



**The development of an open source
human body model of an average
female, ViVA, for low severity
vehicle safety assessment and the
VIRTUAL project**

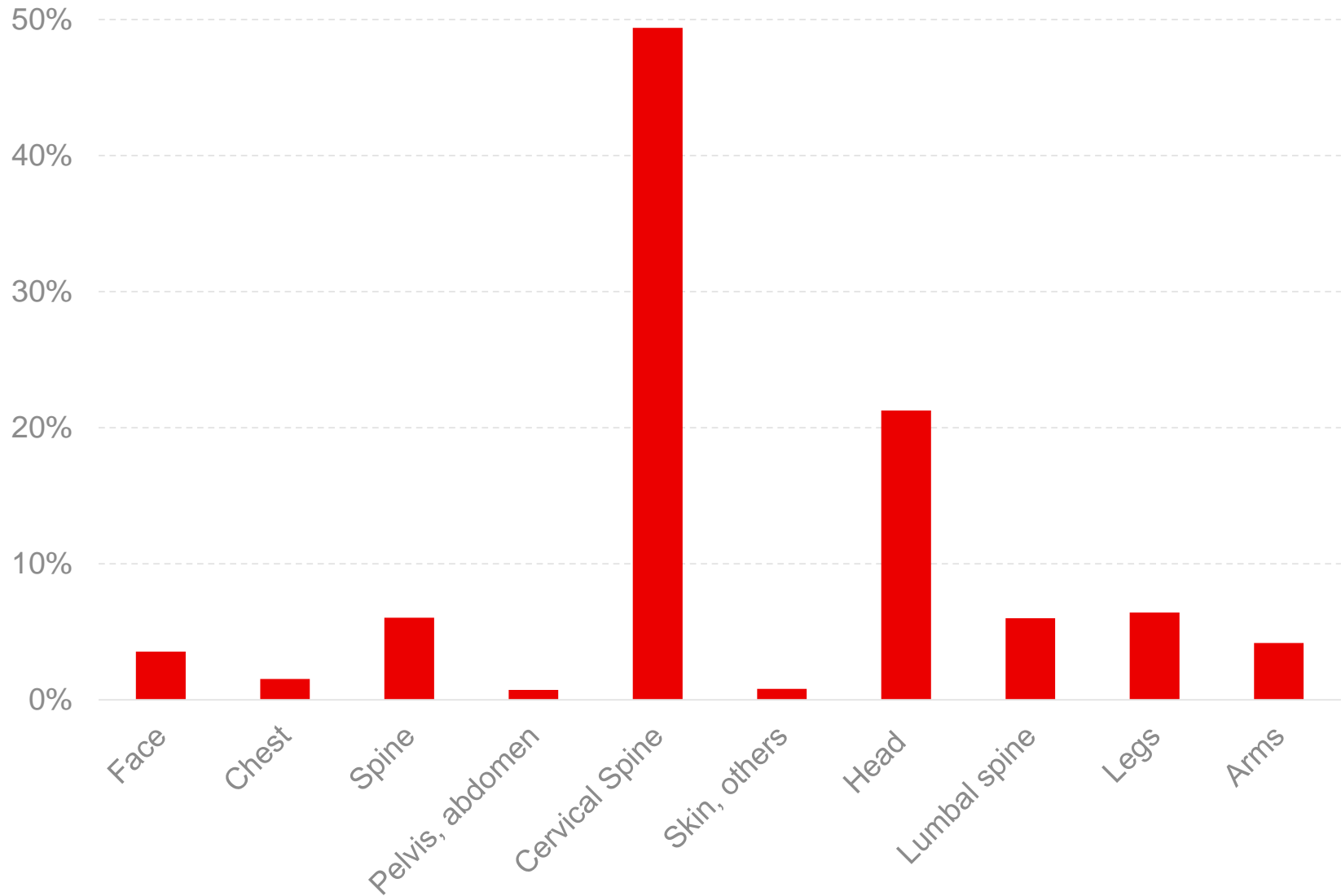
Adj Prof Astrid Linder, PhD

Research Director, Traffic Safety

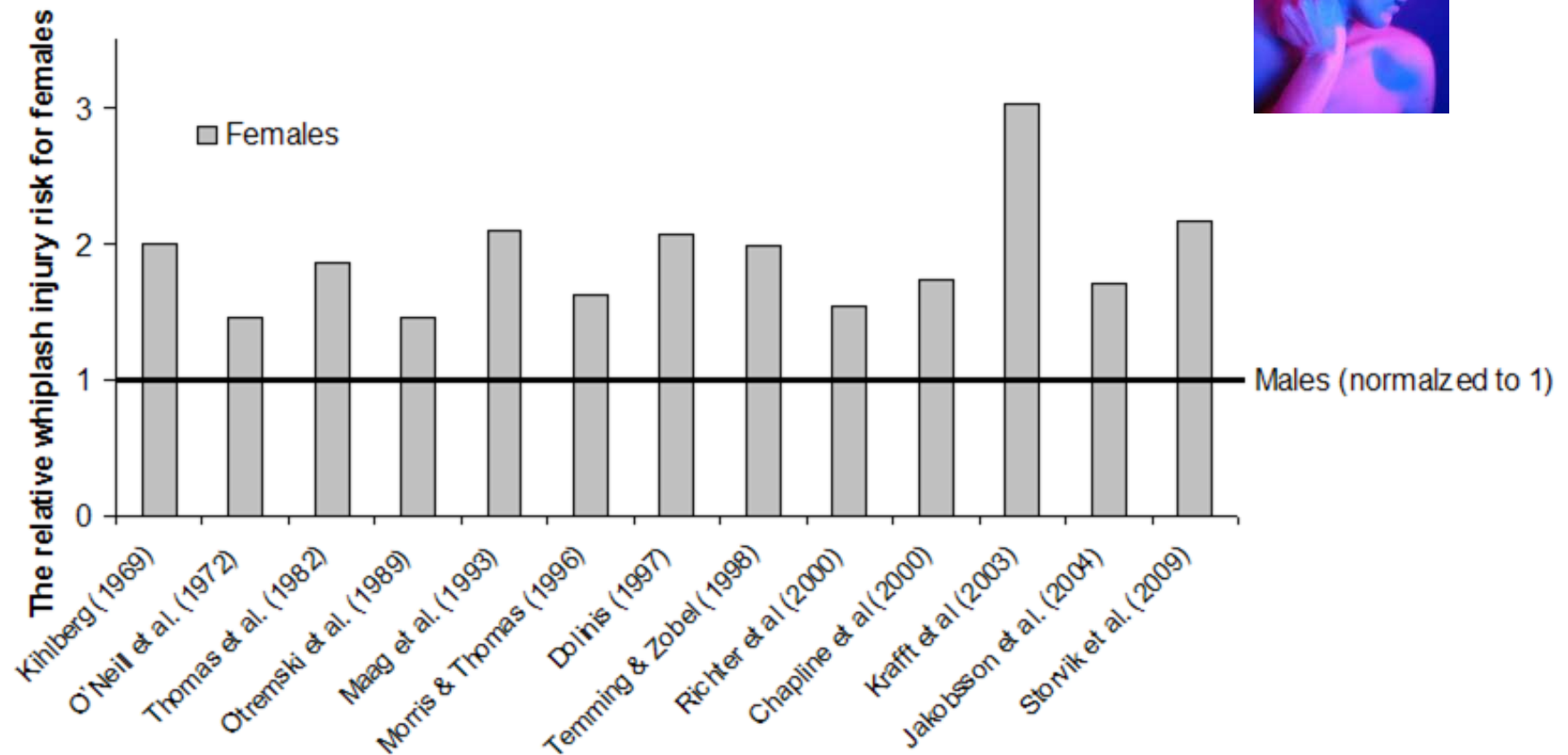
Swedish National Road and Transport Research Institute

Vehicle occupants PMI 10%+

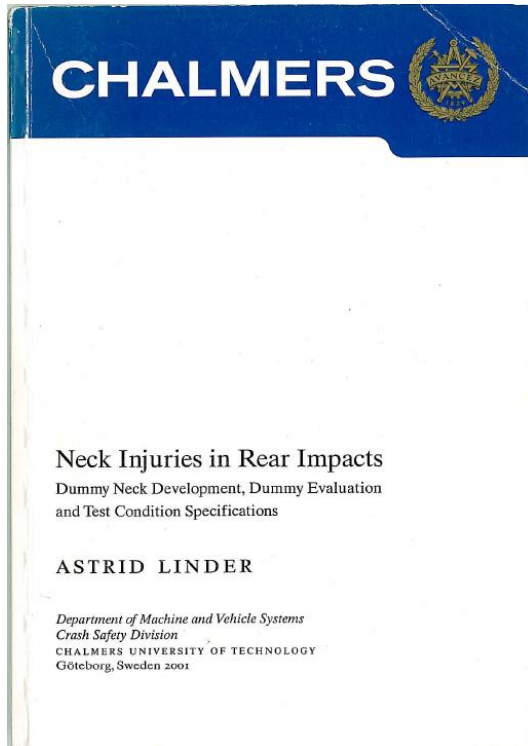
(Sweden 2015, Strada data)



Whiplash – Injury risk



BioRID: Biofidelic Rear Impact Dummy



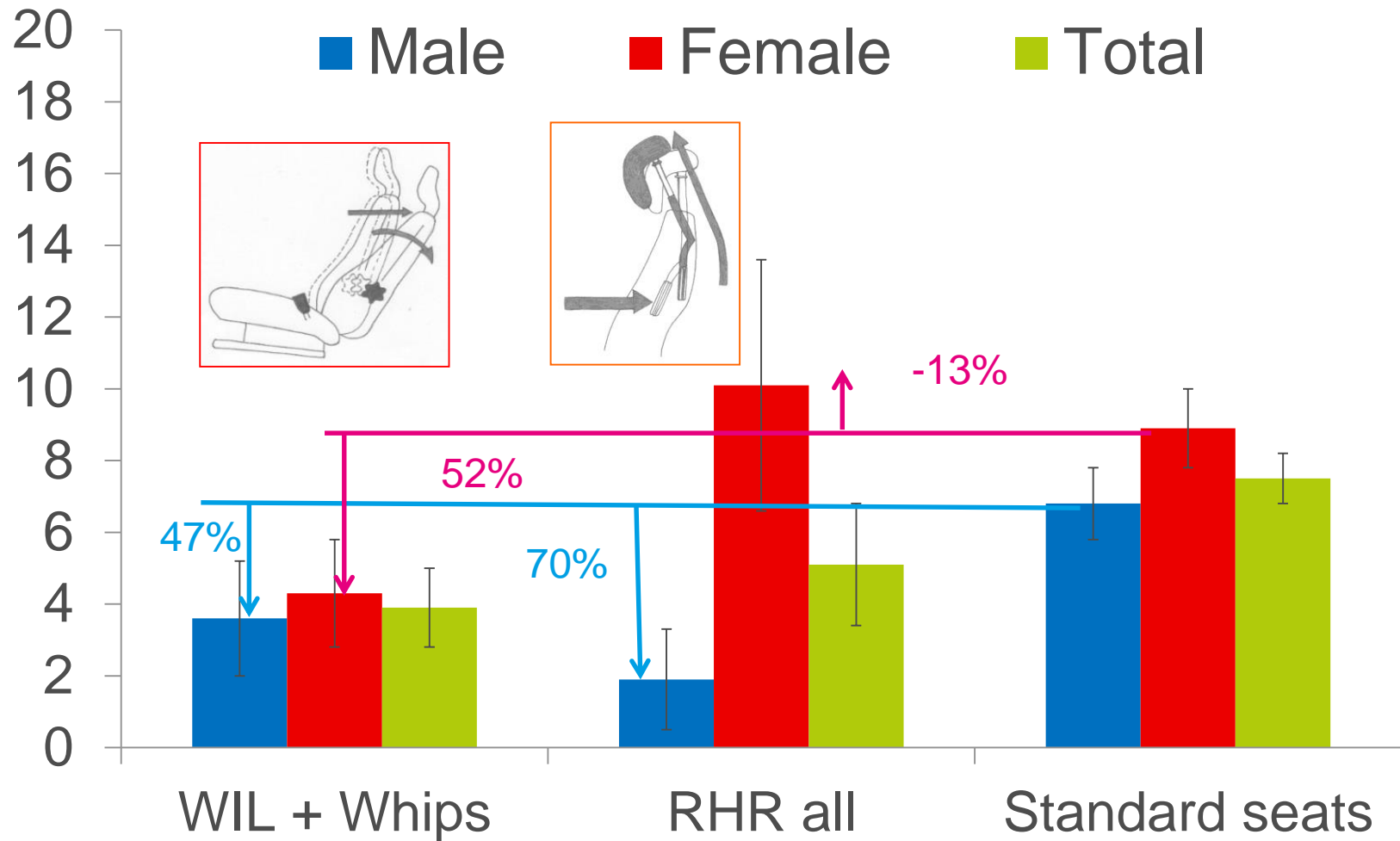
Folksam



Vägverket



Whiplash protection concepts, risk of pmi



Kullgren et al. (2013) Development of Whiplash Associated Disorders for Male and Female Car Occupants in Cars Launched Since the 80s in Different Impact Directions, IRCOB Conference

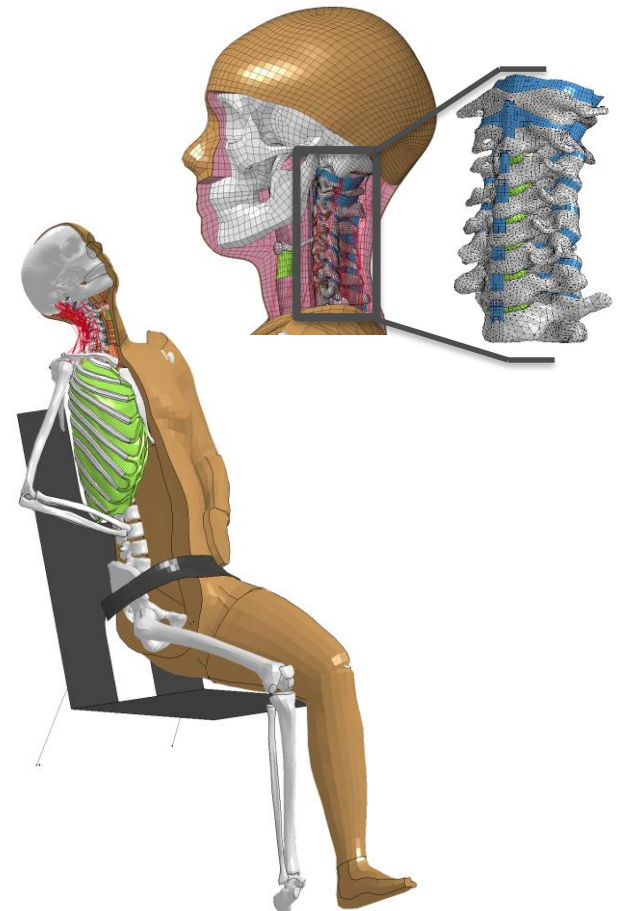
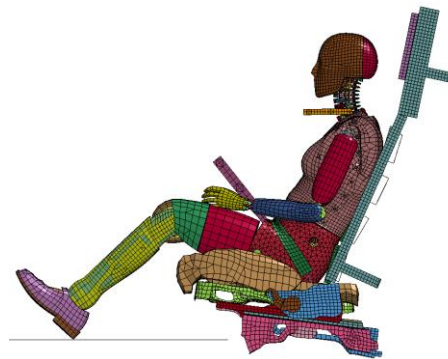
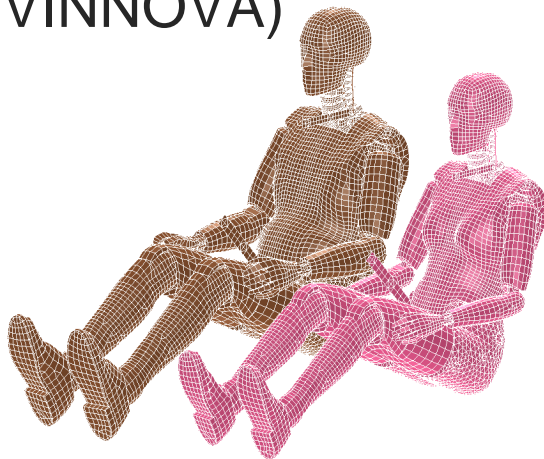
ViVA and ViVA II

Virtual Vehicle Safety Assessment: Open Source Digital Human Body Models and Crash Testing

Duration: 3 + 2.5 years, 1 Jan 2014 - Jun 2019

Budget: 800 000 Euros

Financed by: Swedish Governmental Agency for Innovation Systems (VINNOVA)



ViVA and ViVA II: aim and objectives

Aim

To reduce transport gender inequality in traffic safety assessment by focusing on safety for male and female vehicle occupants and develop an open source human body model for crash simulation

The objectives of the ViVA projects:

- Create an open source virtual Human Body Model (HBM) platform of a prototype of an average female.
- Demonstrate the virtual test method and HBM for females in rear impacts tests.
- Develop the ViVA model with active muscles
- CAD model of concept for a dummy based on the HBM

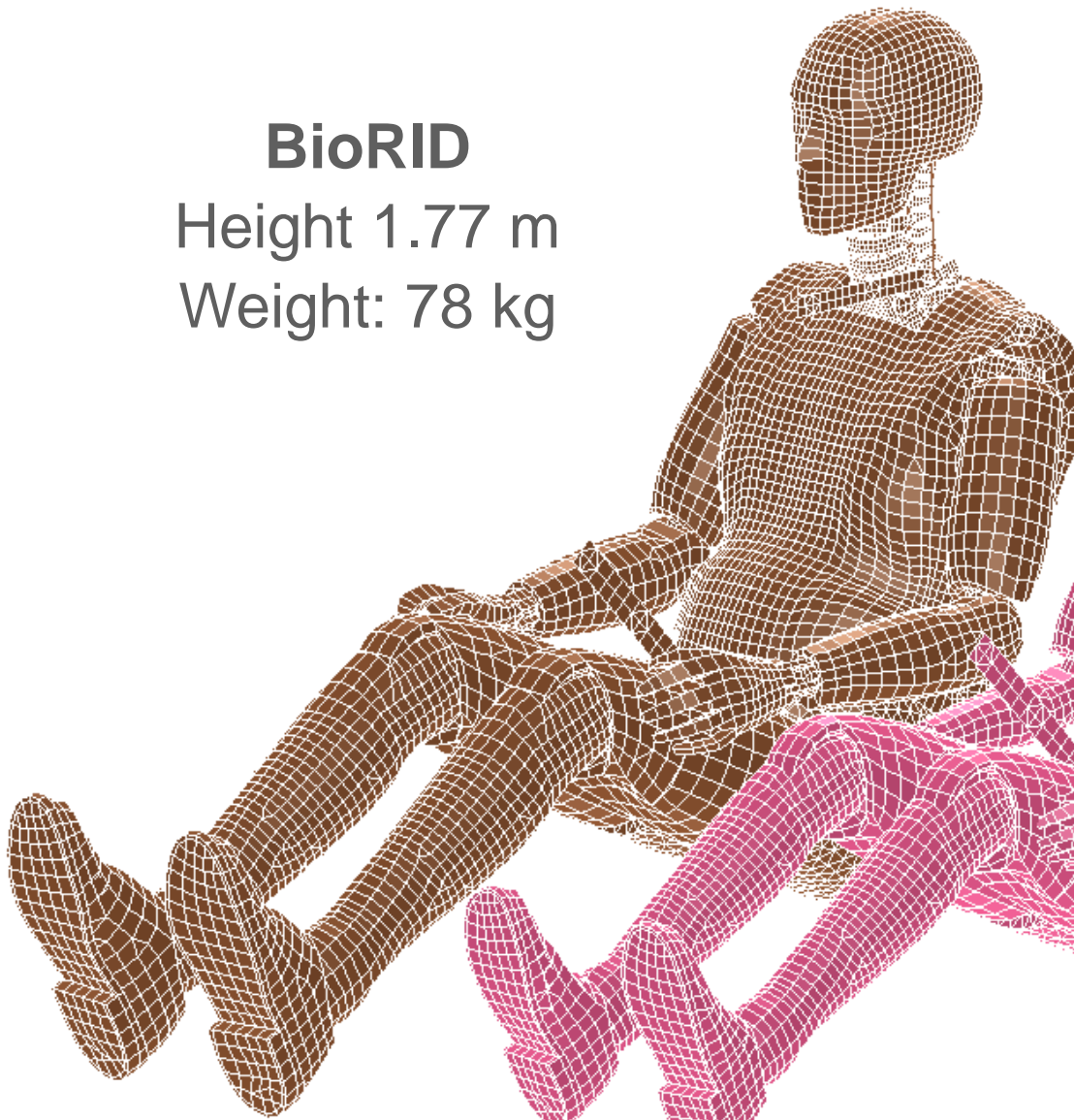
ViVA partners and international collaborators

Organisation	Namn	Role
VTI	Astrid Linder, Anders Flogård	Partner
Chalmers University	Mats Svensson, Karin Brodin, Jonas Östh, Johan Iraeus, Alit Putu Putra	Partner
Folksam Research	Anders Kullgren	Associated Partner
Volvo Cars	Lotta Jakobsson	Associated Partner
JARI	Koshiro Ono	International collaborator
University of Michigan	Stewart Wang	International collaborator
UMTRI	Matt Reed	International collaborator
IIHS	David Zuby	International collaborator
Euro NCAP	Michiel van Ratingen	International collaborator
Toyota Europe	Tjark Kreuzinger	International collaborator
NHTSA	Matthew Craig/Erik Takhouts	International collaborator
IFSTTAR/PIPER	Phillippe Beillas	International collaborator

BioRID

Height 1.77 m

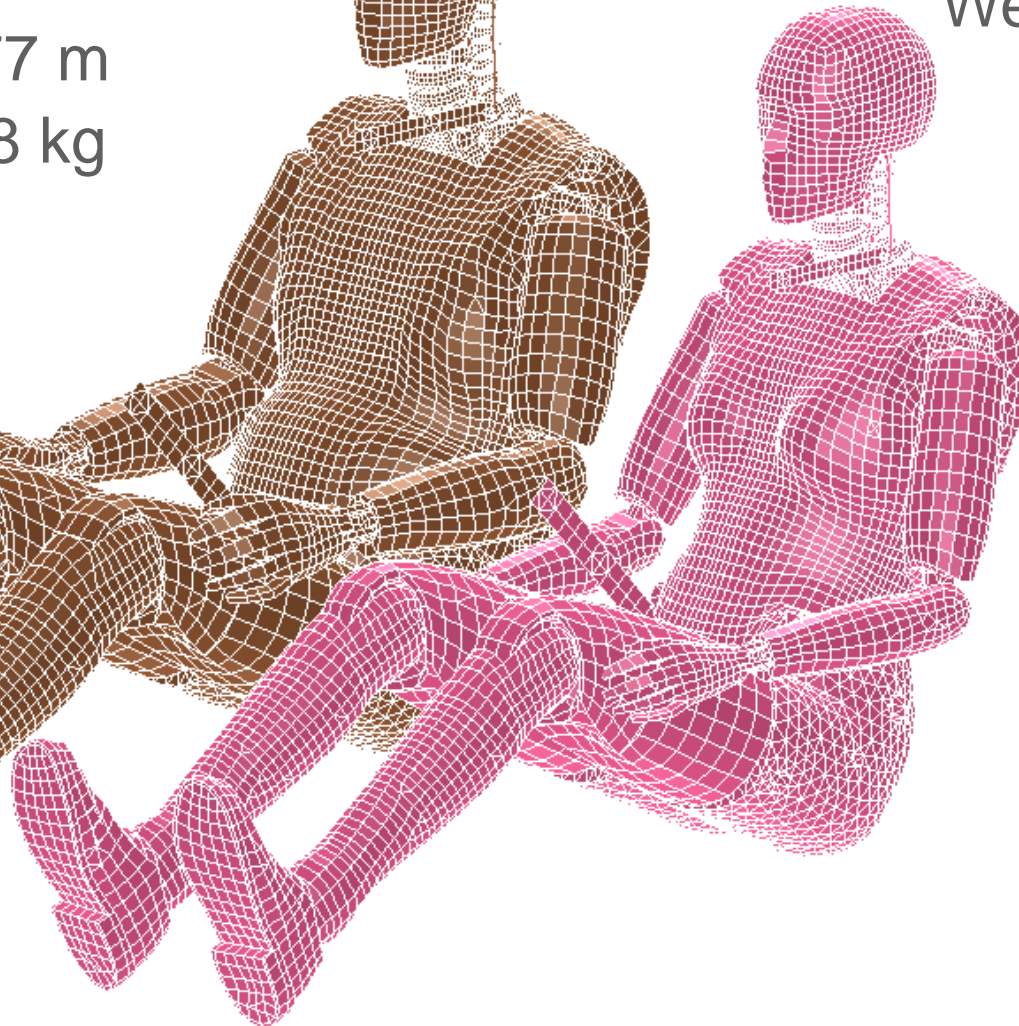
Weight: 78 kg



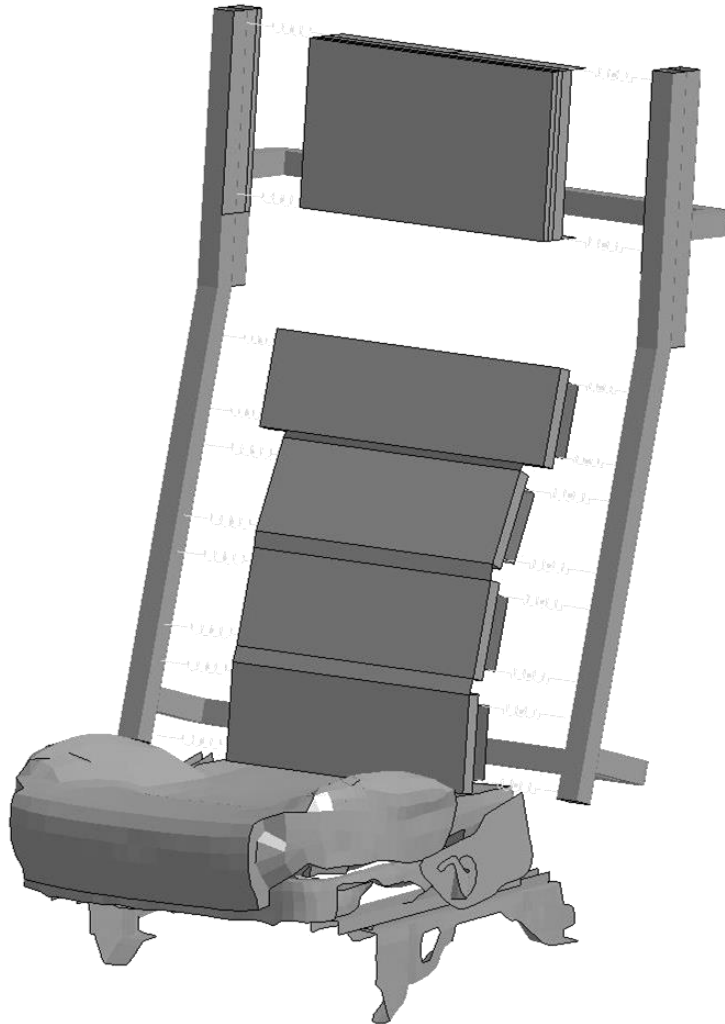
EvaRID

Height: 1.66 m

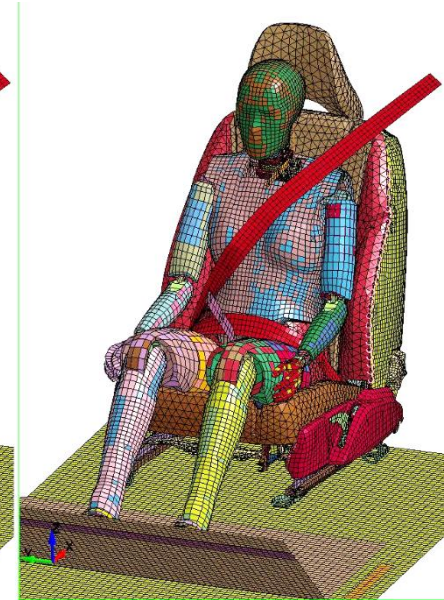
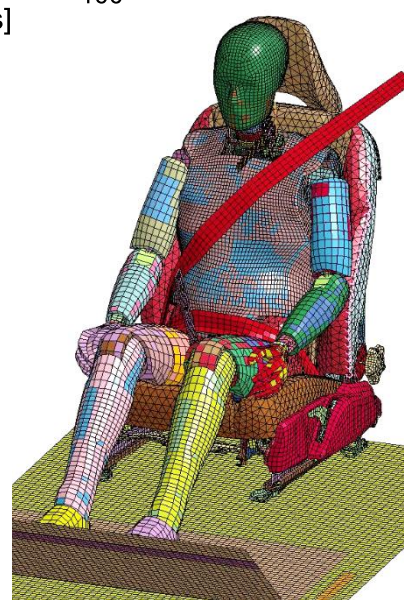
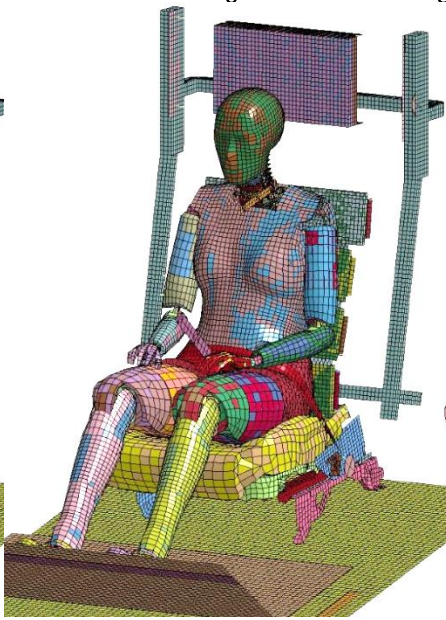
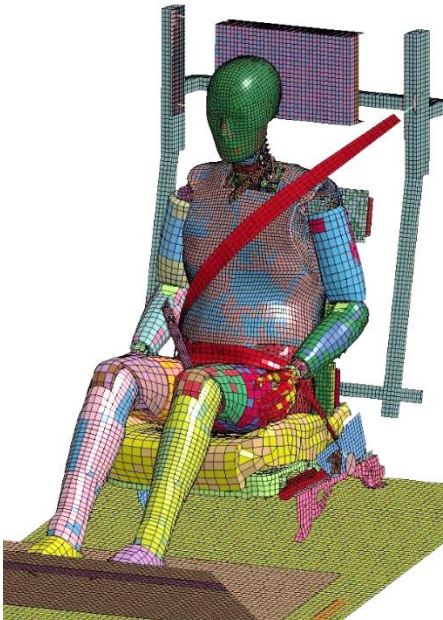
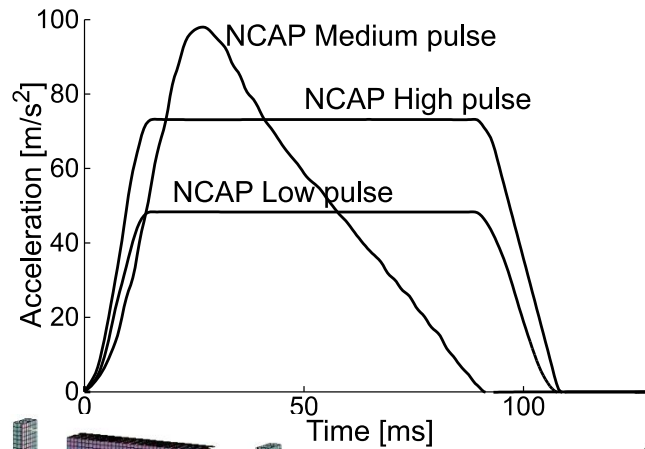
Weight: 62 kg



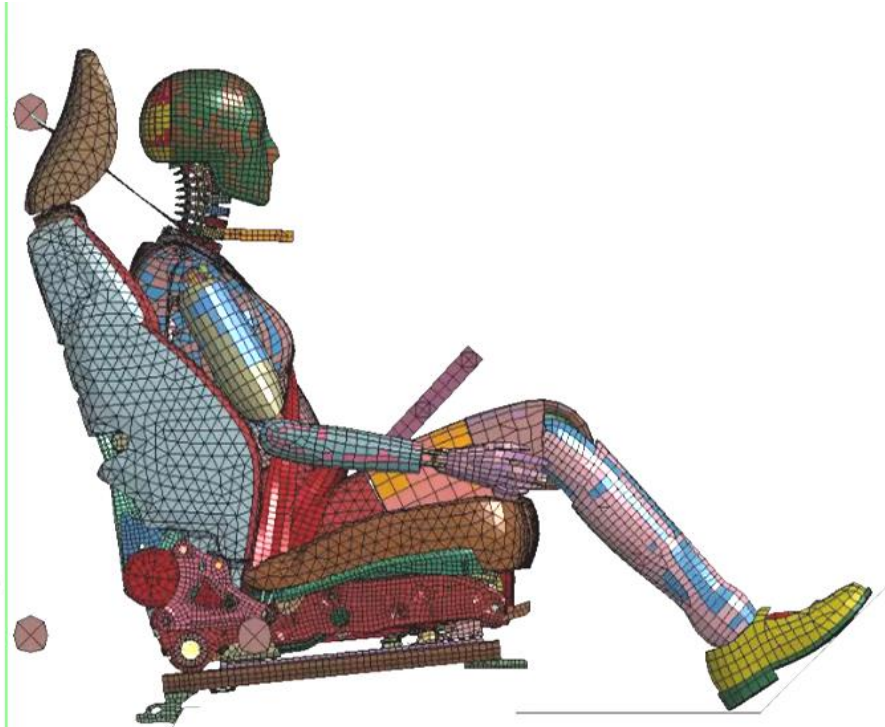
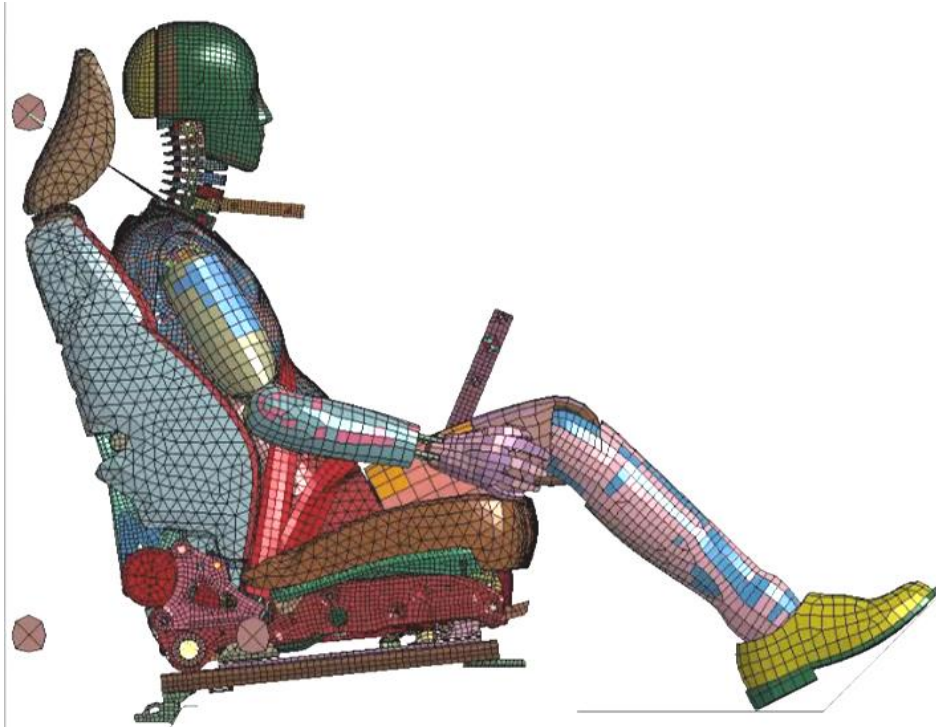
Seat Models



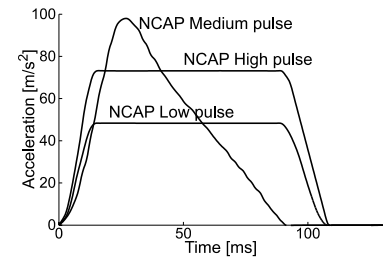
Models exposed to NCAP pulses



Results example (Medium NCAP Pulse)



Results, NIC



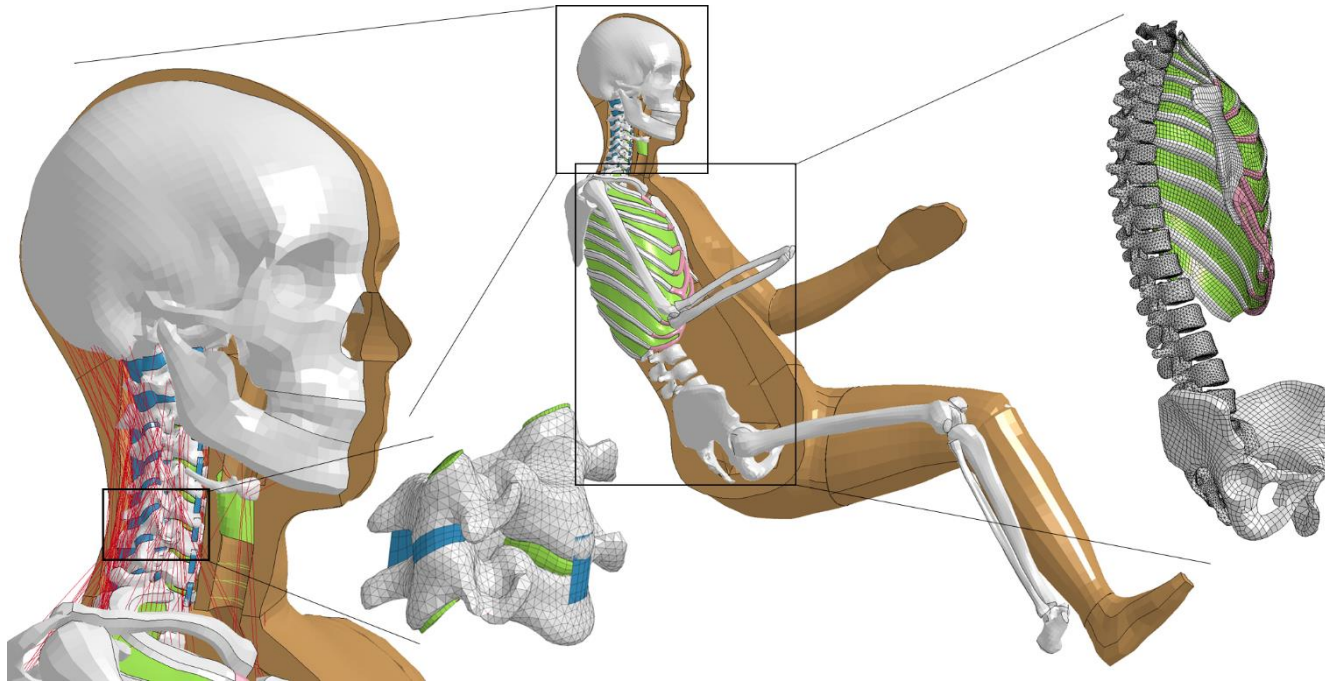
		Low Severity Pulse	Medium Severity Pulse	High Severity Pulse
Seat model	Occupant model	NICmax (m ² /s ²)	NICmax (m ² /s ²)	NICmax (m ² /s ²)
Lab Seat	FE-BioRID	10	16	15
Lab Seat	EvaRID	9	22	21
Concept Seat	FE-BioRID	10	14	13
Concept Seat	EvaRID	13	18	16

NIC: Neck Injury Criteria, Threshold: 15 m²/s² (for the average male model)

Open Source Human Body Model

50th percentile female finite element human body model developed from multimodal (CT, MRI, surface contour scan) surface data.

- Released under the GPL v3 Open Source license, LS-Dyna
- Scalable model architecture, providing a framework for further development
- The model is available for download at:
<http://www.chalmers.se/en/projects/Pages/OpenHBM.aspx>.



Östh J, Medoza-Vazque M, Sato F, Svensson M Y, Linder A, Brolin K (2017) A Female head-neck model for rear impact simulations. Journal of Biomechanics, Vol 51, pp 49-56, <http://dx.doi.org/10.1016/j.jbiomech.2016.11.066>.

Validation

Frontal impact

- Shaw et al. (2009) / Ash et al. (2012) "Gold Standard" test, 40 km/h ~ 14 g, 8 male PMHS

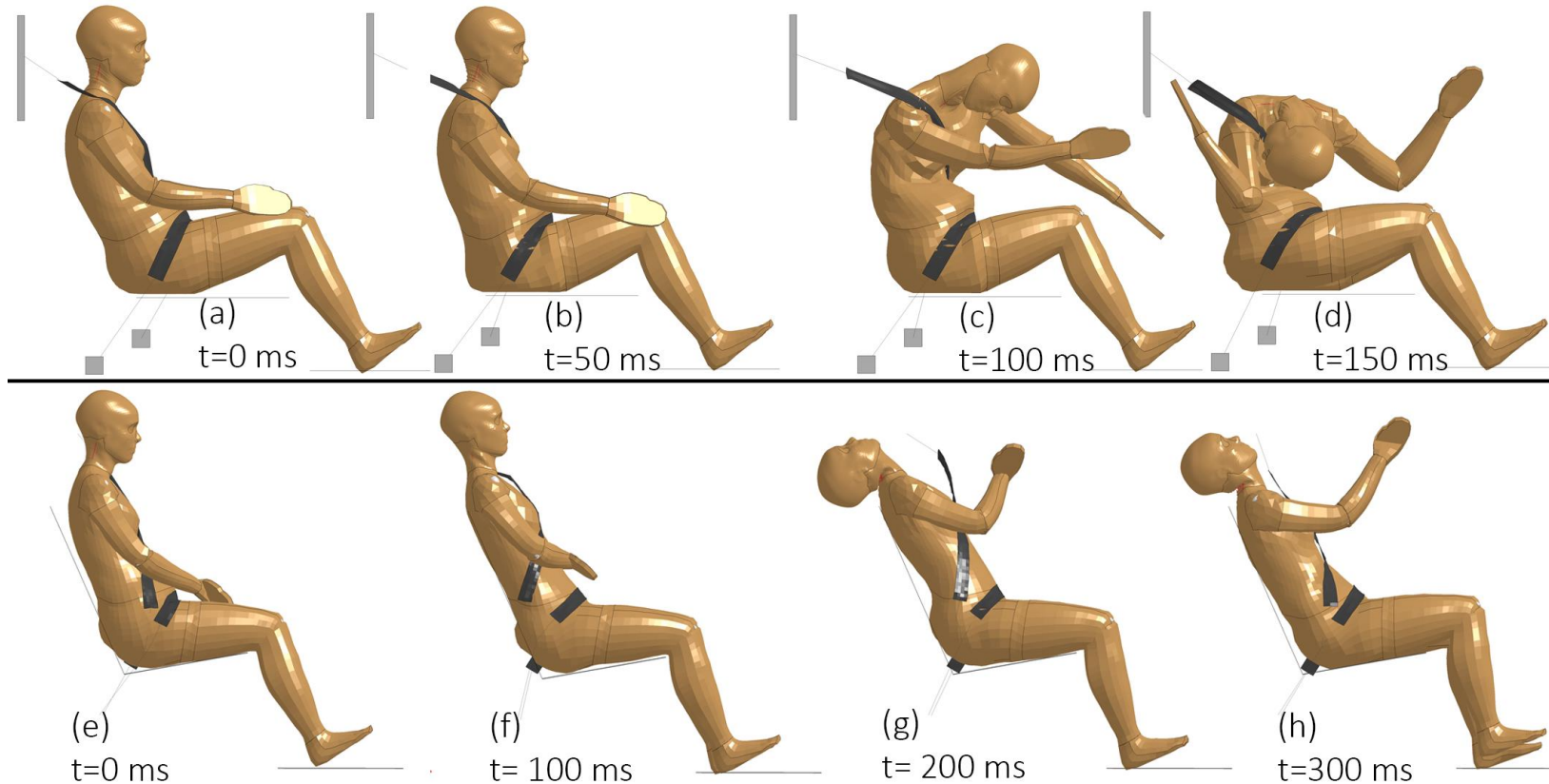
Lateral load case: Roll-over

- Lessley et al. (2014): 3.3 g resultant acceleration (gravity + normal due to rotation). 4 male PMHS, repeated testing (non-injurious)

Rear Impact

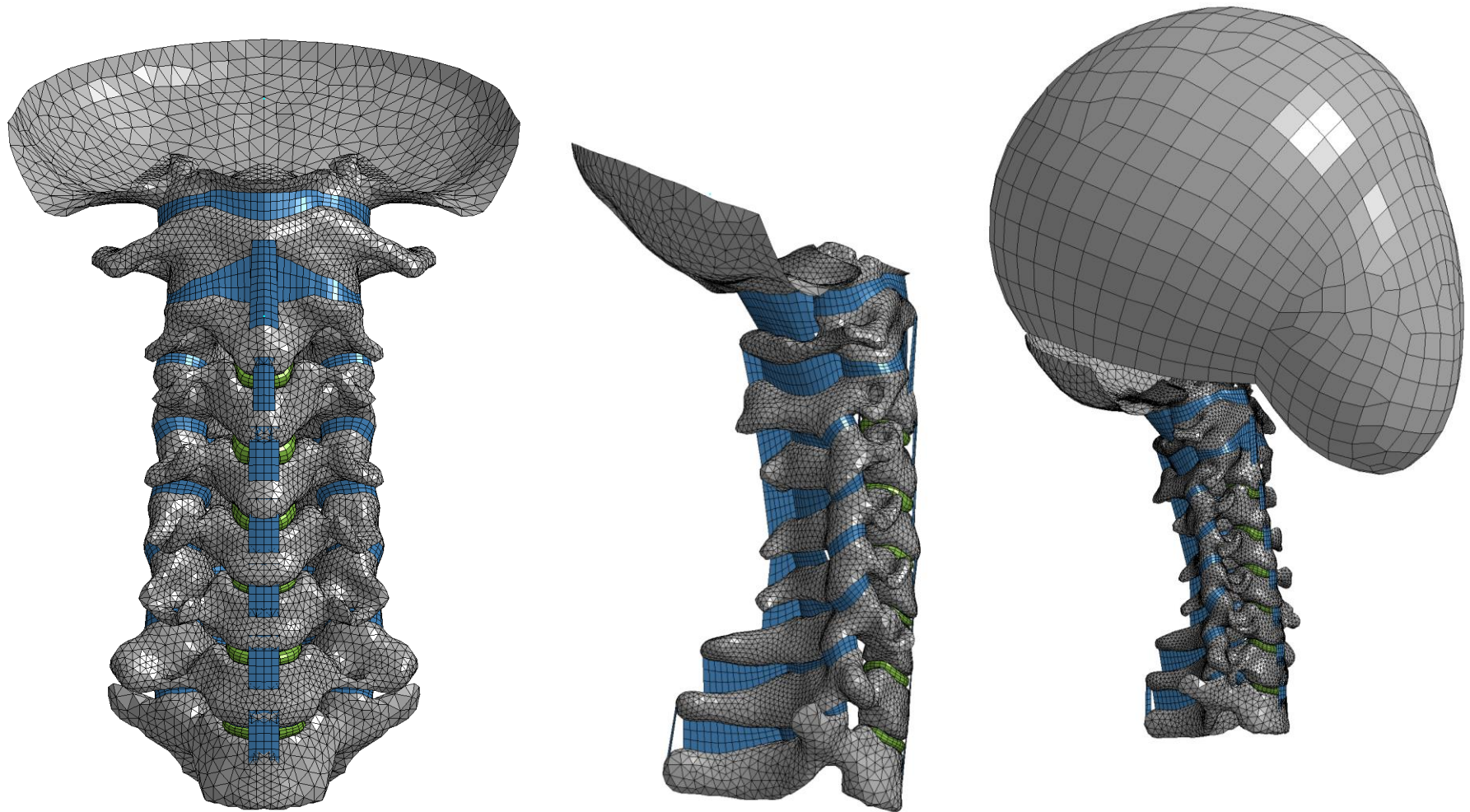
- Yoganandan et al. 2000: One female suitable
- White et al. (2009): two male PMHS

Frontal impact 40 km/h, Rear impact 25 km/h

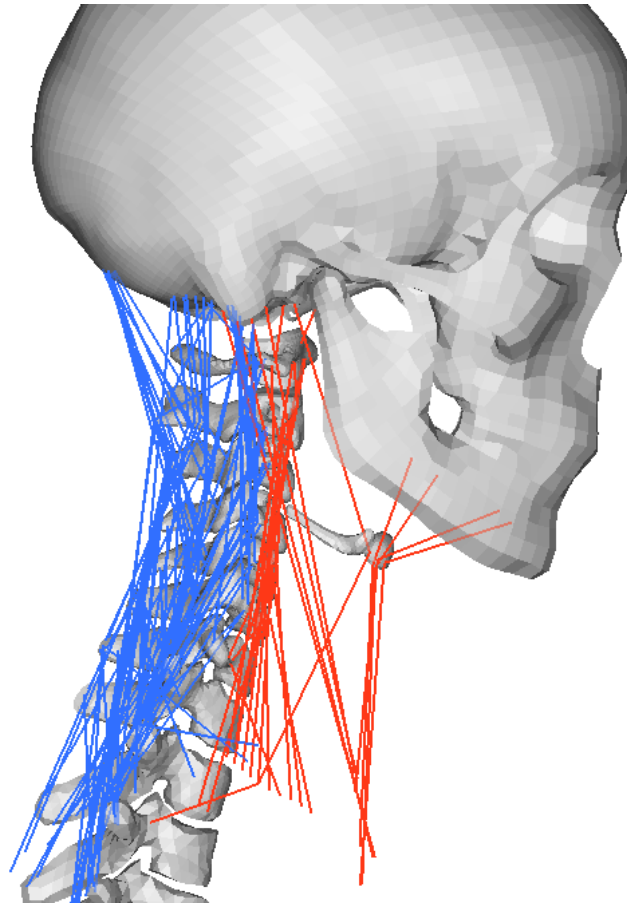


Östh, J., Mendoza-Vazquez, M., Svensson, M.Y., Linder, A., Brodin, K., 2017. The VIVA Open HBM Finite Element 50th Percentile Female Occupant Model: Whole Body Model Development and Kinematic Validation. *Proceedings of the IRCOBI Conference*, Antwerpen, Belgium.

ViVA Detailed Neck Model



Active muscle neck model



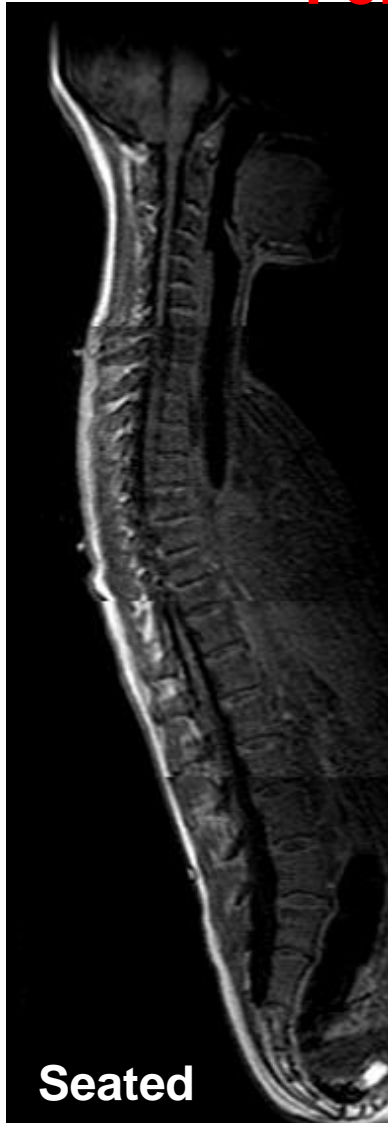
Blue: Active in flexion.

Red: Active in extension.

Kleinbach C, Fehr J, Svensson M, Linder A, Brolin K (2017) The ViVA OpenHBM - Goals and first results in the development of a female human body model, **Crash conference Vortrag Praxiskonferenz Heckaufprall Sitze**, 15-16 November 2017

Midsagittal Images, Open MRI (Sato et al, WCB 2018)

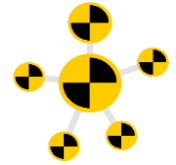
Female



Male



VIRTUAL: Open Access Virtual Testing Protocols for Enhanced Road User Safety



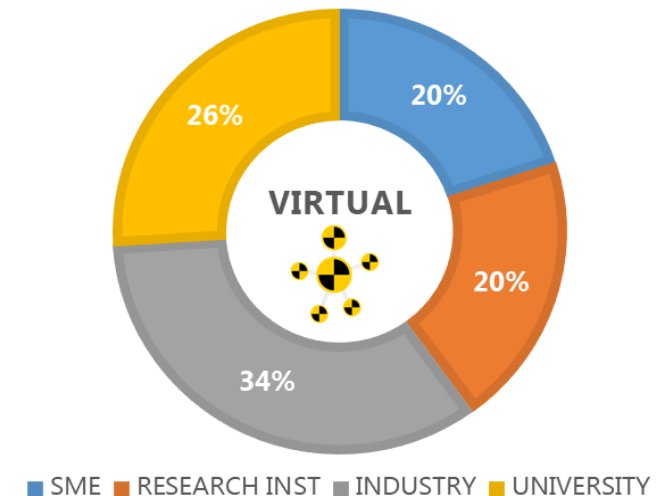
MG-3.2-2017: Protection of all road users in crashes

Duration: 48 Months, started 1 June 2018

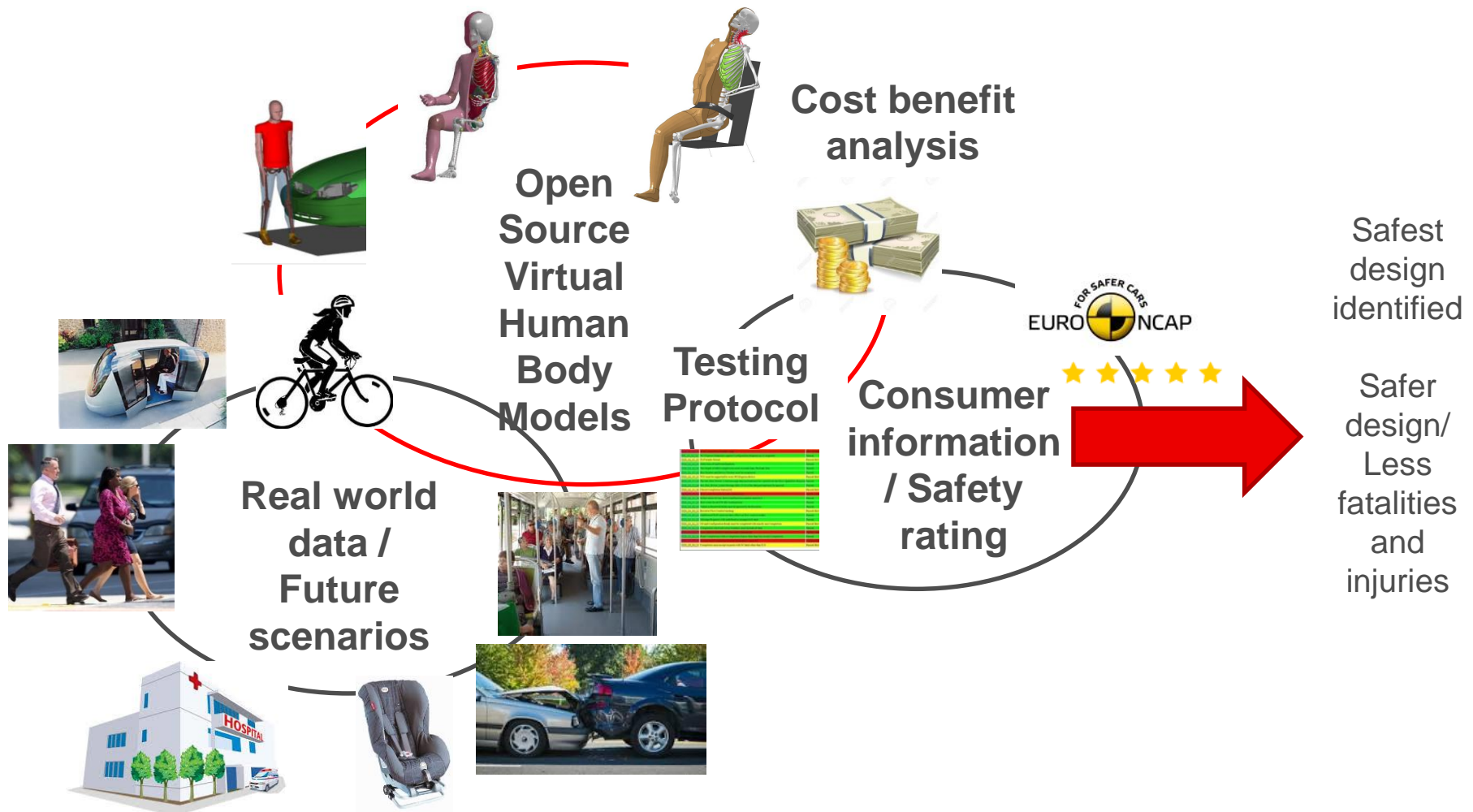
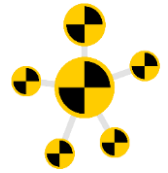
Funding: 6.99 M Euro

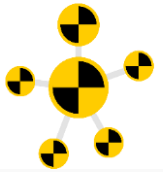
Partners: 15

Countries: 9



VIRTUAL: Open Access Virtual Testing Protocols for Enhanced Road User Safety

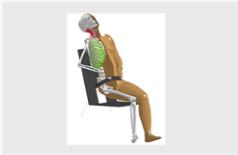




BRIDGING THE GAP

VIRTUAL TESTING

PHYSICAL TESTING



VIRTUAL



Male 50th percentile

Female 50th percentile

Proprietary
Human body model
Not Open Source
(Not-OS)



GHBM
50th Male



THUMS
50th Male

NO EXISTING
MODELS

Open Source (OS)
Human body model

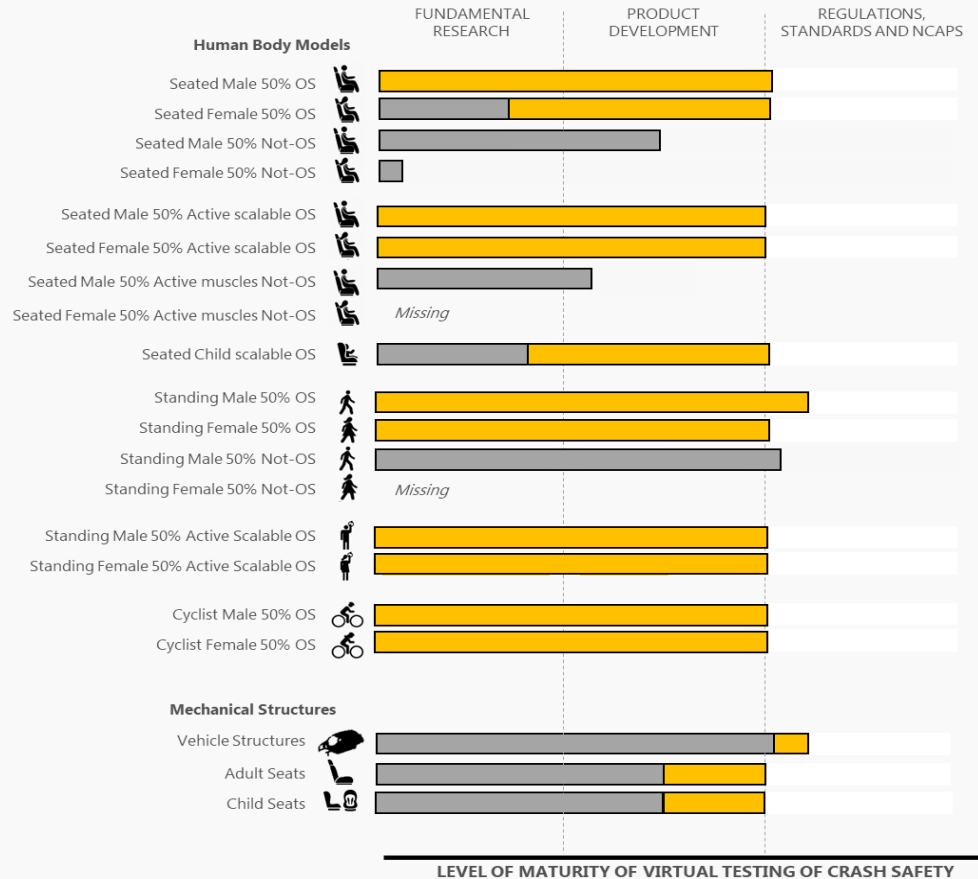


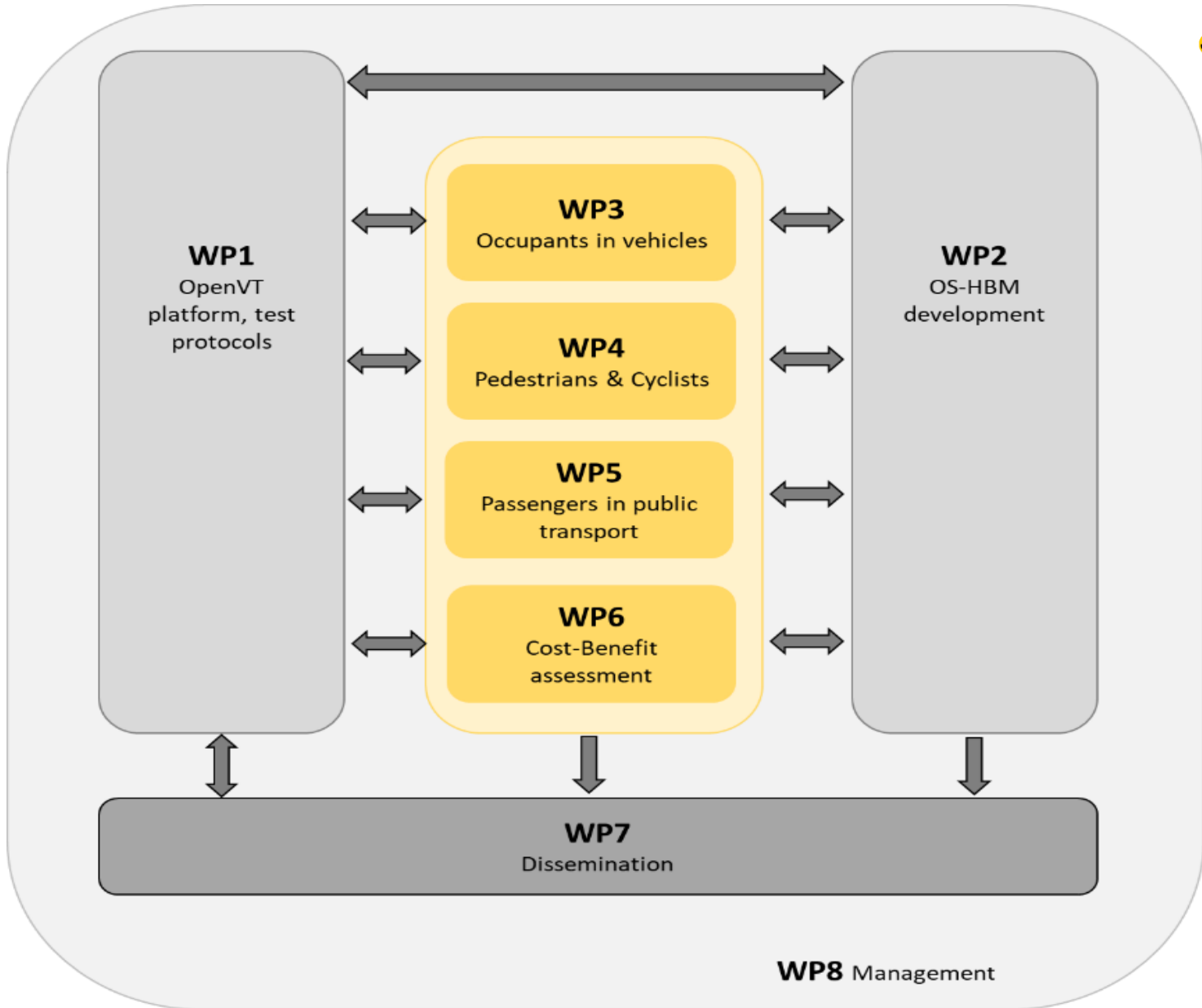
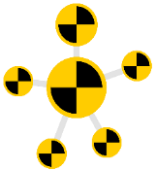
NO EXISTING
MODELS



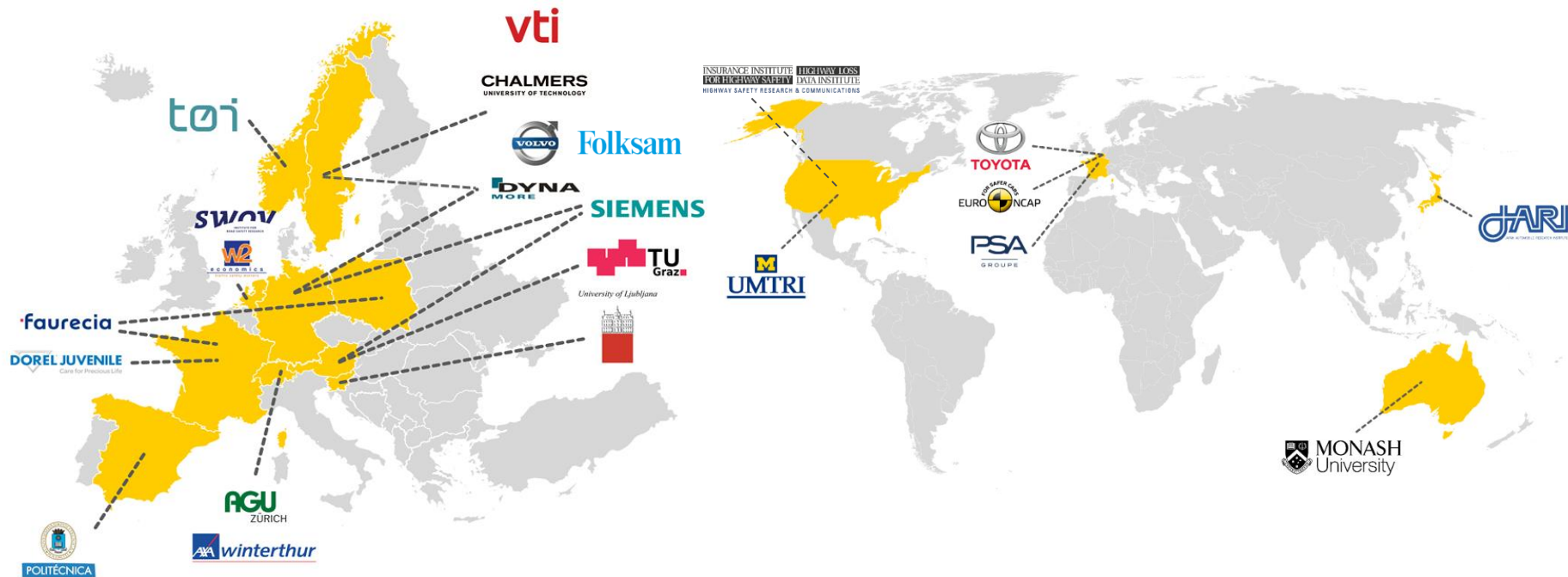
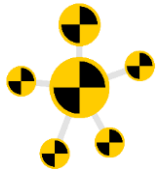
VIVA
50th Female

BEFORE & AFTER VIRTUAL



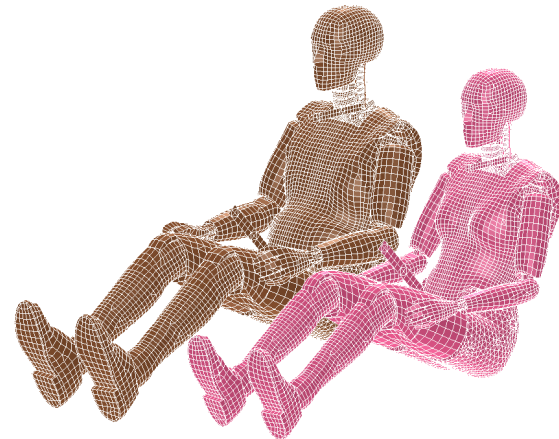


VIRTUAL: Partners and International collaboration



Vision:

By 2030, the injury protection performances of new cars will be assessed for both men and women



Thank you for your attention!

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