4	13.742	27.402	101.6	25.712
8706	59.504	15		7.2166	37.3	5.8911	31.118	102.7	30.071

15	G	MU :	60.34	km/h	n :	3			
MEAN VALUE :			12.138		43.5	10.36	27.916	101	26.753
MAX. VALUE :			16.141		49.4	13.742	31.118	102.7	30.071
MIN. VALUE :			7.2166		37.3	5.8911	25.227	98.4	24.475

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : HEAD 2 Z

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		2.6483	182.8	0	32.025	75.5	30.136
8703	59.405	11		13.581	205.9	3.057	40.606	66	40.606
8701	59.504	11		3.9526	8.5	1.6078	50.222	74.6	44.744
8622	59.016	11		8.7033	205.3	2.7133	49.506	74.4	49.506
8621	59.504	11		3.7757	0	.65664	34.034	58.2	31.046
8620	58.537	11		5.23	222.3	2.7876	30.565	65.7	29.897
8618	59.016	11		5.4171	213.3	1.2781	41.411	68.3	38.163
8616	59.016	11		4.948	197.1	2.1472	39.316	69.3	37.989
8615	58.537	11		12.009	210.9	5.0118	97.993	69.3	76.878
8614	59.016	11		13.462	209.1	2.2721	72.901	70.9	47.059

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				7.3727	166	2.1532	48.858	69.2	42.602
MAX. VALUE :				13.581	222.3	5.0118	97.993	75.5	76.878
MIN. VALUE :				2.6483	8.5	.65664	30.565	58.2	29.897

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		5.478	158.8	5.3148	55.525	61.7	54.352
8709	60.5	15		8.8269	146.4	7.838	50.663	67.2	50.663
8706	59.504	15		13.947	144.2	11.94	47.845	56.3	45.45

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				9.4173	150	8.3643	51.344	61.7	50.155
MAX. VALUE :				13.947	158.8	11.94	55.525	67.2	54.352
MIN. VALUE :				5.478	144.2	5.3148	47.845	56.3	45.45

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN

DER UNIVERSITAET HEIDELBERG

BIOMECHANICS GROUP

MES. LOCATION : HEAD 3 X

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		9.4576	51.6	6.9595	25.638	89.2	19.846
8703	59.405	11		17.902	50.5	10.209	29.697	71.1	27.763
8701	59.504	11		23.982	52.8	15.199	43.985	117.4	40.493
8622	59.016	11		21.77	61.8	17.776	39.785	123.2	39.785
8621	59.504	11		7.6083	55	6.4356	35.204	125.5	33.414
8620	58.537	11		11.618	48.6	11.618	35.725	108.9	32.761
8618	59.016	11		13.534	47.7	12.949	40.705	111.6	38.925
8616	59.016	11		9.5556	58.4	8.49	36.103	121.9	33.747
8615	58.537	11		23.928	60.8	22.84	44.643	81.1	33.573
8614	59.016	11		21.846	50.4	13.154	35.396	93.2	30.323

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				16.12	53.8	12.563	36.688	104	33.063
MAX. VALUE :				23.982	61.8	22.84	44.643	125.5	40.493
MIN. VALUE :				7.6083	47.7	6.4356	25.638	71.1	19.846

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		24.913	46.3	23.135	28.983	98.3	28.539
8709	60.5	15		26.181	49.3	20.433	30.396	163.2	28.571
8706	59.504	15		18.521	49.4	15.439	34.213	108.3	33.175

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				23.205	48.3	19.669	31.197	123	30.095
MAX. VALUE :				26.181	49.4	23.135	34.213	163.2	33.175
MIN. VALUE :				18.521	46.3	15.439	28.983	98.3	28.539

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
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 BIOMECHANICS GROUP

MES. LOCATION : HEAD 3 Z

UNIT : G

TIME : ms

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11		5.2814	182.7	1.6944	12.001	55.3	9.5685
8703	59.405	11		4.5677	4.8	3.0349	13.644	66.9	13.469
8701	59.504	11		5.7463	66.9	2.7125	14.631	136	11.232
8622	59.016	11		4.6637	230.8	3.6311	11.903	63.3	9.0082
8621	59.504	11		7.0639	56.8	4.5411	15.936	134.1	12.258
8620	58.537	11		9.0597	137	4.968	8.4378	175.5	6.1928
8618	59.016	11		12.757	68.8	10.24	7.2889	186.5	5.0328
8616	59.016	11		6.1056	0	4.442	12.003	126.7	9.7123
8615	58.537	11		19.903	77.5	9.1956	19.923	69.9	14.96
8614	59.016	11		11.851	70.7	8.4851	30.897	49.5	11.776

11 G MV : 59.105 km/h n : 10

MEAN VALUE :				8.6999	89.6	5.2945	14.666	106	10.321
MAX. VALUE :				19.903	230.8	10.24	30.897	186.5	14.96
MIN. VALUE :				4.5677	4.8	1.6944	7.2889	49.5	5.0328

R-NR.	KM/H	SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15		12.787	75.4	11.299	6.9933	169.3	5.5827
8709	60.5	15		6.5659	84.8	4.2602	8.0558	114.1	7.3394
8706	59.504	15		9.6063	103.7	8.5785	8.9182	56.3	7.1668

15 G MV : 60.34 km/h n : 3

MEAN VALUE :				9.6531	88	8.0459	7.9891	113	6.6963
MAX. VALUE :				12.787	103.7	11.299	8.9182	169.3	7.3394
MIN. VALUE :				6.5659	75.4	4.2602	6.9933	56.3	5.5827

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. HEAD 0 X,Y,Z

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	34.422	58.4	31.923	0	0	0
8703	59.405	11	46.177	70.6	41.682	0	0	0
8701	59.504	11	48.942	81.6	46.408	0	0	0
8622	59.016	11	49.24	75.8	48.013	0	0	0
8621	59.504	11	36.266	114.3	36.266	0	0	0
8620	58.537	11	43.279	108.8	39.423	0	0	0
8618	59.016	11	45.734	67.4	43.097	0	0	0
8616	59.016	11	39.128	121.4	38.056	0	0	0
8615	58.537	11	77.718	80.9	75.175	0	0	0
8614	59.016	11	59.831	71	47.517	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			48.074	85	44.756	0	0	0
MAX. VALUE :			77.718	121.4	75.175	0	0	0
MIN. VALUE :			34.422	58.4	31.923	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	60.094	61	57.845	0	0	0
8709	60.5	15	51.573	70.6	50.018	0	0	0
8706	59.504	15	52.305	56.3	50.952	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			54.657	62.6	52.938	0	0	0
MAX. VALUE :			60.094	70.6	57.845	0	0	0
MIN. VALUE :			51.573	56.3	50.018	0	0	0

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN

DER UNIVERSITAET HEIDELBERG

BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. HEAD 1 Y,Z

UNIT : G

TIME : MS

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	32.867	57.1	31.279	0	0	0
8703	59.405	11	41.42	68.5	40.179	0	0	0
8701	59.504	11	41.152	77.5	41.152	0	0	0
8622	59.016	11	48.455	72.6	48.455	0	0	0
8621	59.504	11	32.531	59.6	32.234	0	0	0
8620	58.537	11	31.66	65.7	31.205	0	0	0
8618	59.016	11	40.251	65.2	40.179	0	0	0
8616	59.016	11	41.716	61.8	38.946	0	0	0
8615	58.537	11	70.79	77.9	68.31	0	0	0
8614	59.016	11	50.361	71	44.293	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :	43.12	67.7	41.623	0	0	0
MAX. VALUE :	70.79	77.9	68.31	0	0	0
MIN. VALUE :	31.66	57.1	31.205	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	52.564	55	52.416	0	0	0
8709	60.5	15	48.517	65.9	48.368	0	0	0
8706	59.504	15	51.175	53.6	51.175	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :	50.752	58.2	50.653	0	0	0
MAX. VALUE :	52.564	65.9	52.416	0	0	0
MIN. VALUE :	48.517	53.6	48.368	0	0	0

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. HEAD 2 X,Z

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	36.198	80	35.234	0	0	0
8703	59.405	11	43.925	69	43.258	0	0	0
8701	59.504	11	52.143	79.5	48.134	0	0	0
8622	59.016	11	50.425	77.4	50.27	0	0	0
8621	59.504	11	38.316	116.2	36.469	0	0	0
8620	58.537	11	41.476	108.8	38.666	0	0	0
8618	59.016	11	47.854	68.3	44.53	0	0	0
8616	59.016	11	41.233	69.3	39.12	0	0	0
8615	58.537	11	98.044	69.3	79.521	0	0	0
8614	59.016	11	73.574	70.9	48.822	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			52.319	80.9	46.402	0	0	0
MAX. VALUE :			98.044	116.2	79.521	0	0	0
MIN. VALUE :			36.198	68.3	35.234	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	58.561	61.7	56.731	0	0	0
8709	60.5	15	53.14	70.7	53.092	0	0	0
8706	59.504	15	52.074	62.1	50.448	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			54.592	64.8	53.424	0	0	0
MAX. VALUE :			58.561	70.7	56.731	0	0	0
MIN. VALUE :			52.074	61.7	50.448	0	0	0

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. HEAD 3 X,Y

UNIT : G

TIME : MS

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	26.911	89.2	21.191	0	0	0
8703	59.405	11	31.505	76.3	28.864	0	0	0
8701	59.504	11	44.329	117.4	41.243	0	0	0
8622	59.016	11	40.83	123.2	38.033	0	0	0
8621	59.504	11	37.574	125.5	35.56	0	0	0
8620	58.537	11	35.75	108.9	32.186	0	0	0
8618	59.016	11	40.767	111.6	40.166	0	0	0
8616	59.016	11	36.316	120.4	36.316	0	0	0
8615	58.537	11	45.087	81.1	36.171	0	0	0
8614	59.016	11	37.023	49.5	31.291	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			37.609	100	34.102	0	0	0
MAX. VALUE :			45.087	125.5	41.243	0	0	0
MIN. VALUE :			26.911	49.5	21.191	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	28.987	98.3	28.243	0	0	0
8709	60.5	15	30.484	163.2	29.444	0	0	0
8706	59.504	15	34.22	108.3	32.511	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			31.23	123	30.066	0	0	0
MAX. VALUE :			34.22	163.2	32.511	0	0	0
MIN. VALUE :			28.987	98.3	28.243	0	0	0

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : THORAX 1 X

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	10.998	207.4	3.429	17.651	64.1	17.157
8703	59.405	11	23.706	220.6	1.6841	17.434	64.9	13.192
8701	59.504	11	104.72	204.9	1.7089	38.125	205.3	17.558
8622	59.016	11	12.934	209.5	2.4024	20.561	54.2	19.512
8621	59.504	11	7.7212	233.2	1.5419	24.216	124.5	19.999
8620	58.537	11	7.2105	217.4	3.26	34.461	109.4	20.11
8618	59.016	11	13.092	213.6	1.7649	15.876	62.5	15.541
8616	59.016	11	8.6845	204	1.6664	17.901	122.5	17.363
8615	58.537	11	8.5902	202.8	3.57	23.167	58.5	20.975
8614	59.016	11	9.4889	211.3	1.8785	15.534	62.3	14.253

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			20.715	212	2.2906	22.493	92.8	17.566
MAX. VALUE :			104.72	233.2	3.57	38.125	205.3	20.975
MIN. VALUE :			7.2105	202.8	1.5419	15.534	54.2	13.192

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	11.007	161.5	8.846	23.395	57.8	22.03
8709	60.5	15	10.622	162.5	9.4656	30.037	56.3	26.232
8706	59.504	15	12.176	83.2	8.9296	31.686	82.5	19.663

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			11.268	136	9.0804	28.373	65.5	22.642
MAX. VALUE :			12.176	162.5	9.4656	31.686	82.5	26.232
MIN. VALUE :			10.622	83.2	8.846	23.395	56.3	19.663

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
DER UNIVERSITAET HEIDELBERG
BIOMECHANICS GROUP

MES. LOCATION : THORAX 1 Y

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	7.9948	93.7	6.0737	4.8753	208.9	3.7248
8703	59.405	11	25.271	223.8	6.1351	25.391	221.6	2.8271
8701	59.504	11	26.464	204.5	4.2079	26.752	205.7	7.2034
8622	59.016	11	8.7598	198.2	2.5173	11.044	53.5	6.002
8621	59.504	11	5.4754	213.8	2.4238	9.5321	44.4	6.945
8620	58.537	11	4.9624	82.9	3.5298	6.2406	122.2	4.2257
8618	59.016	11	5.2884	228	2.8846	6.5083	112.6	6.3496
8616	59.016	11	6.3908	204	1.1256	9.6875	69.2	7.7068
8615	58.537	11	4.0619	224.4	2.3972	13.299	47	11.083
8614	59.016	11	6.7303	216	1.3917	8.6875	62.5	7.7719

11 G MV : 59.105 km/h n : 10

MEAN VALUE :			10.14	189	3.2687	12.201	115	6.3839
MAX. VALUE :			26.464	228	6.1351	26.752	221.6	11.083
MIN. VALUE :			4.0619	82.9	1.1256	4.8753	44.4	2.8271

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	9.4772	96.2	6.7336	7.4524	150.6	7.0666
8709	60.5	15	8.3919	68.6	3.3145	11.099	56.3	6.7136
8706	59.504	15	16.834	83.6	8.263	8.6682	84.7	4.9195

15 G MV : 60.34 km/h n : 3

MEAN VALUE :			11.568	82.8	6.1037	9.0732	97.2	6.2332
MAX. VALUE :			16.834	96.2	8.263	11.099	150.6	7.0666
MIN. VALUE :			8.3919	68.6	3.3145	7.4524	56.3	4.9195

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN

DER UNIVERSITAET HEIDELBERG

BIOMECHANICS GROUP

MES. LOCATION : THORAX 1 Z

UNIT : 6

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	6.2282	198.1	2.8447	23.361	46.1	21.104
8703	59.405	11	19.888	222	3.0467	20.604	54.7	18.581
8701	59.504	11	52.75	207.8	2.7126	30.046	204.5	18.65
8622	59.016	11	15.364	196.3	1.9576	32.415	53.4	26.06
8621	59.504	11	6.4619	212.4	3.0368	18.965	124.3	16.293
8620	58.537	11	6.0096	73.3	1.2816	23.021	114.5	22.388
8618	59.016	11	11.55	92.4	2.6129	18.51	116	17.33
8616	59.016	11	6.2189	216.3	1.684	17.675	47.2	17.221
8615	58.537	11	9.3739	202.2	1.1675	24.06	59.3	22.873
8614	59.016	11	7.1788	202.3	0	18.346	62.5	16.809

11 6 MV : 59.105 km/h n : 10

MEAN VALUE :			14.102	182	2.0344	22.7	88.3	19.731
MAX. VALUE :			52.75	222	3.0467	32.415	204.5	26.06
MIN. VALUE :			6.0096	73.3	1.1675	17.675	46.1	16.293

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	13.833	139.2	11.008	35.896	98.7	33.066
8709	60.5	15	21.049	184.1	14.261	23.267	110.3	21.412
8706	59.504	15	15.658	144.1	12.64	27.394	44.6	24.61

15 6 MV : 60.34 km/h n : 3

MEAN VALUE :			16.847	156	12.636	28.852	84.5	26.363
MAX. VALUE :			21.049	184.1	14.261	35.896	110.3	33.066
MIN. VALUE :			13.833	139.2	11.008	23.267	44.6	21.412

FRONTAL - KOLLISION D O T

INSTITUT FUER RECHTSMEDIZIN
 DER UNIVERSITAET HEIDELBERG
 BIOMECHANICS GROUP

MES. LOCATION : RES. ACCEL. THORAX 1 X,Y,Z

UNIT : G

TIME : ms

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8705	59.504	11	26.705	46.1	23.086	0	0	0
8703	59.405	11	30.086	221.7	22.521	0	0	0
8701	59.504	11	104.98	204.9	27.026	0	0	0
8622	59.016	11	32.312	53.7	30.895	0	0	0
8621	59.504	11	24.242	124.8	23.297	0	0	0
8620	58.537	11	28.561	108.3	27.271	0	0	0
8618	59.016	11	24.218	116.3	24.119	0	0	0
8616	59.016	11	23.072	47.8	22.691	0	0	0
8615	58.537	11	34.643	58.6	32.106	0	0	0
8614	59.016	11	25.561	62.5	22.084	0	0	0

11 G MV : 59.105 km/h n : 10

MEAN VALUE :	35.438	104	25.51	0	0	0
MAX. VALUE :	104.98	221.7	32.106	0	0	0
MIN. VALUE :	23.072	46.1	22.084	0	0	0

R-NR.	KM/H SLED	DECEL.	MAX POS	TIME	3msVALUE	MAX NEG	TIME	3msVALUE
8710	61.017	15	37.056	98.7	33.279	0	0	0
8709	60.5	15	34.937	47.5	31.202	0	0	0
8706	59.504	15	40.471	82.4	31.61	0	0	0

15 G MV : 60.34 km/h n : 3

MEAN VALUE :	37.488	76.2	32.03	0	0	0
MAX. VALUE :	40.471	98.7	33.279	0	0	0
MIN. VALUE :	34.937	47.5	31.202	0	0	0

APPENDIX D: VERTEBRAL COLUMN CONDITION AND MEDICAL
FINDINGS OF THE POST-MORTEM HUMAN SUBJECT
TESTS

RUN NO. 8615 DOT

Subject: Male, 50 years, body weight 80 kg,
body length 176 cm

Cause of death: poisoning

Vertebral column
condition: small degenerative alterations in
the cervical- and thoracic vertebral
column area.

Medical findings: No injuries.

RUN NO. 8616 DOT

Subject: Male, 51 years, body weight 66 kg,
body length 170 cm

Cause of death: poisoning acute

Vertebral column
condition: Medium severe up to severe degenerative
alterations in the cervical spine area;
hardening of parts of the vertebral
bodies near to upperplate at C 6/C 7.

Medical findings: Hemorrhage in the intervertebral disc
C 6/C 7 (NCTJ1)

RUN NO. 8618 DOT

Subject: Female, 61 years, body weight 58 kg,
body length 155 cm

Cause of death: suffocation

Vertebral column
condition: Medium severe up to severe degenerative
alterations in the cervical and thoracic
vertebral column area. Discreet pro-
trusion of intervertebral discs under-
neath the posterior longitudinal liga-
ment in the level of C 2/C 3 and C 3/
C 4 in the vertebral canal.

Medical findings: Small laceration of the ligamentum
flavum Th 5/Th 6 (NPLJ1). Hemorrhage
in the intervertebral discs Th 2/Th 3,
Th 3/Th 4 dorsal (BCTJ1). Hemorrhage
in the intervertebral discs Th 1/Th 2,
Th 3/Th 4, Th 4/Th 5, Th 5/Th 6
ventral (BCTJ1).

RUN NO. 8620 DOT

Subject: Female, 51 years, body weight 78 kg,
body length 165 cm

Cause of death: drown

Vertebral column
condition: Moderate degree of degenerative
alterations in the central thoracic
spine in the sense of a reduction
and exsiccation of the vertebral
discs and discreet intensity of
Schmorl's node. The spongy bone
appears altered. In the cervical
spine area occurred a partial fusion
of the vertebral bodies 3 and 4.

Medical findings: Hemorrhage in the intervertebral disc
C 5/C 6 dorsal (NPTJ1). Fracture of
the upper front edge of the Th 2 with
extension to the center of the verte-
bral body (BAFV2).

RUN NO. 8621 DOT

Subject: Female, 46 years, body weight 72 kg,
body length 166 cm

Cause of death: poisoning acute

Vertebral column
condition: Medium severe degenerations of inter-
vertebral discs of the lower thoracic
vertebral and upper lumbar vertebral
column with protrusions underneath the
posterior longitudinal ligament, re-
duction of the intervertebral discs
and several Schmorl's nodes.

Medical findings: No injuries.

RUN NO. 8622 DOT

Subject: Male, 37 years, body weight 80 kg,
body length 182 cm

Cause of death: poisoning acute

Vertebral column
condition: Moderate up to medium severe degenerative
alterations of the intervertebral discs
in the lower thoracic column with ex-
siccation and reduction.

Medical findings: Hemorrhage in the intervertebral disc C 3/C 4 left dorsal (NPTJ1). Hemorrhage in the intervertebral discs C 3/C 4, C 4/C 5 ventral (NATJ1).

RUN NO. 8701 DOT

Subject: Female, 24 years, body weight 74 kg, body length 168 cm

Cause of death: poisoning acute

Vertebral column condition: No degenerative alterations.

Medical findings: Strain in the ligament apparatus between top of the clivus and top of C 2 (NCTJ1). Hemorrhage in the intervertebral disc C 5/C 6 (NPTJ1).

RUN NO. 8703 DOT

Subject: Male, 59 years, body weight 66 kg, body length 154 cm

Cause of death: poisoning acute

Vertebral column condition: Exsiccation of the intervertebral discs in the cervical spine region, main point C 5/C 6 with reduction in the dorsal segment; small protrusion of the intervertebral disc C 6/C 7 below the posterior longitudinal ligament.

Medical findings: Hemorrhage in the joint between base of the skull and C 1 right (NRTJ1).

RUN NO. 8705 DOT

Subject: Male, 38 years, body weight 71 kg, body length 175 cm

Cause of death: poisoning acute

Vertebral column condition: No degenerative alterations.

Medical findings: Hemorrhage in the joint between C 1 and C 2 left (NLTJ1).

RUN NO. 8706 DOT

Subject: Male, 50 years, body weight 72 kg,
body length 172 cm

Cause of death: poisoning acute

Vertebral column
condition: Moderate severe degenerative alterations
in the intervertebral discs of the
thoracic vertebral column, increased
thoracic kyphosis.

Medical findings: Hemorrhage in the intervertebral disc
C 4/C 5 dorsal (NCTJ1). Hemorrhage in
the joint between base of the skull
and C 1 left (NLTJ1). Hemorrhage in
the muscles between base of the skull
and arc of C 1 (NLTM1).

RUN NO. 8709 DOT

Subject: Male, 27 years, body weight 74 kg,
body length 170 cm

Cause of death: cardiac infarction.

Vertebral column
condition: No degenerative alterations.

Medical findings: No injuries.

RUN NO. 8710 DOT

Subject: Female, 43 years, body weight 53 kg,
body length 175 cm.

Cause of death: suffocation

Vertebral column
condition: Moderate severe degenerative alterations
of all intervertebral discs of the
thoracic vertebral column, increased
thoracic kyphosis.

Medical findings: Laceration of the ligamentum flavum
between Th 2 and Th 3 (BPLJ2). Fracture
of the lower front edge of Th 2 (BAFS2).
Small hemorrhage in the intervertebral
disc Th 2/Th 3 (BATJ1). Hemorrhage in
the joint between C 1 and C 2 left
(NLTJ1). Hemorrhage between the front
area of axis and rear side of atlas
(NPTJ1).

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Kallieris,

Comparison
Volunteer

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