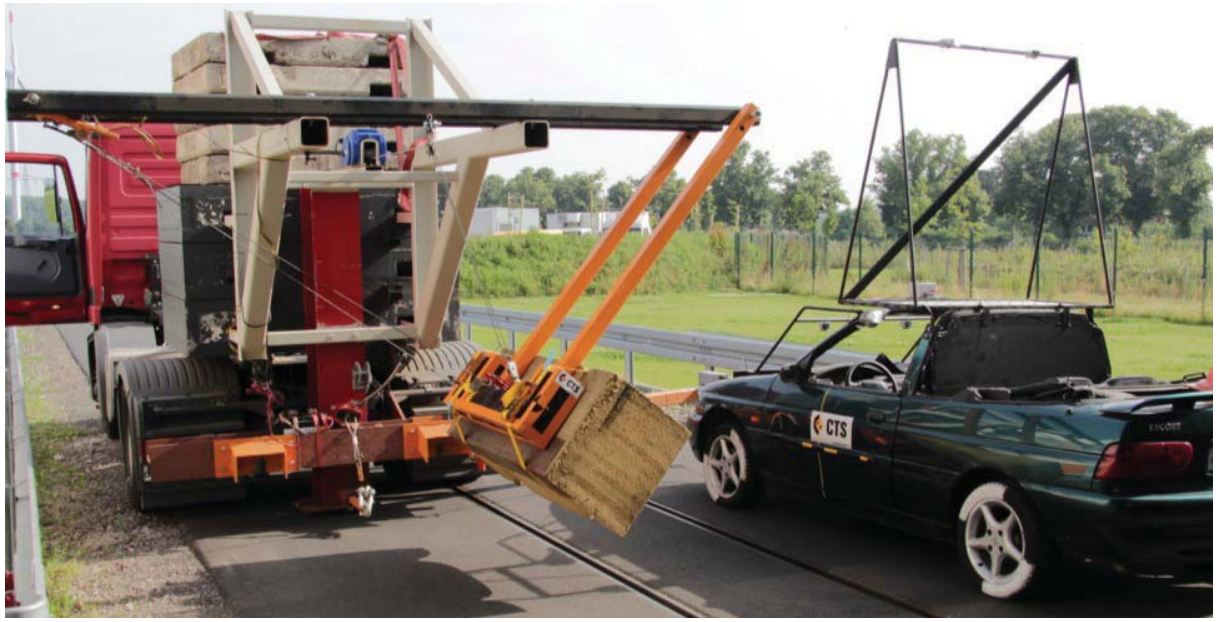
BG Verkehr
Berufsgenossenschaft für
Transport und Verkehrswirtschaft

Research study

Multidimensional analysis of lateral & oblique collisions to improve passenger safety

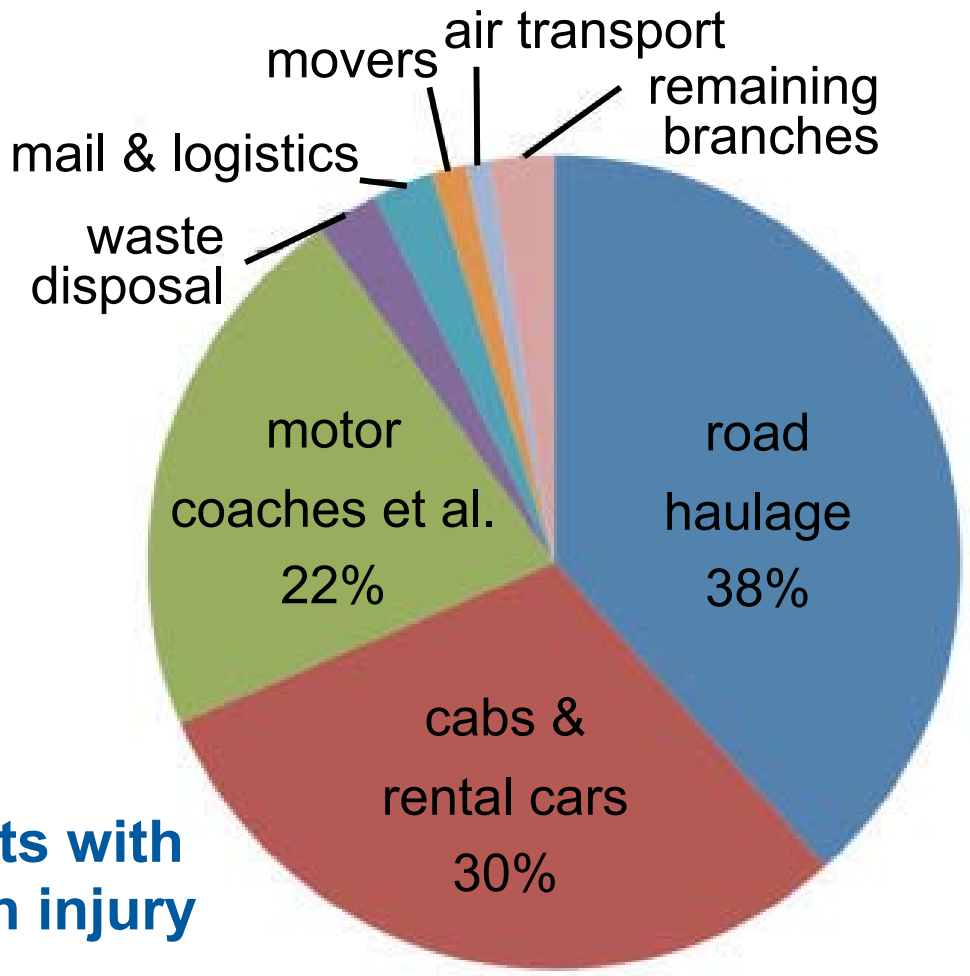


Work related & commuting accidents 2012

5.383 accidents total
2.820 with whiplash injury

52,4%

in 89% whiplash injury was listed as the no. 1 injury

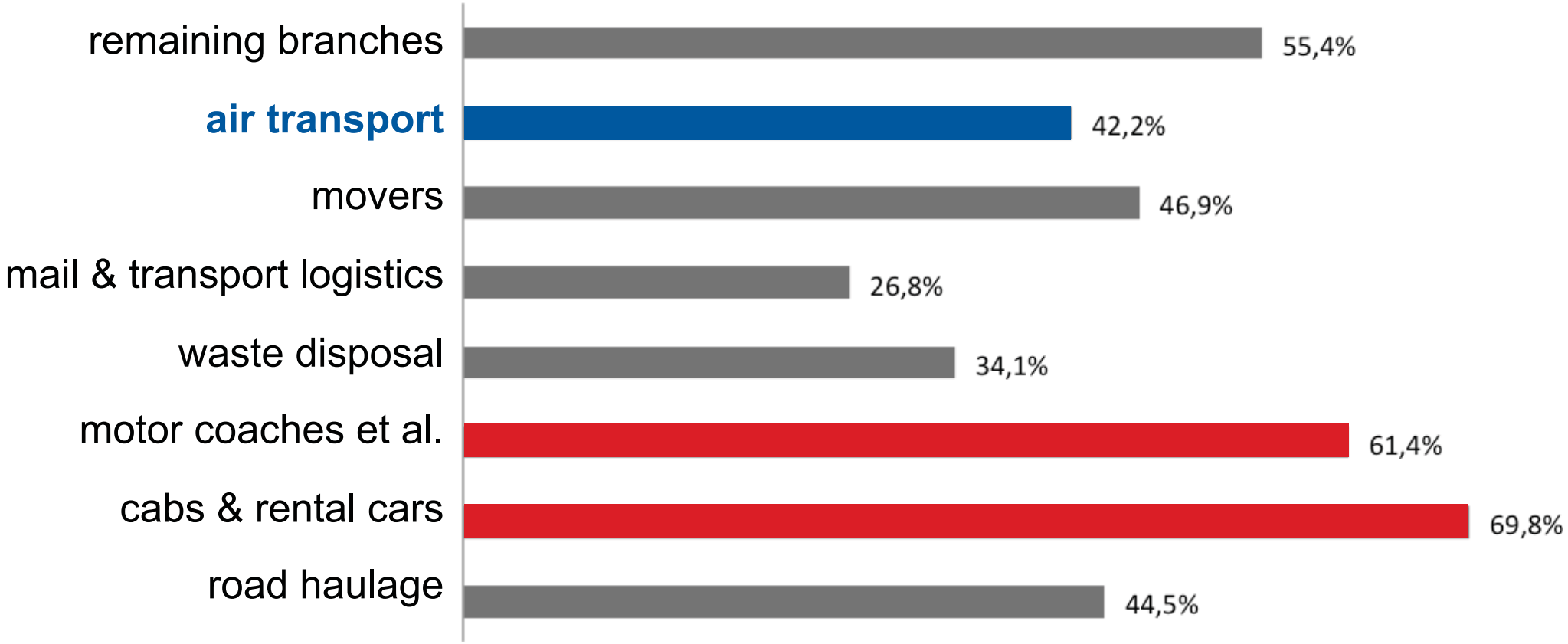


Accidents with whiplash injury

(Source: BG Verkehr, Shz)

Work related & commuting accidents 2012

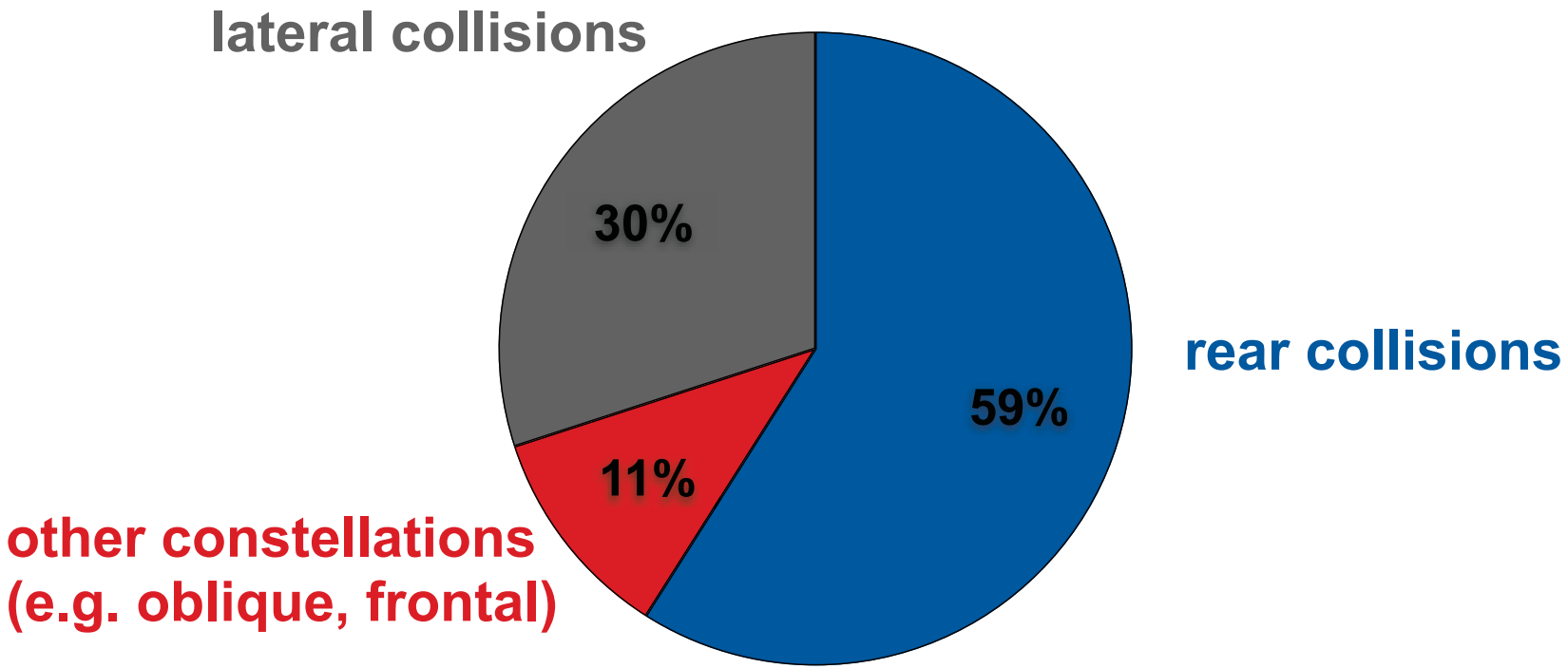
Accidents with whiplash injury relative to all accidents of the trade branch



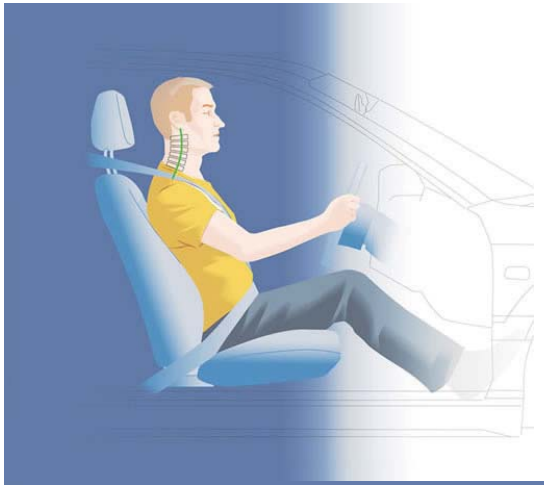
(Source: BG Verkehr, Shz)

Constellations of collisions

N=600



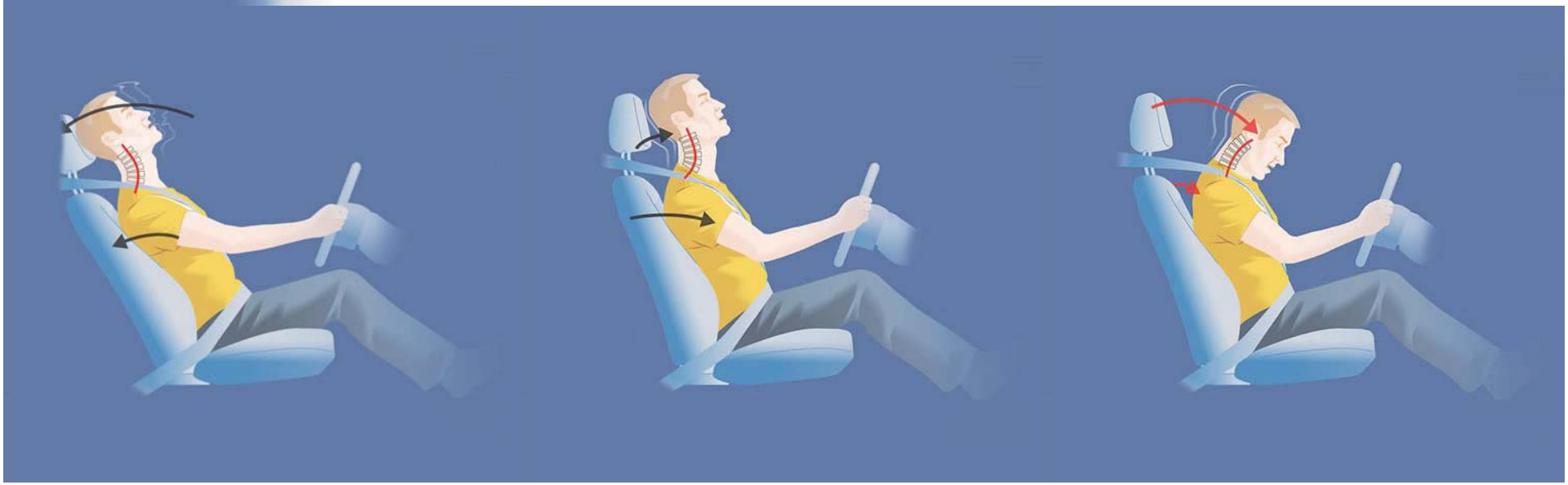
(Source: Eichenberger et al. 1997, Chipman 2004)



Rear collision

90% result in velocity changes of **<15 km/h**

(Eichenberger 1995)



primary motion **secondary motion**

Lateral collision

Symptom complex - Whiplash injury

- neck pain*
- head ache*
- tinnitus*
- vertigo, nausea
- arm troubles
- jaw joint pain
- fatigue, drowsiness*
- cognitive dysfunctions*
- ...

*persisting if chronification occurs
(10-15% of patients become chronic)

(Source: Langwieder & Hell 2002)

State of research

Focus of previous investigations

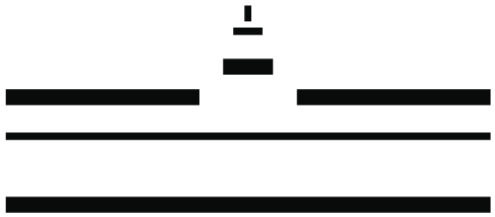
- ➡ rear collisions
- ➡ recordings with 'passive' crash-test dummies
- ➡ in part only standing passenger compartments

Project goal

Impact of **lateral** & **oblique-frontal** collisions on passengers of a **moving passenger compartment** at **low speeds**

Collaborators

- Prof. Dr. H. Wagner; University Münster, Motion Sciences
- Prof. Dr. W.H.M. Castro, Dr. M.F. Hein; Orthopedic Research Institute
- Dr. M. Becke, Dipl. Ing. W. Kalthoff; Schimmelpfennig & Becke



Westfälische Wilhelms-Universität Münster

Aims & Approaches

Analyses of the course of the events of accidents	First-time collection of comprehensive motion and acceleration data of the vehicle and (co-)driver
Impact of various parameters (speed, impact force etc.)	Modeling & simulations using various input parameters
Impact of passive safety systems (airbag, belt, head rest, seat type)	Tests with & without; various design and adjustments
Influence of the impact side (driver, co-driver)	Recording of the side facing and opposite to the impact
Role of the musculature	Recordings of muscle activity and reflective responses
Influence of the driver's parameters (sex, body size, seat height etc.)	Variation of the driver vs. seat and/or passenger compartment dimensions

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EAGOSH Meeting - November 2015

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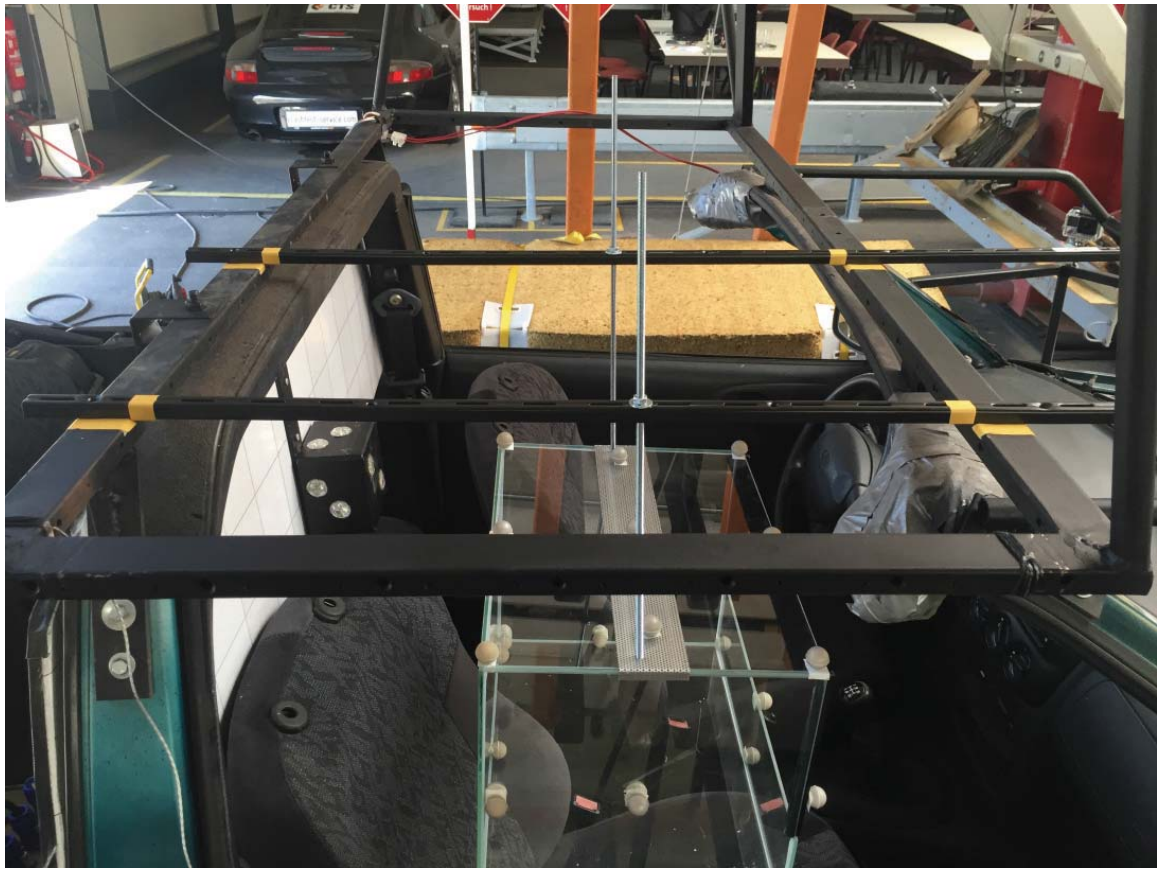
Motion analysis - Kinematics

Calibration of the passenger compartment



Motion analysis - Kinematics

Subject instrumentation

Passive reflective markers to determine absolute and relative head and chest motions

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Motion analysis - Kinematics

Recordings of the passengers' motions

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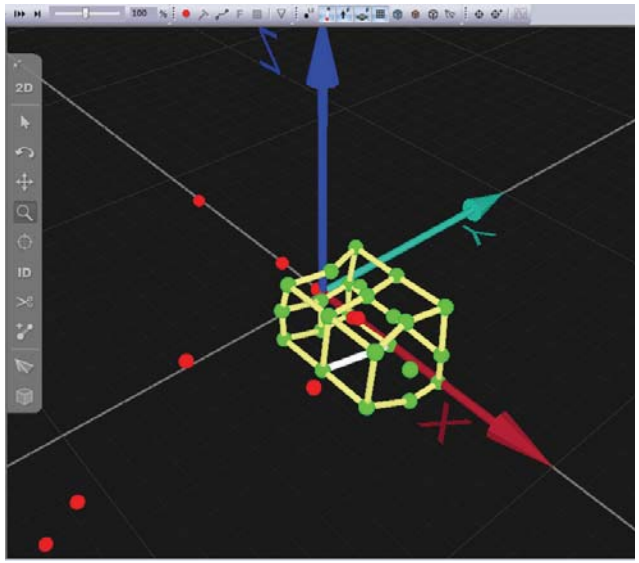
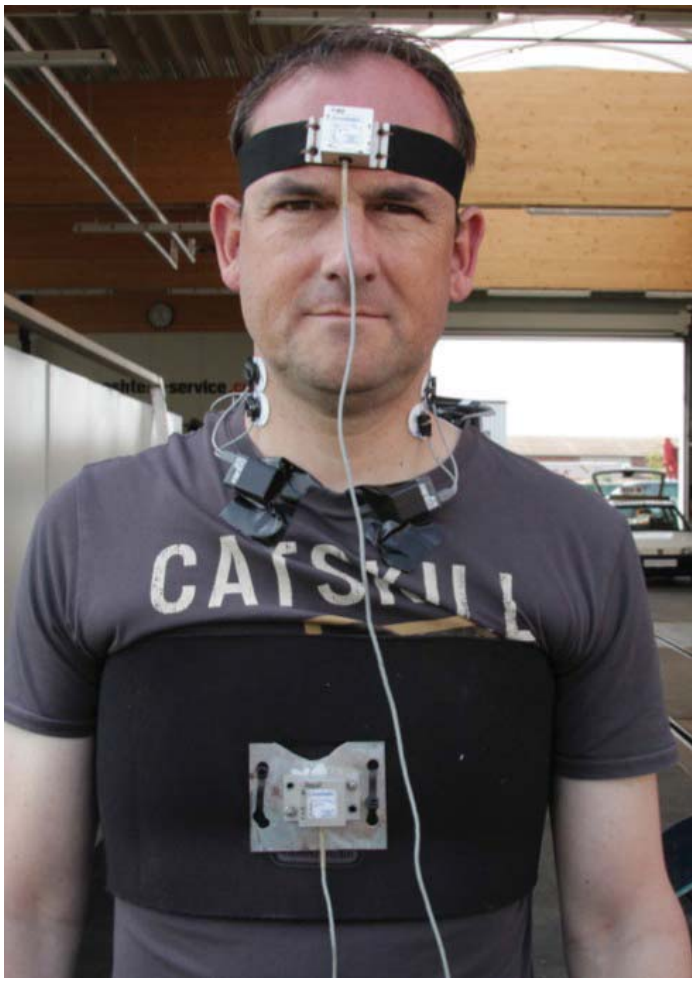
Motion analysis - Kinematics

Head & chest acceleration

Head & chest angles etc.



Motion analysis - Accelerations

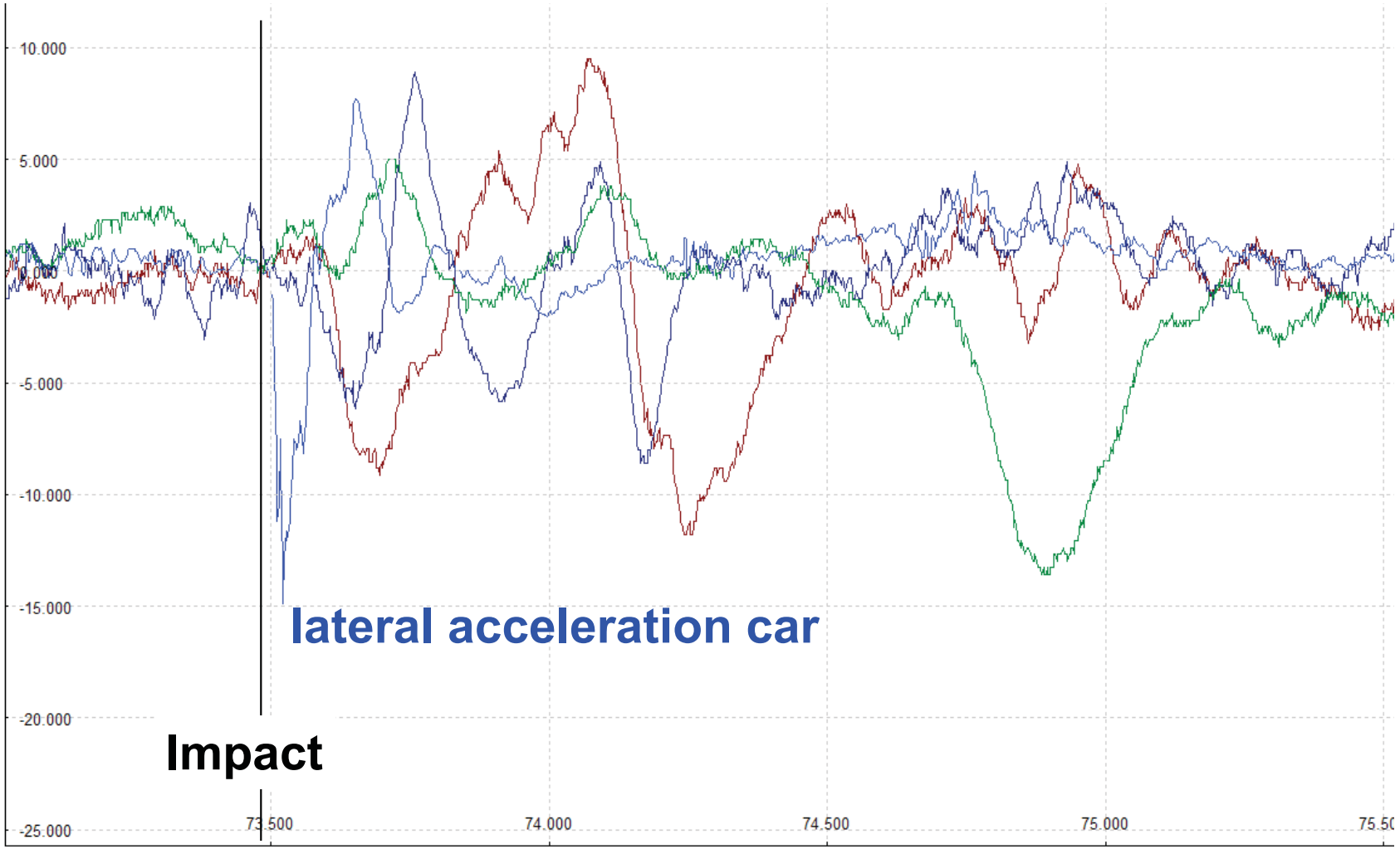


Accelerometers on
head & chest

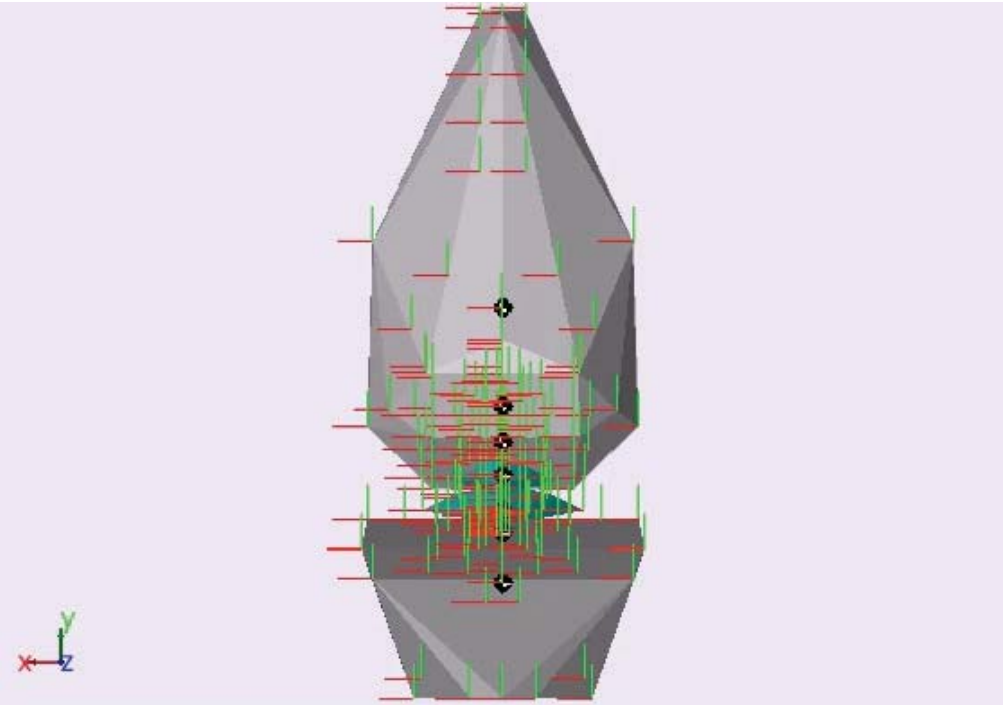
Electromyography of
neck musculature

Accelerometers on the car

Accelerations of the head



Motion analysis - Dynamics



3D musculo-skeletal model

Determination of forces & moments

Simulation of important accident constellations e.g. at/with:

higher speed
various angles
various (co-)driver constitutions
various safety systems

Prospective outcomes

- Improved understanding of the course of events & the consequences of accidents
- First-time experimental data for oblique-frontal collisions
- Conclusions and recommendations for prevention
- Recommendations for passive safety systems (design, optimal adjustment of current & new systems)
- Reduction of accident consequences & sick days via improved diagnosis & therapy
- National & international publications & presentations
- Training & information materials, high-speed videos, animations
- Raised awareness of workers

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Thank you very much for your attention!