New Energy Absorbing Materials and their Use in Personal Protective Equipment

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Outline

- Introduction
- MOTORIST Network
- Personal Protective equipment (PPE)
- New Energy Absorbing Materials
- What Has Been Done
- Perspective

Research Title:

New Energy Absorbing Materials and their use in Personal Protective Equipment

Supervisor:

Prof. U. Galvanetto

Curriculum:

Sciences and Technologies for Aeronautics and Satellite Applications (STASA)

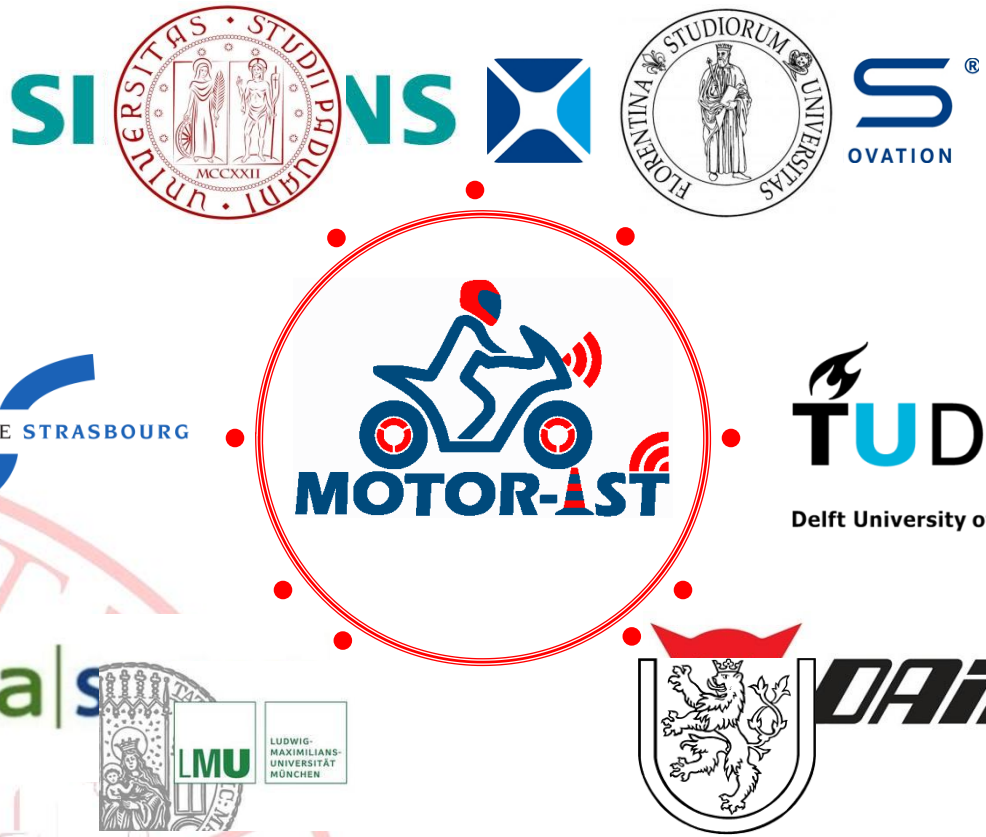
Type of the Grant:

Marie Curie Fellowship, 7th Framework Pragramme of European Research Council (ERC)

Network:

Motorcycle Rider Integrated Safety (MOTORIST)

Who we are?!


SI NS
OVATION
UNIVERSITÉ DE STRASBOURG
MOTOR-AST
TU Delft
Delft University of Technology
swerea
LMU
LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
DAINESE

What are we doing?!

The main goal of MOTORIST is to increase the safety of motorcyclist.

WP1: Education.

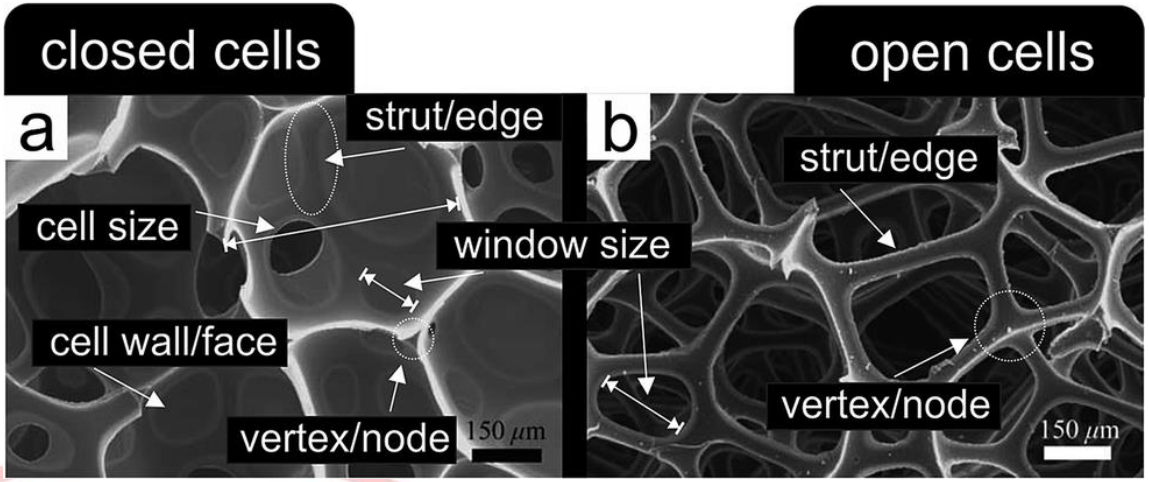
WP3: Passive Safety Systems (PPE).

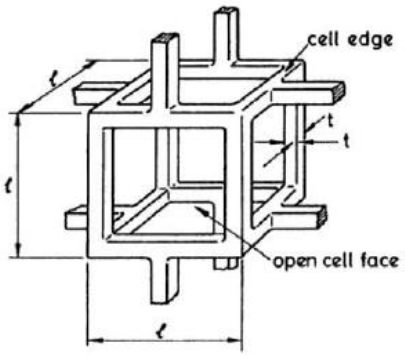
WP2: Active Safety Systems.

Personal Protective Equipment (PPE)

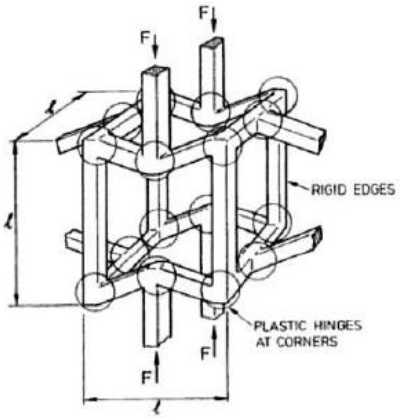
Photos are adopted from: http://abcawesomepix.com/, https://en.wikipedia.org/wiki/Personal_armor, Chanel perume official commercial and Dainese S.p.A.

How do they protect us?





Energy absorbing materials consume the energy of the impact in order to deform!



The photos are adopted from: Niklaus Kra¨nzlin and Markus Niederberger, Mater. Horiz., 2015,2, 359. L. Di Landro et al. / Polymer Testing 21 (2002) 217–228. Patrick J. Veale, University of Massachusetts – Amherst, 2010.

Why the PPE should be improved??!!

1. Evolution of motorcycles!

The photos are adopted from: http://ridersclaw.com and http://www.sujian919.com.

Why the PPE should be improved??!!

1. Evolution of motorcycles!
2. Evolution of motorcycle riders!!!!!!!

The photos are adopted from: http://kitee.sblo.jp and http://stuntride.com.

How can we improve PPE items?

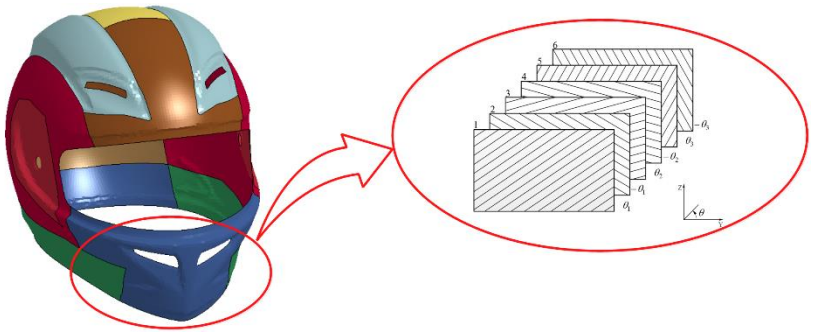
1. Making the PPE lighter.

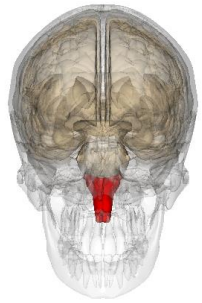
2. Increasing the energy absorbing capability of the PPE components.

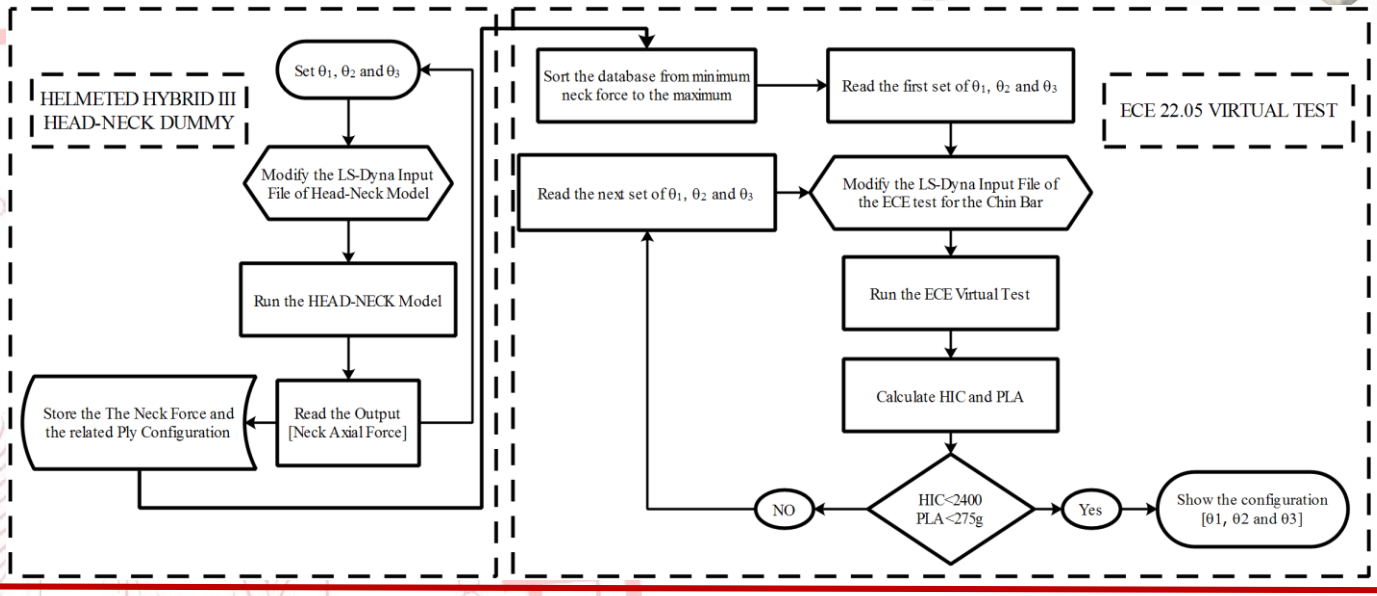
   - Modifying currently used materials.
   - Using new energy absorbing material.

IRCOBI
International Research Council on Biomechanics of Injury

S. Farajzadeh Khosroshahi, M. Ghajari, U. Galvanetto, “A Numerical Approach for the Optimization of a Composite Chin Bar for Protection against Basilar Skull Fracture”, IRCOBI, Malaga, Spain, September 2016.







SPECTRA fibres for helmet.

Intentionally left blank because of confidentiality.

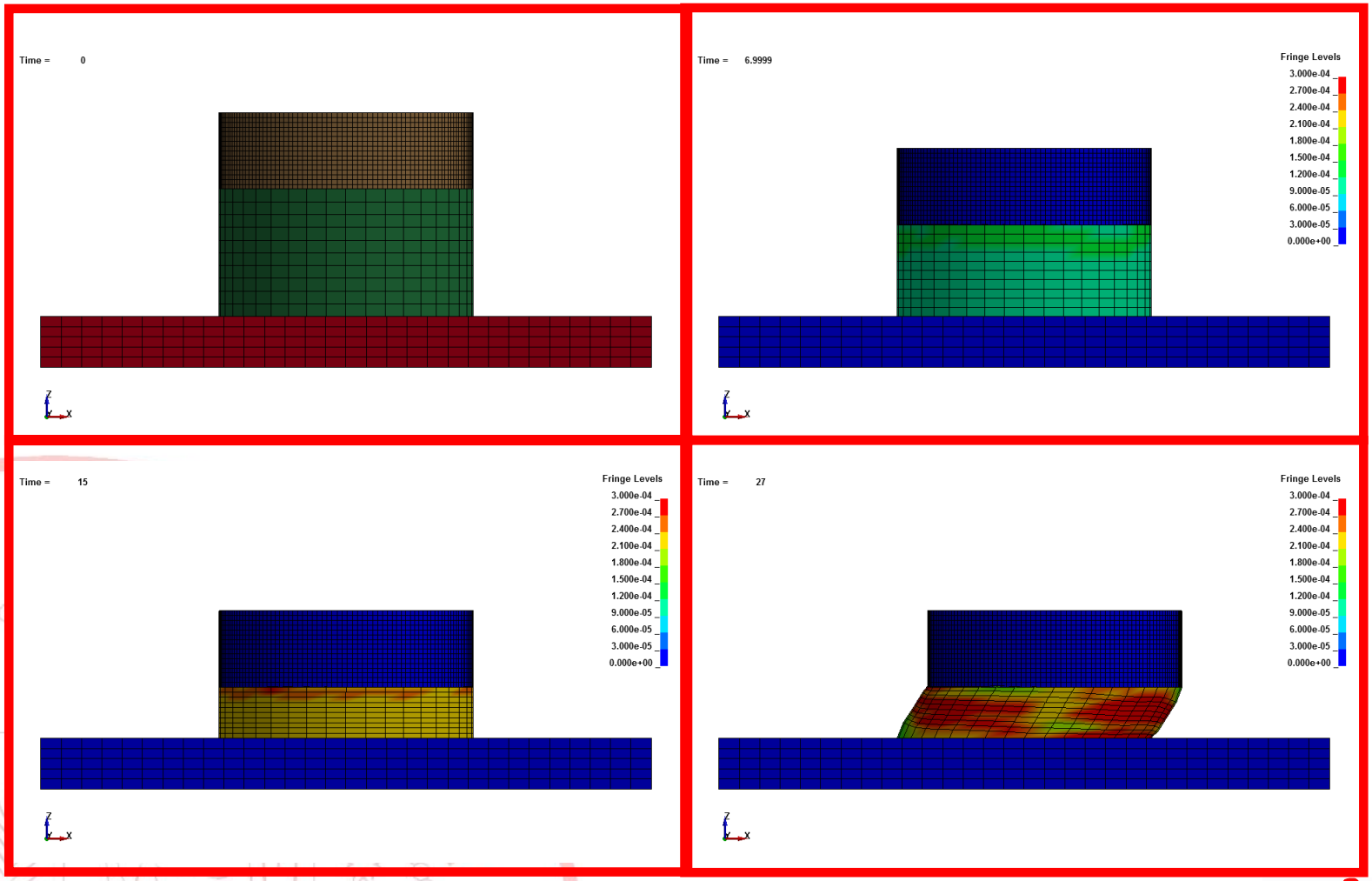
SPECTRA fibres for helmet.

Intentionally left blank because of confidentiality.

Testing conventional energy absorbing material under more realistic (biasxial) load condition.

Intentionally left blank because of confidentiality.

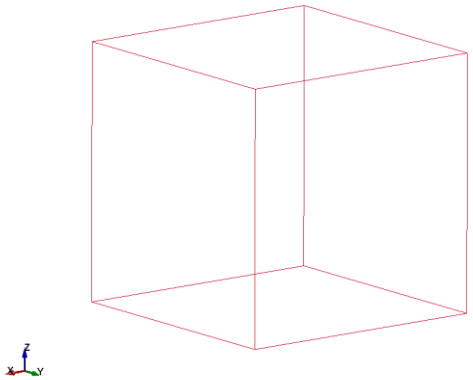
FE simulation of EPS under biasxial load condition.



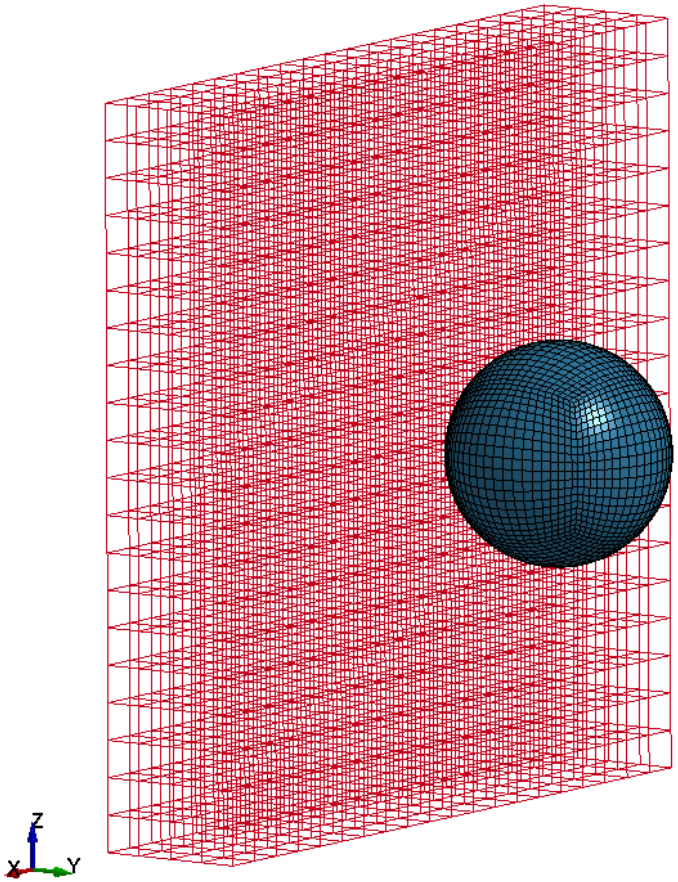
The contours show Von Mises Stress [GPa].

Feasibility study of using lattice structures as the helmet liner.

Beam element

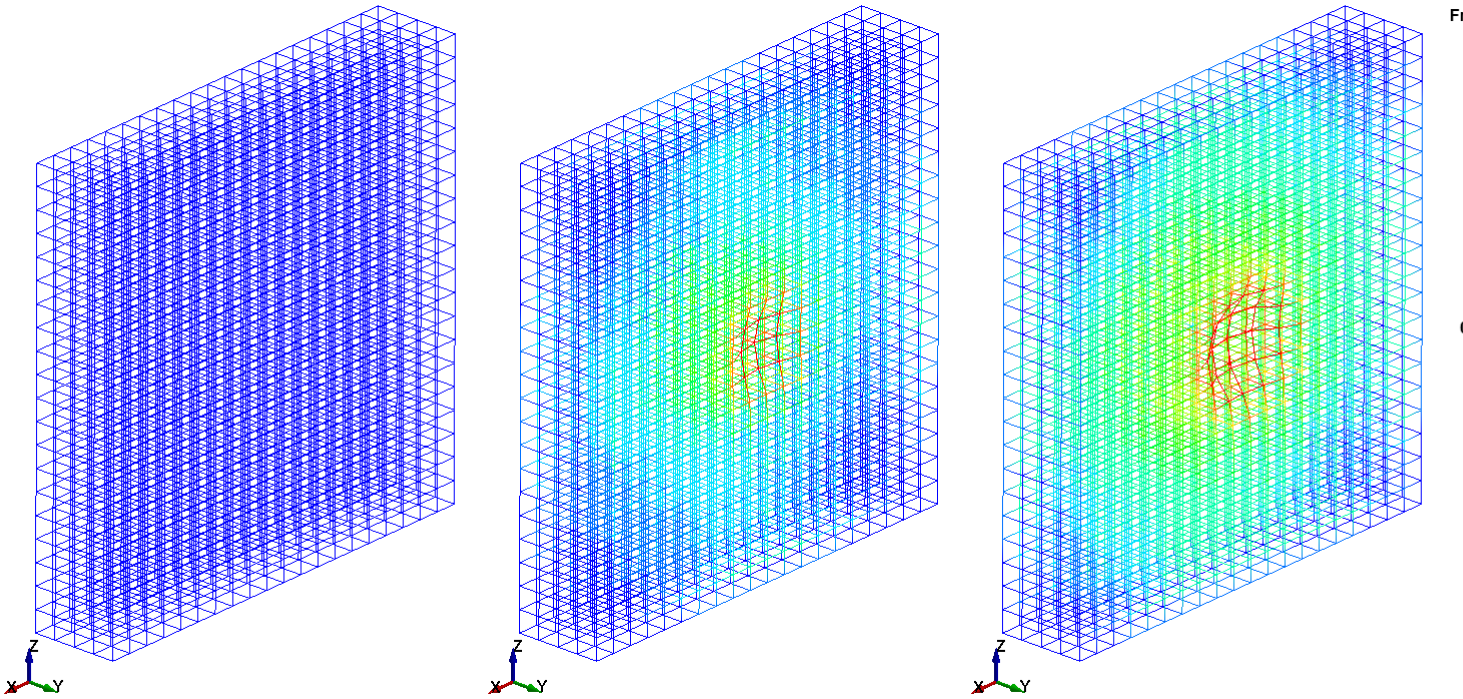


Unit Cell



Lattice Structure

Feasibility study of using lattice structures as the helmet liner.



Von Mises Stress [GPa]

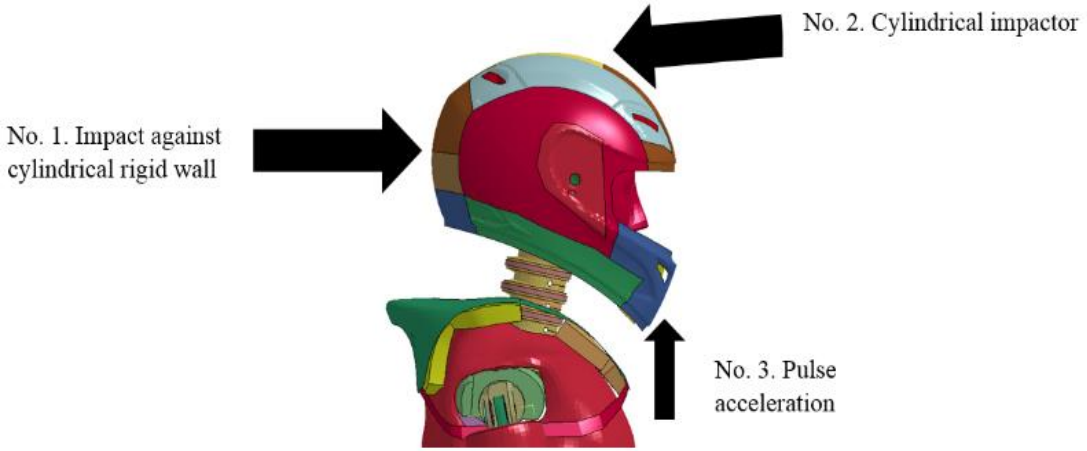
t=0 ms

t=1 ms

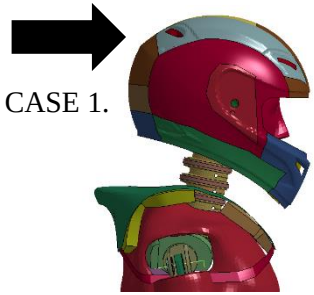
t=2.4 ms

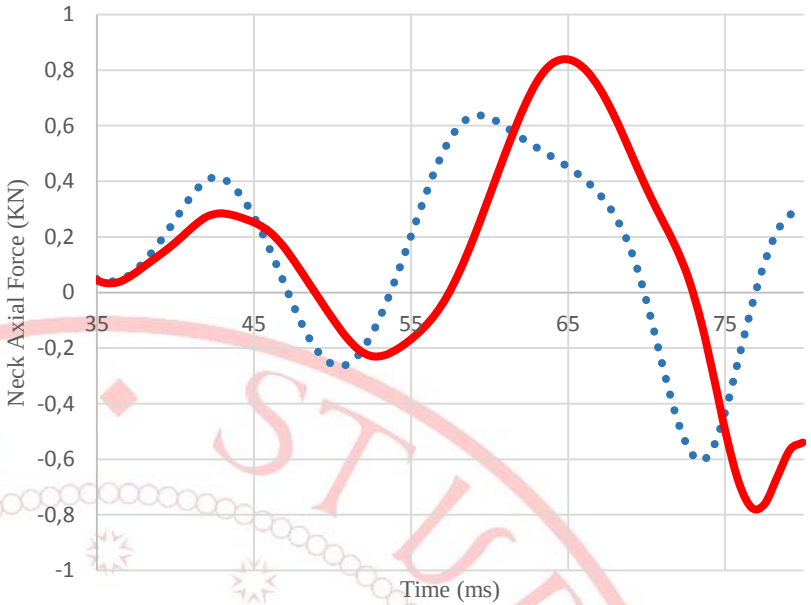
What Has Been Done?! 2. Neck Brace

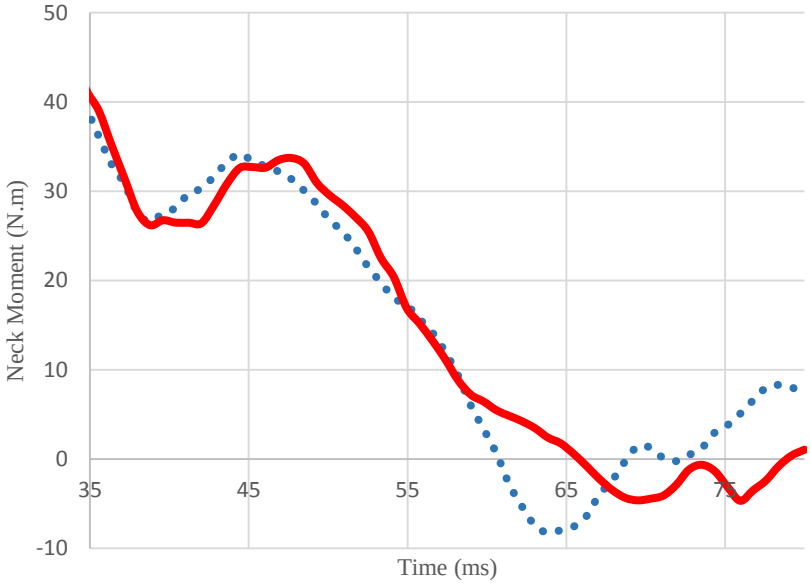
S. Farajzadeh Khosroshahi, M. Ghajari, U. Galvanetto, “Finite Element Simulation of Neck Brace Protective Equipment for Motorcycle Riders”, 1st International Conference on Impact Loading of Structures and Materials, Turin, Italy, May 2016.



NECK Axial Force and Sagittal Moments:



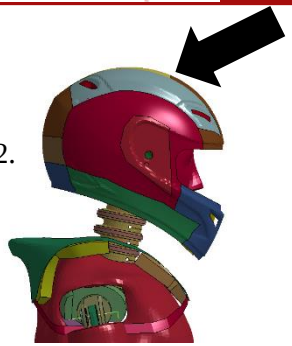


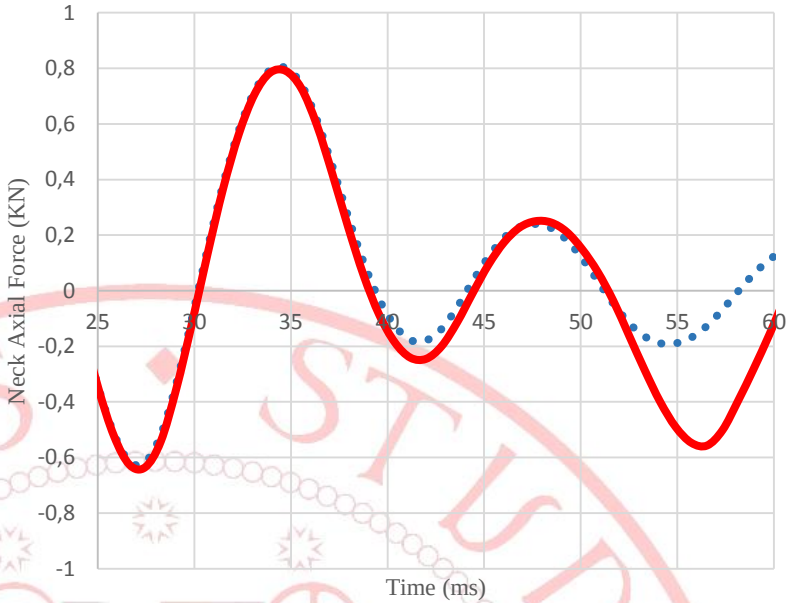


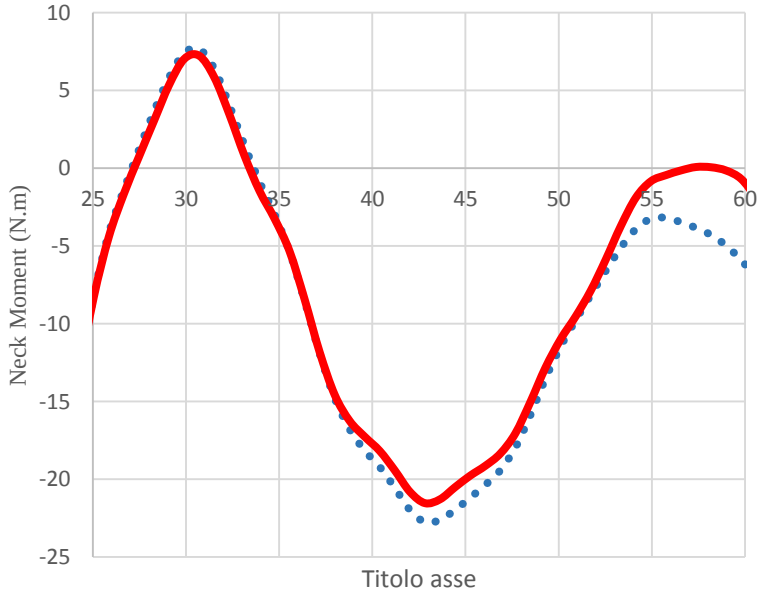
With Brace Without Brace

NECK Axial Force and Sagittal Moments:

CASE2.



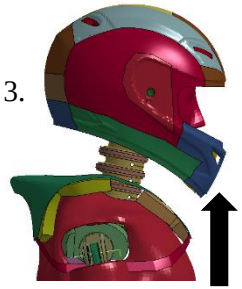


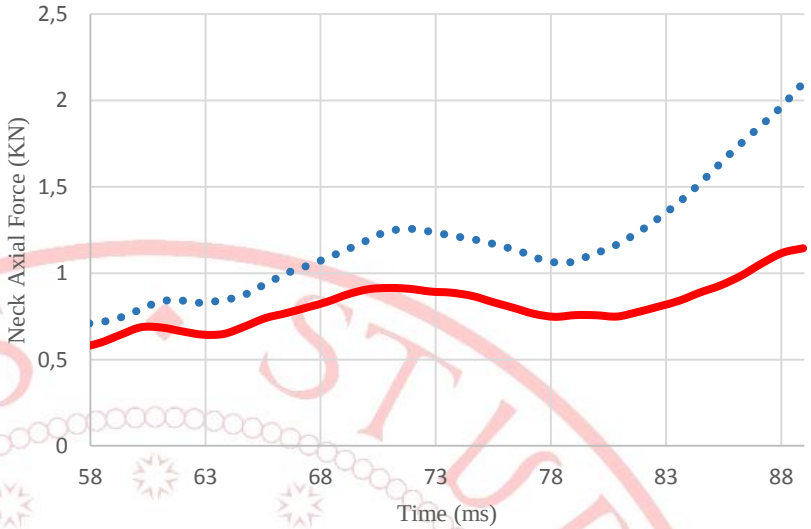


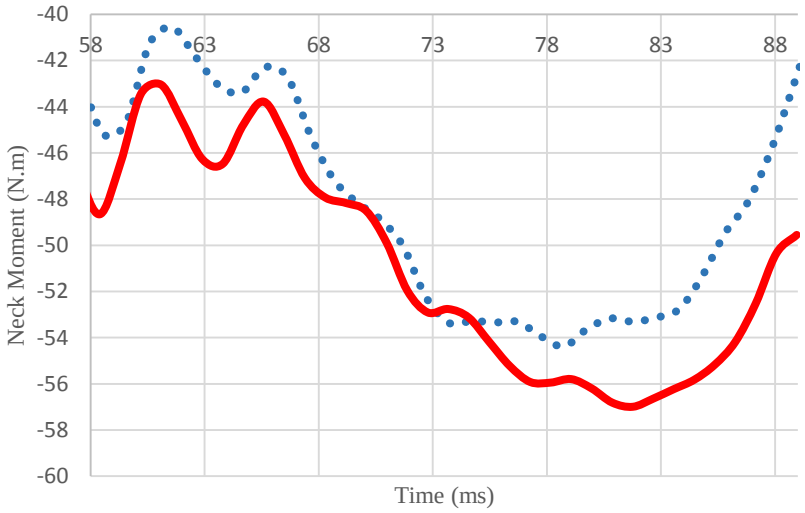
With Brace Without Brace

NECK Axial Force and Sagittal Moments:

CASE 3.







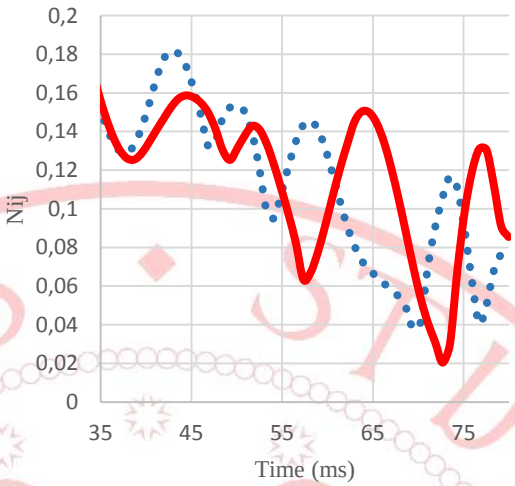
With Brace Without Brace

Neck Injury Criterion [Nij]:

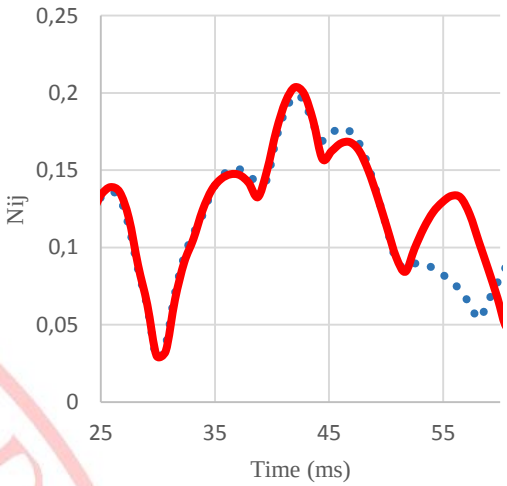
$$N_{ij} = \frac{F_z}{F_{int}} + \frac{M_y}{M_{int}}$$

Table 4.4 Intercept values for calculating N_{ij} as included in FMVSS 208.

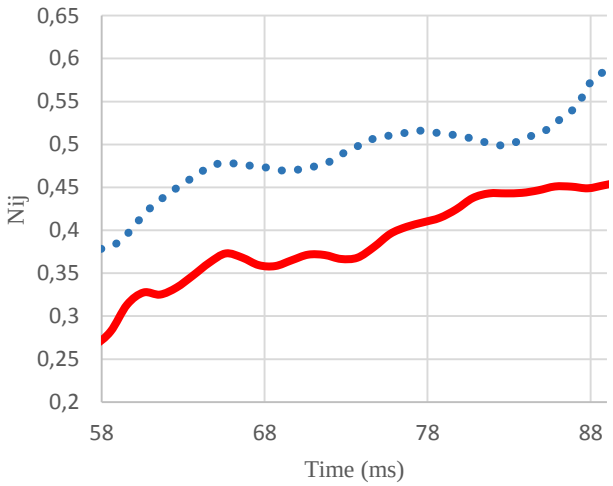
Dummy	My (flexion/extension) [Nm]	Fz (compression/tension) [N]
HIII 50%	310/ 135	6160/ 6806



CASE 1.



CASE 2.

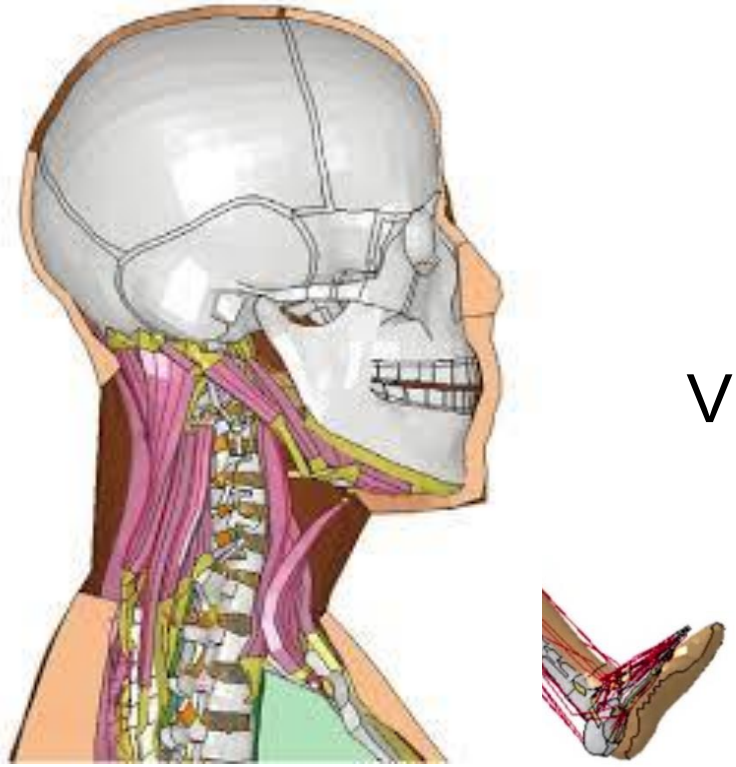


CASE 3.

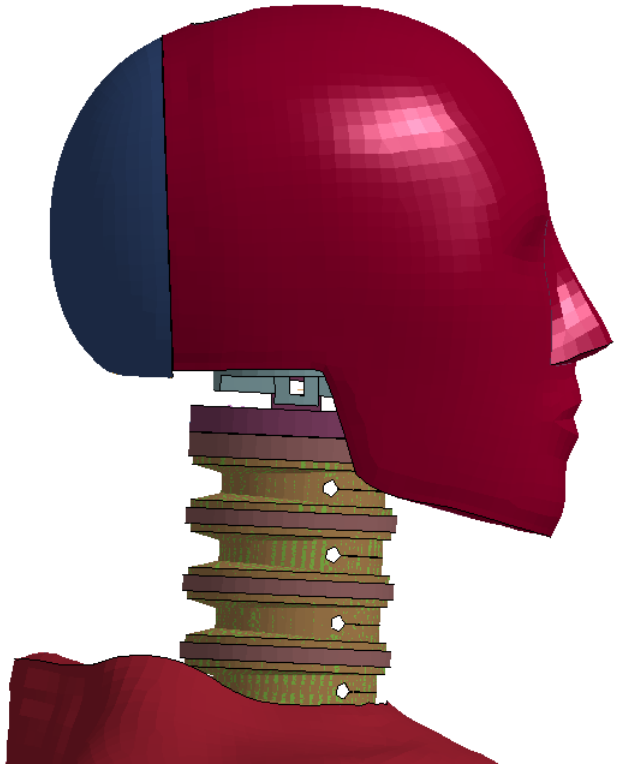
With Brace Without Brace

Table is adopted from Kai-Uwe Schmitt, Peter F. Niederer, Markus H. Muser, Felix Walz, "Trauma biomechanics- accidental injury in traffic and sports" 2007

Are we using a suitable human body surrogate?!!



VS.



THUMS

Hybrid III

What are the next steps?!

- Validation of Neck Brace FE model.
- Evaluation of the neck brace using THUMS.
- Testing helmets liner foam under biaxial loading (Swerea Sicomp, Sweden).
- Molding few prototype helmet shells with Spectra fibres (Dainese S.p.A.).
- Feasibility study of using lattice structures as the helmet liner.
- Studying the difference of different type of Back Protectors (Collaboration with Nassim).

THANKS FOR YOUR ATTENTION