MOTOrcycle Rider Integrated SafeTy

NEW ENERGY ABSORBING MATERIALS AND THEIR USE IN PERSONAL PROTECTIVE EQUIPMENT

Siamak F. Khosroshahi

WARNING

This presentation contains videos that some audiences may find disturbing.

Why do we need PPE?

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The video is adopted from Instagram @mx___passion.

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Why do we need to improve PPE?

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The video is adopted from youtube.com.

Why do we need to improve PPE?

The video is adopted from Instagram @dirtbike_insanity.

Why do we need to improve PPE?

The video is adopted from Instagram @street.bikes.

How to realize that a protective device is good?

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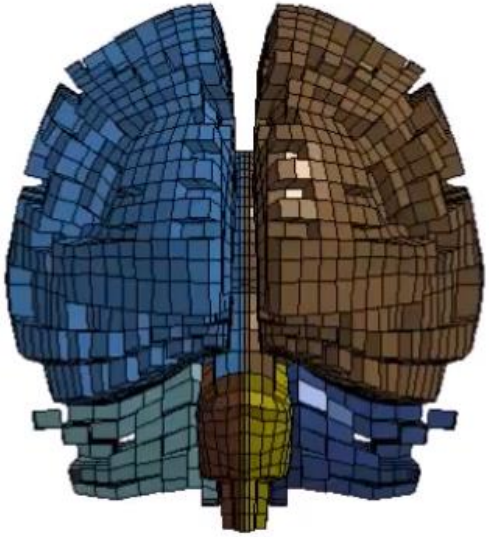
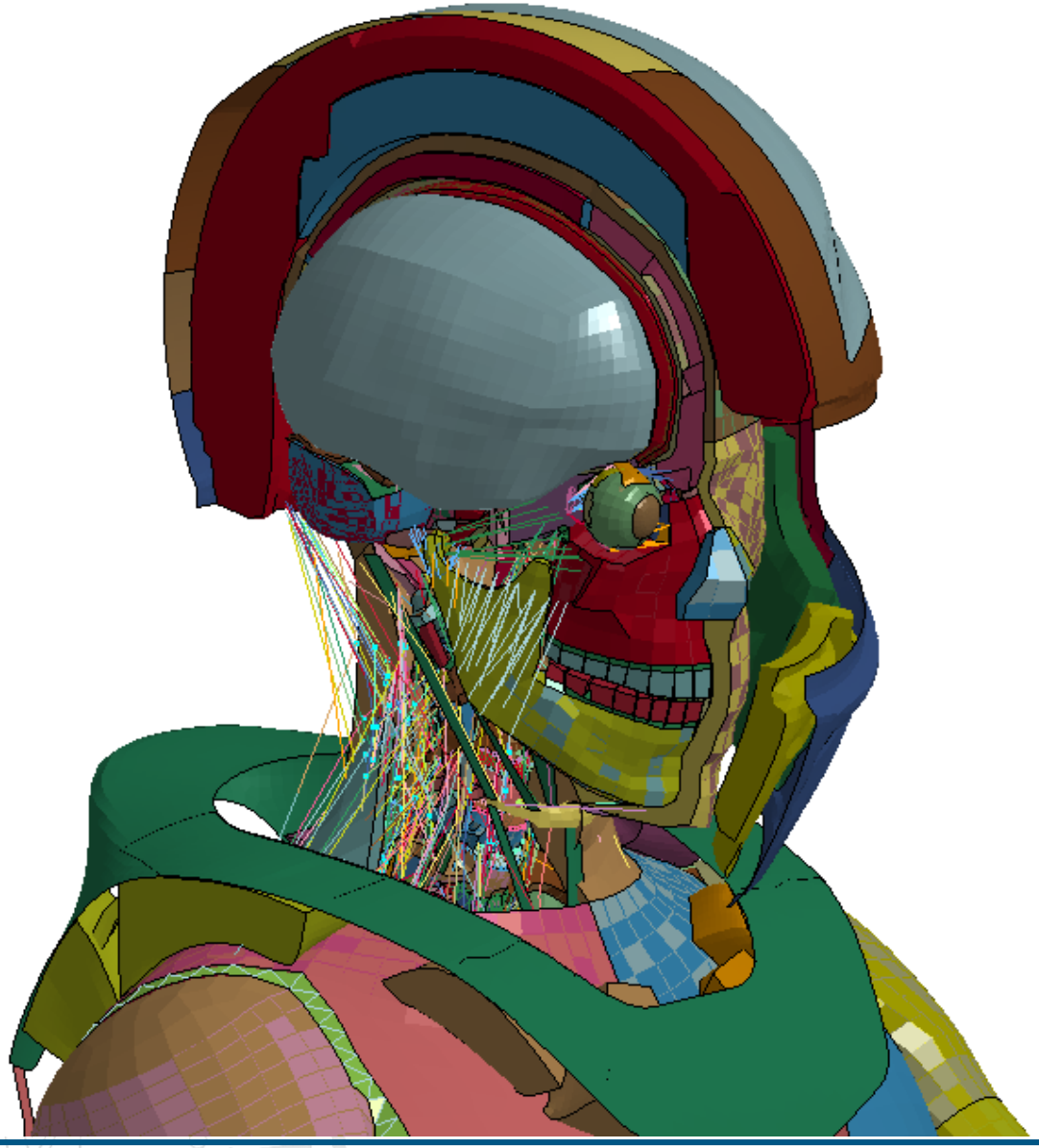
The picture is adopted from www.bikebandit.com/

How to realize that a protective device is good?



How to realize that a protective device is good?



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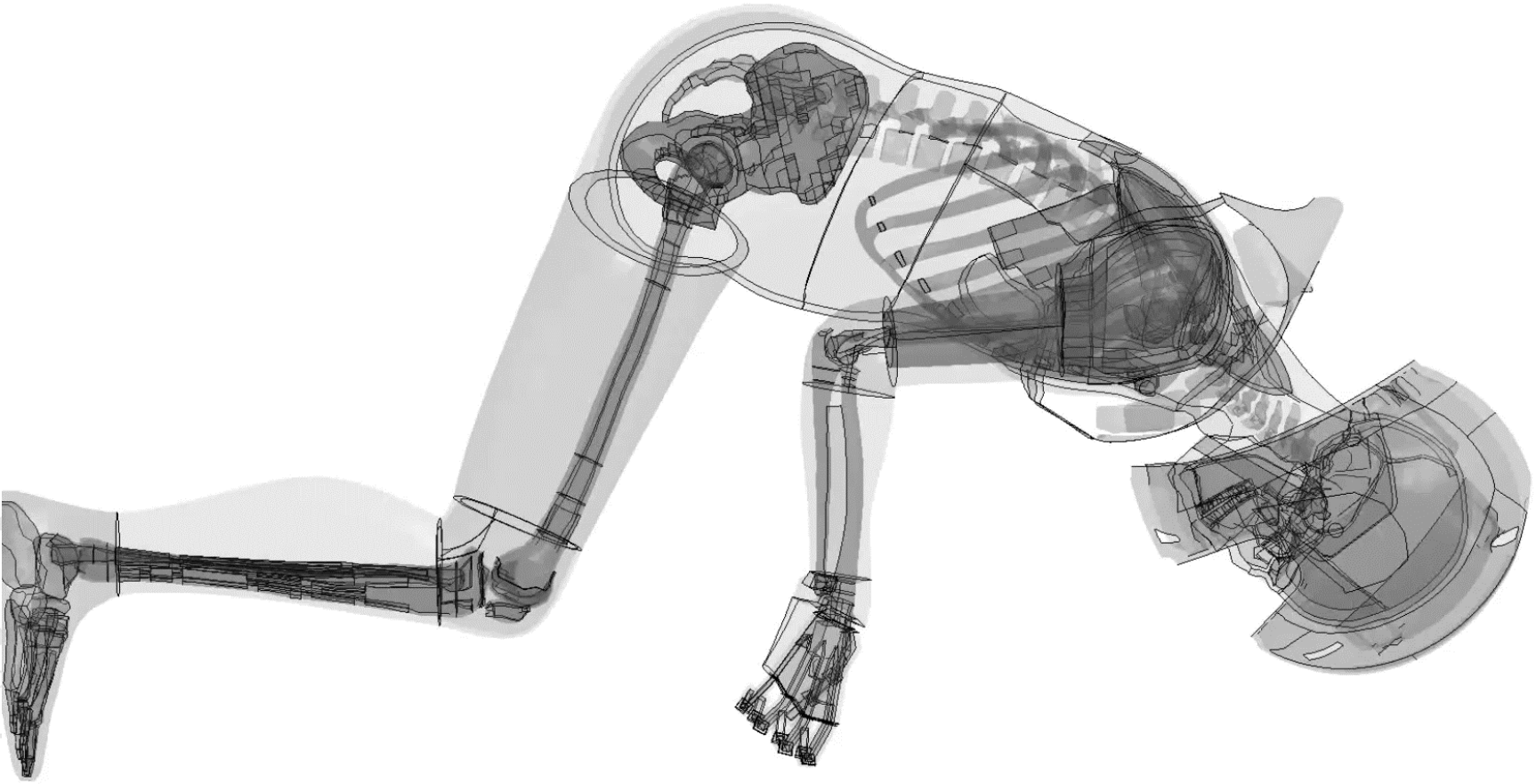


What has been done?

- Head protection:
  - Realistic material characterization for FE based injury criteria.
  - Partial optimization of helmet.
  - New materials for new generation of helmets.
- Neck Protection:
  - Assessment of a neck protective device.

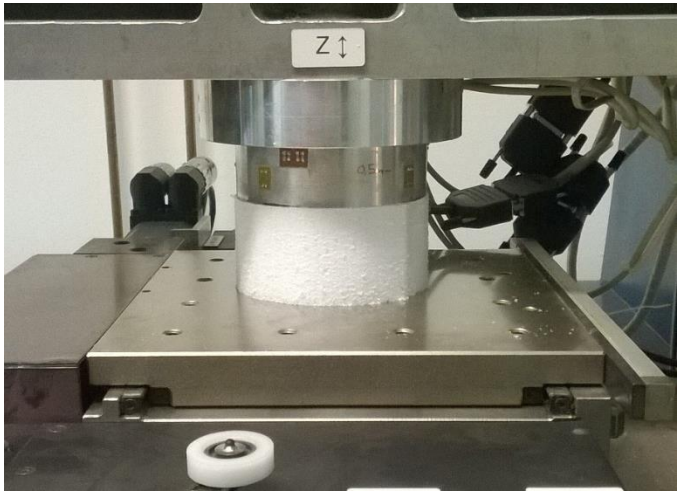
Head and Neck PPE

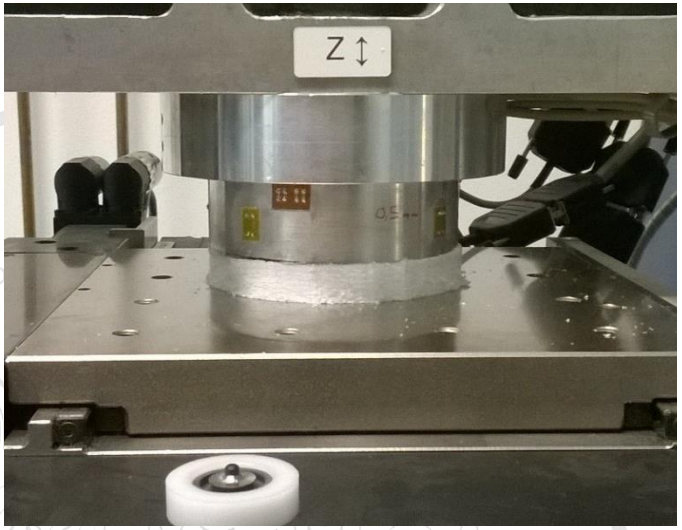
The pictures are adopted from www.dainese.com/

Realistic material characterization for FE based injury criteria

Realistic material characterization

Uniaxial Test.





EPS Compressive Stress-Strain [Ro=17 Kg/m^3]

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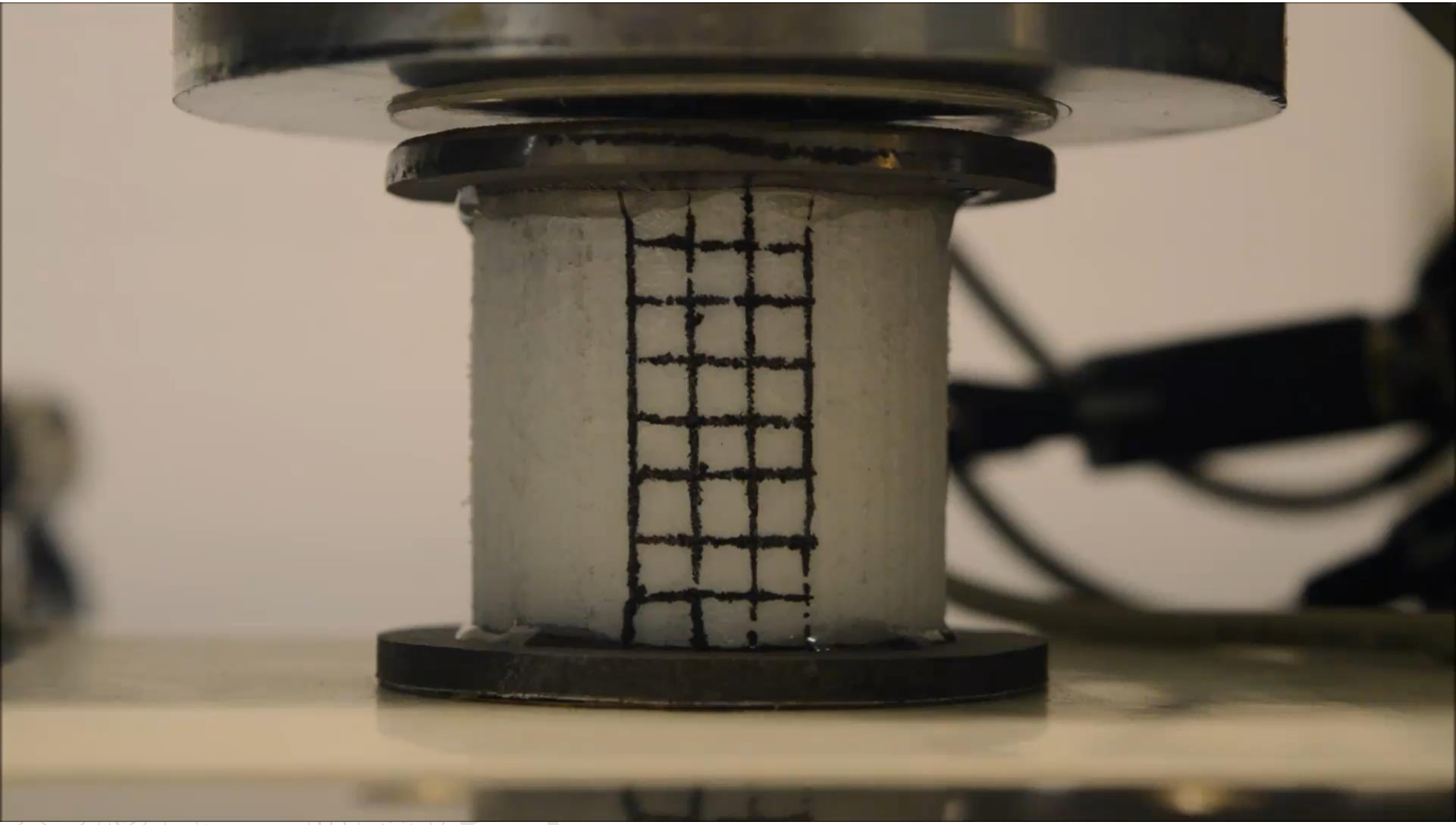
Realistic material characterization



Shear Stress-strain curve of EPS foam (25 gr/lit)

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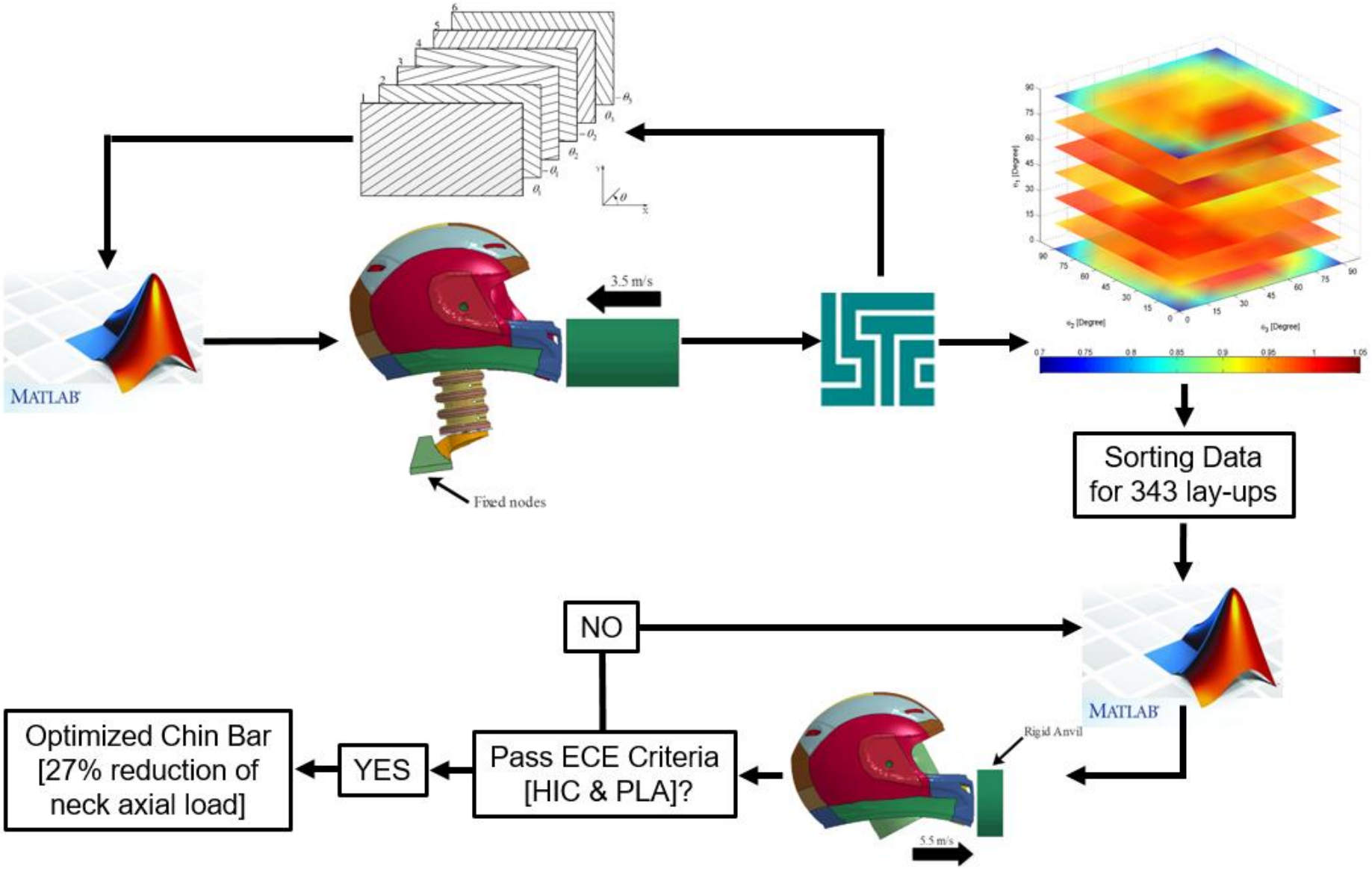
Partial optimization of helmet

Optimization of the chin bar to mitigate the risk of BSF



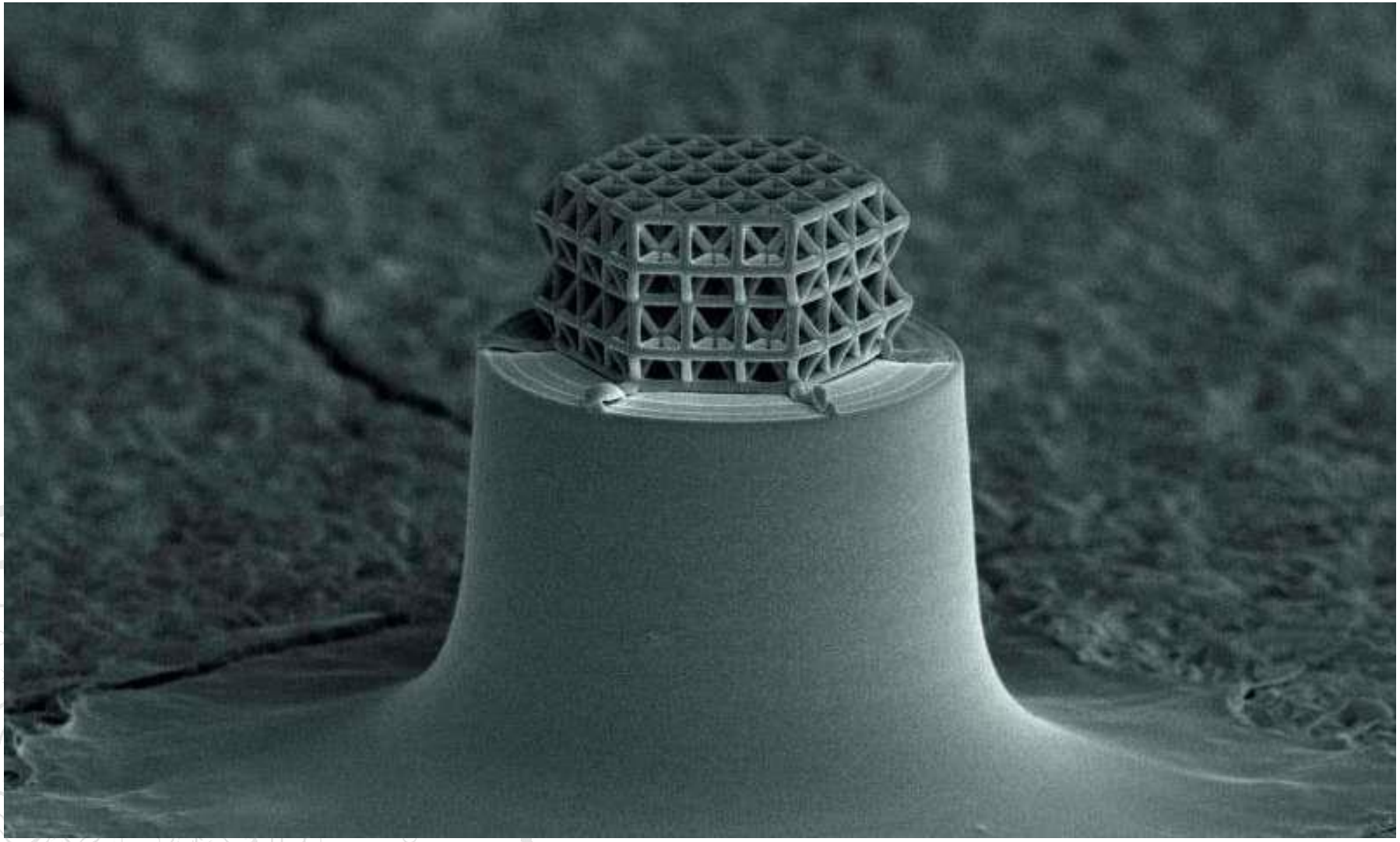
New materials for new generation of helmets: More reliable helmets

Lattice Structures

The picture is adopted from http://www.livescience.com.

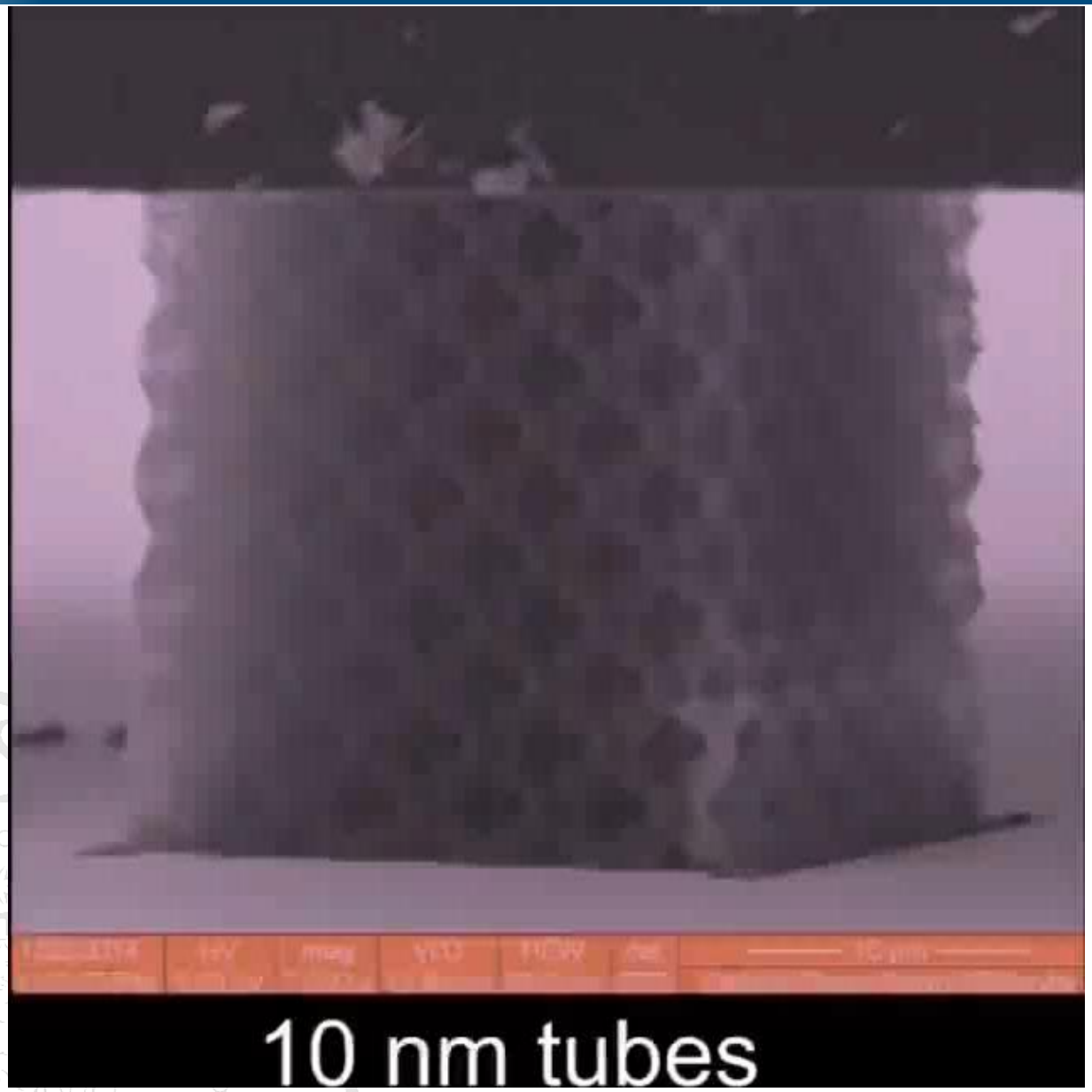
Lattice Structures

Struts and braces are 0.2 µm in diameter. Total size of the lattice is about 10 µm.



J. Bauer et al, Nature Materials, 2016.

Lattice Structures



The video is adopted from http://cen.acs.org.

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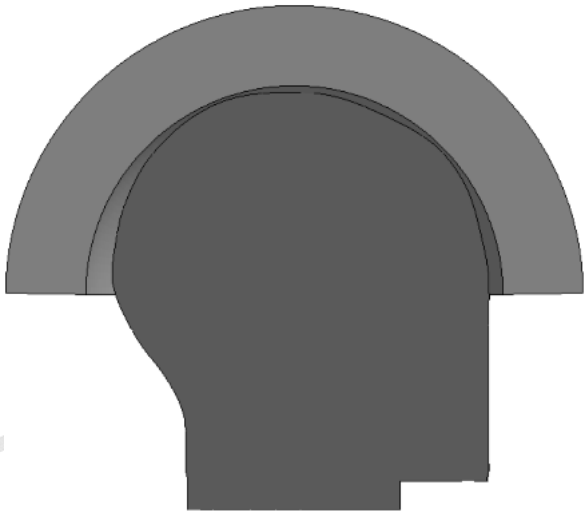
Lattice structures for helmet's liner



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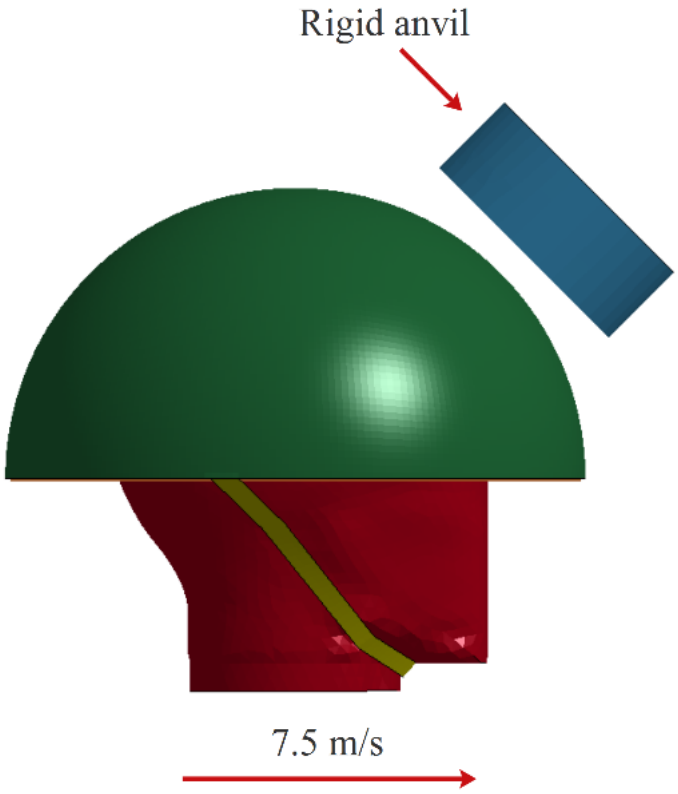

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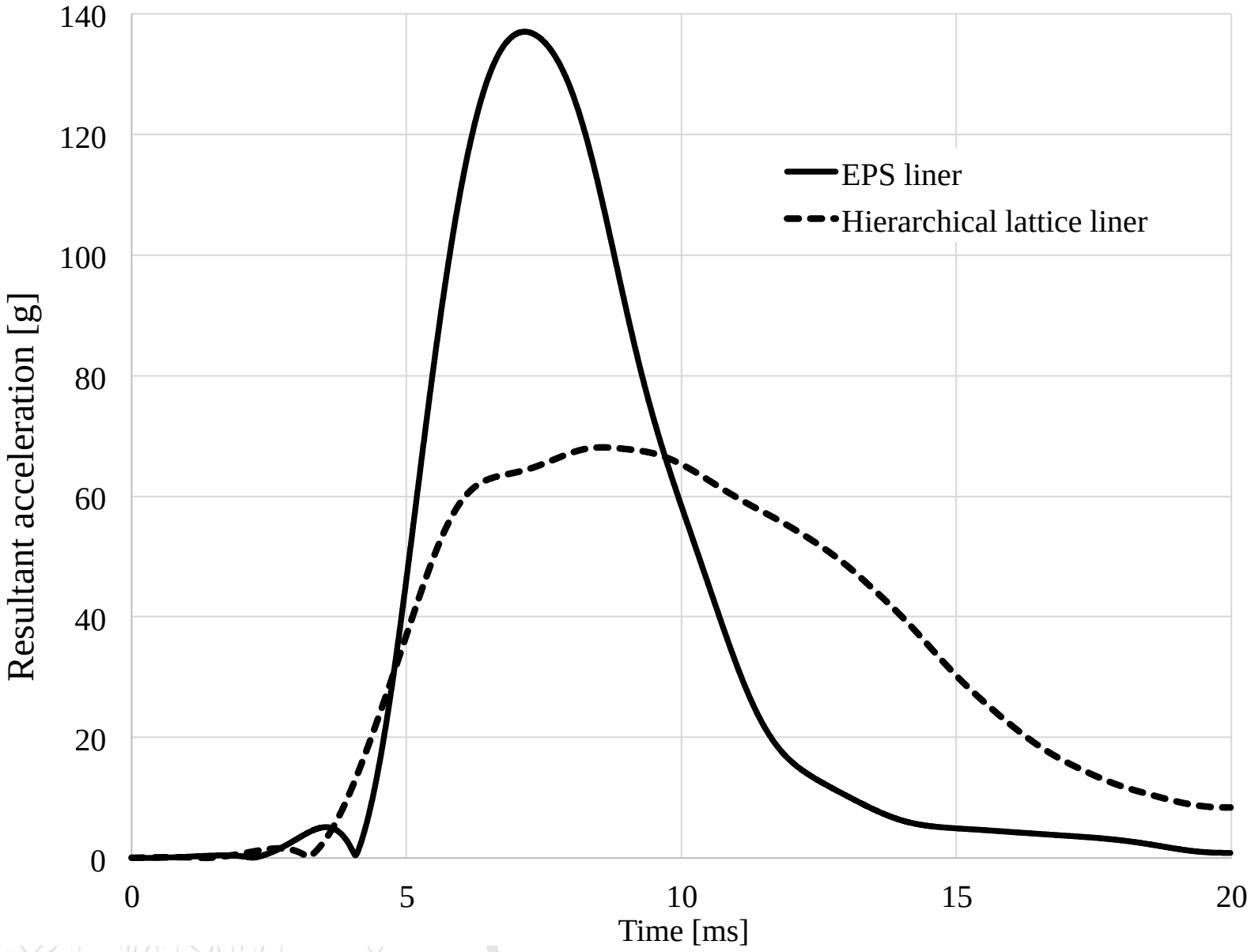

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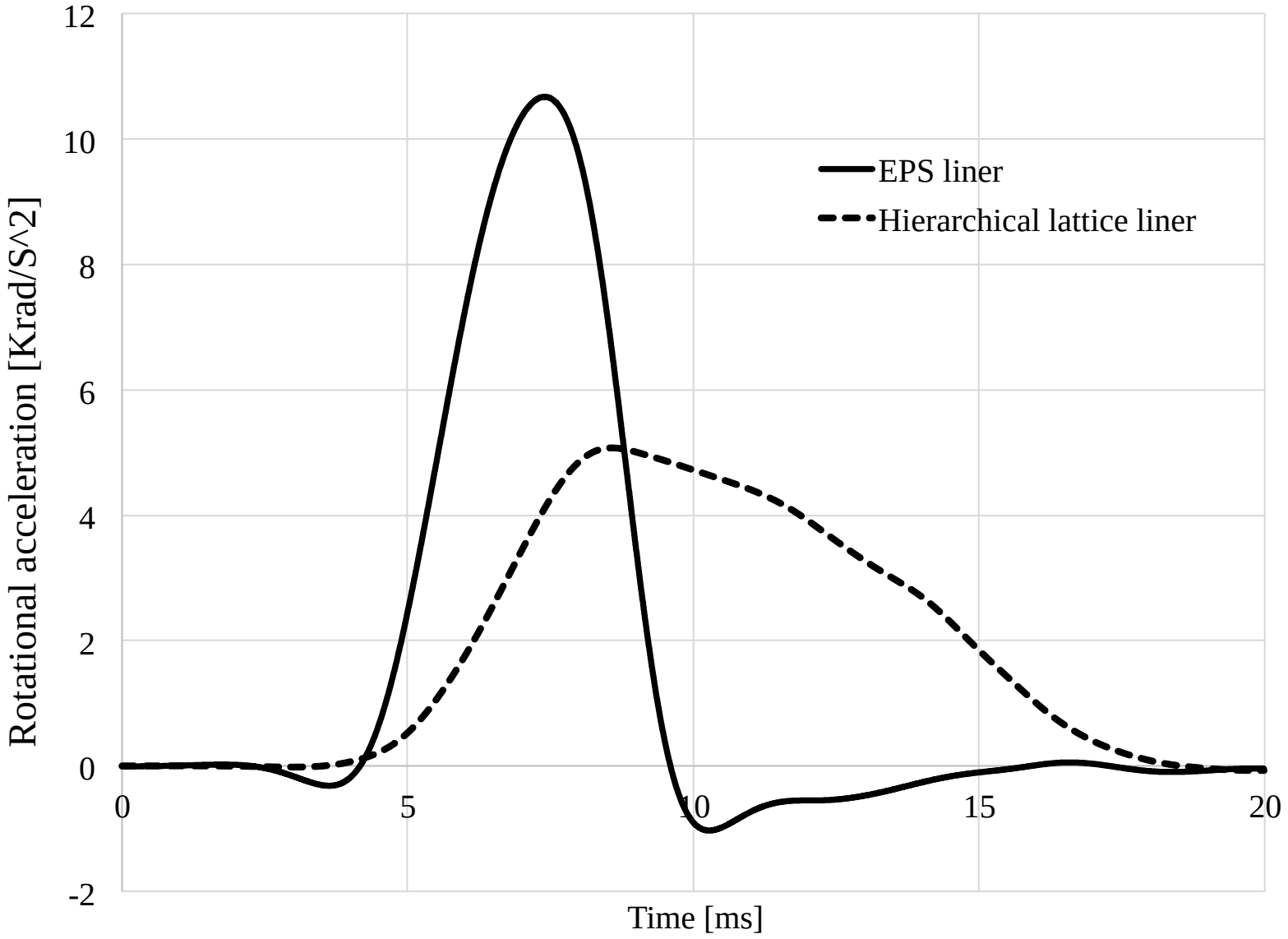

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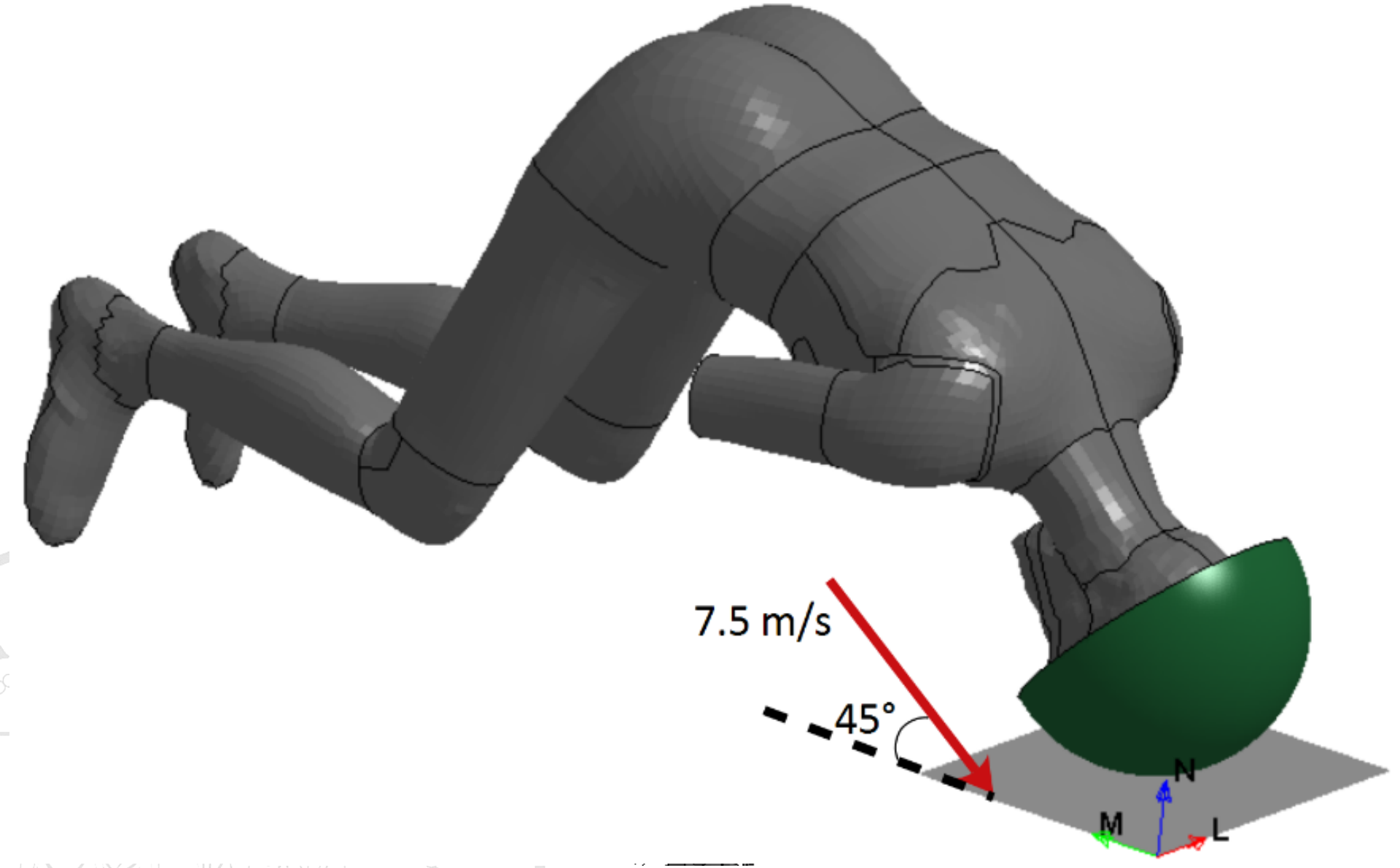

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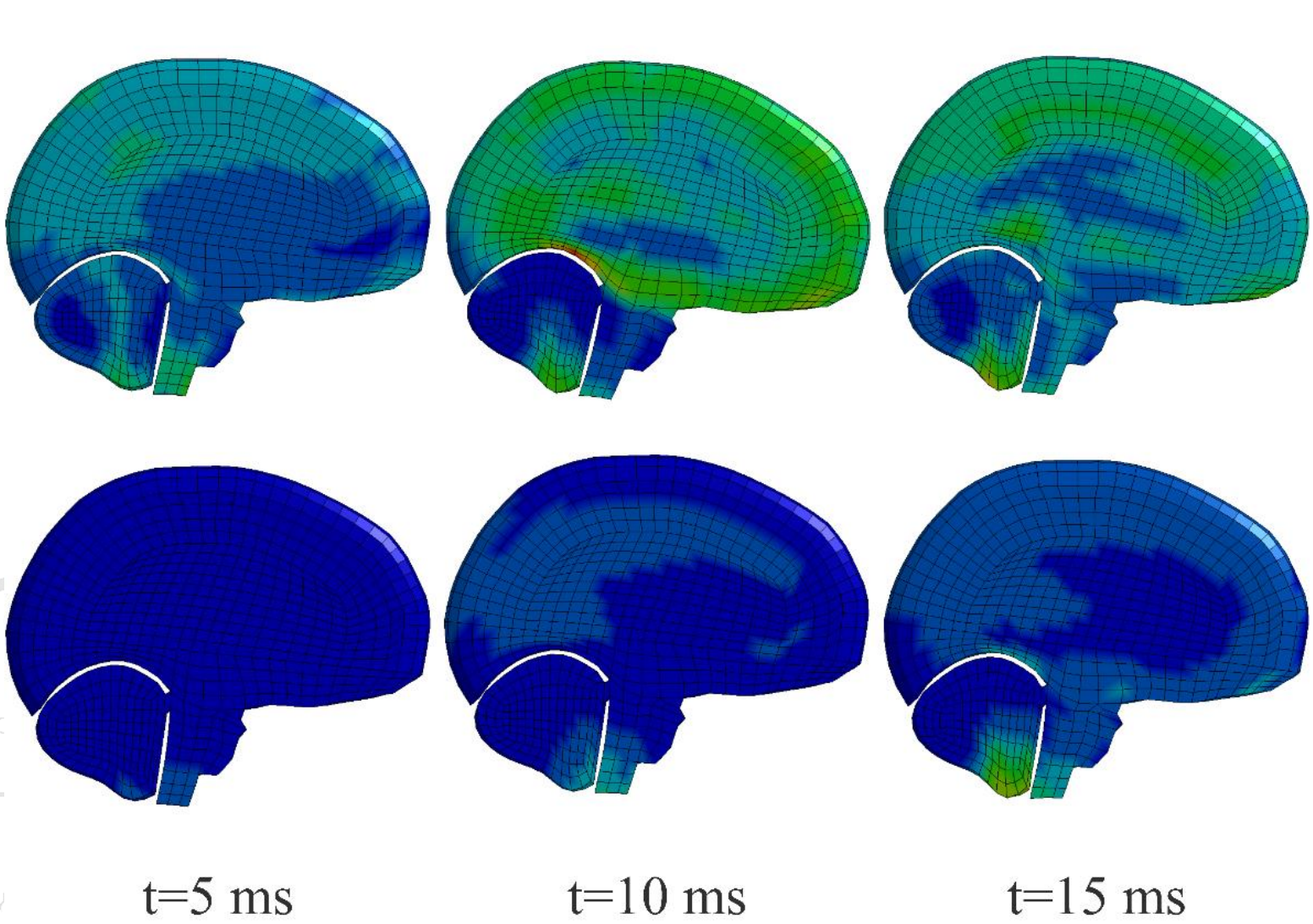

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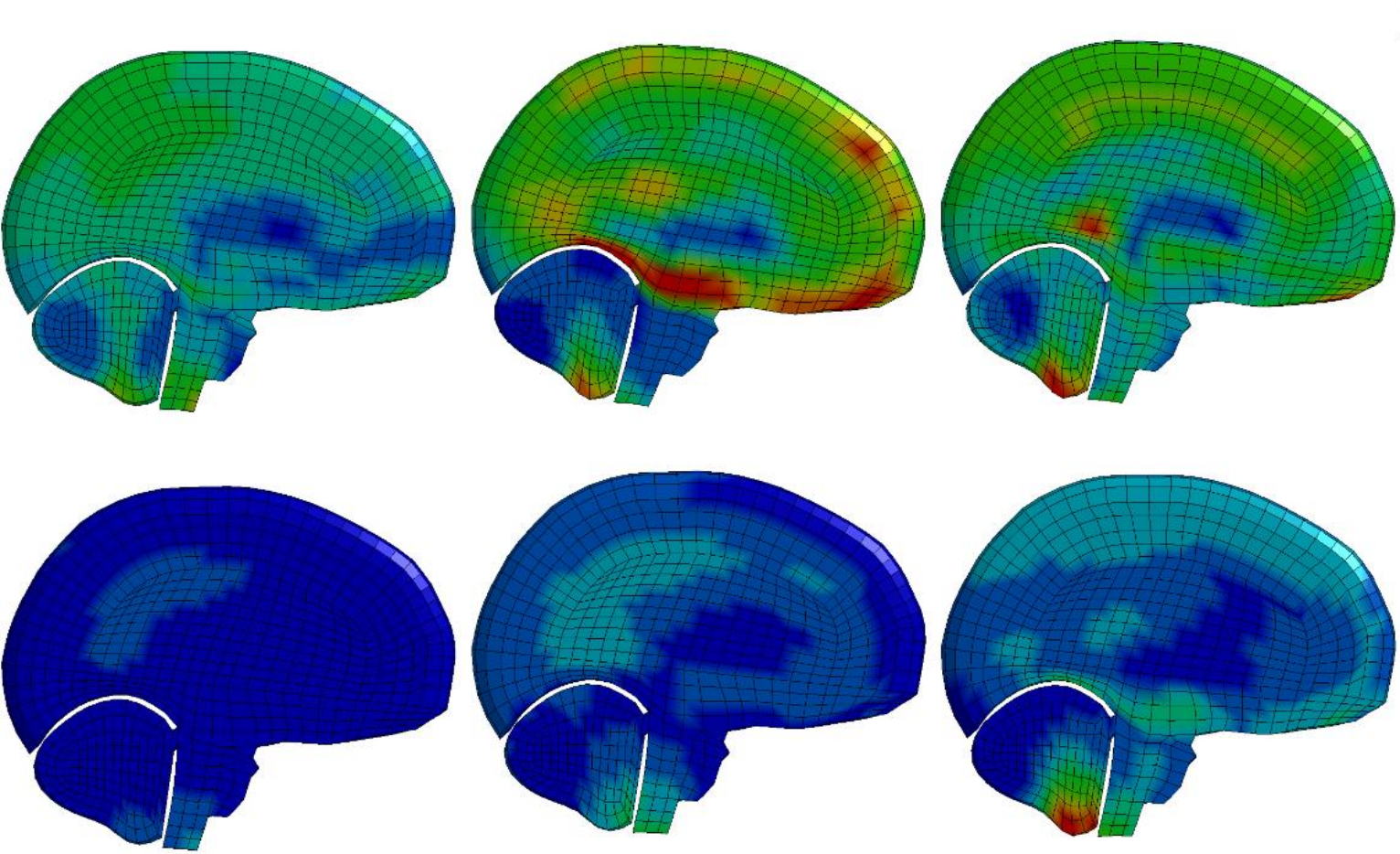

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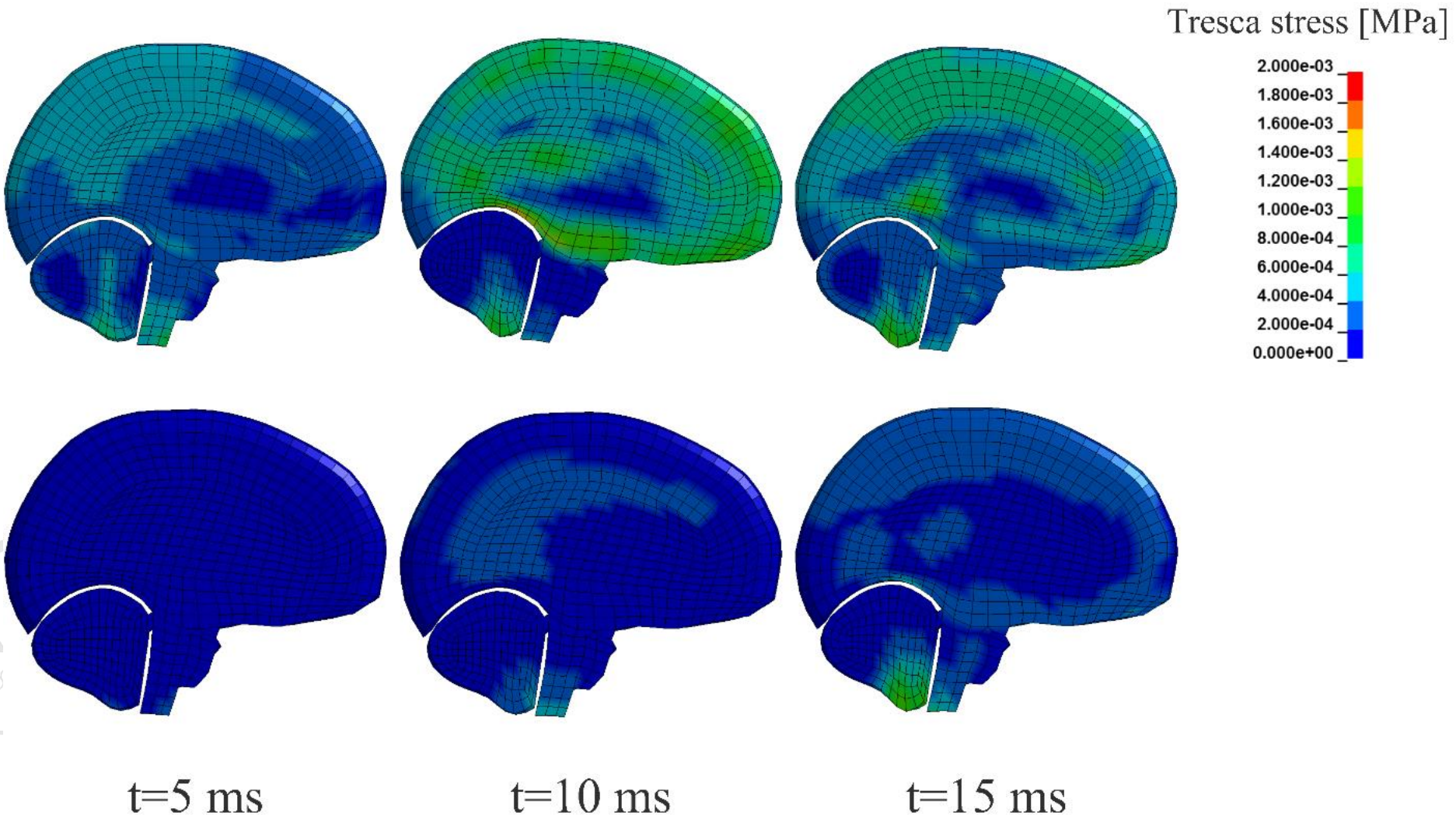
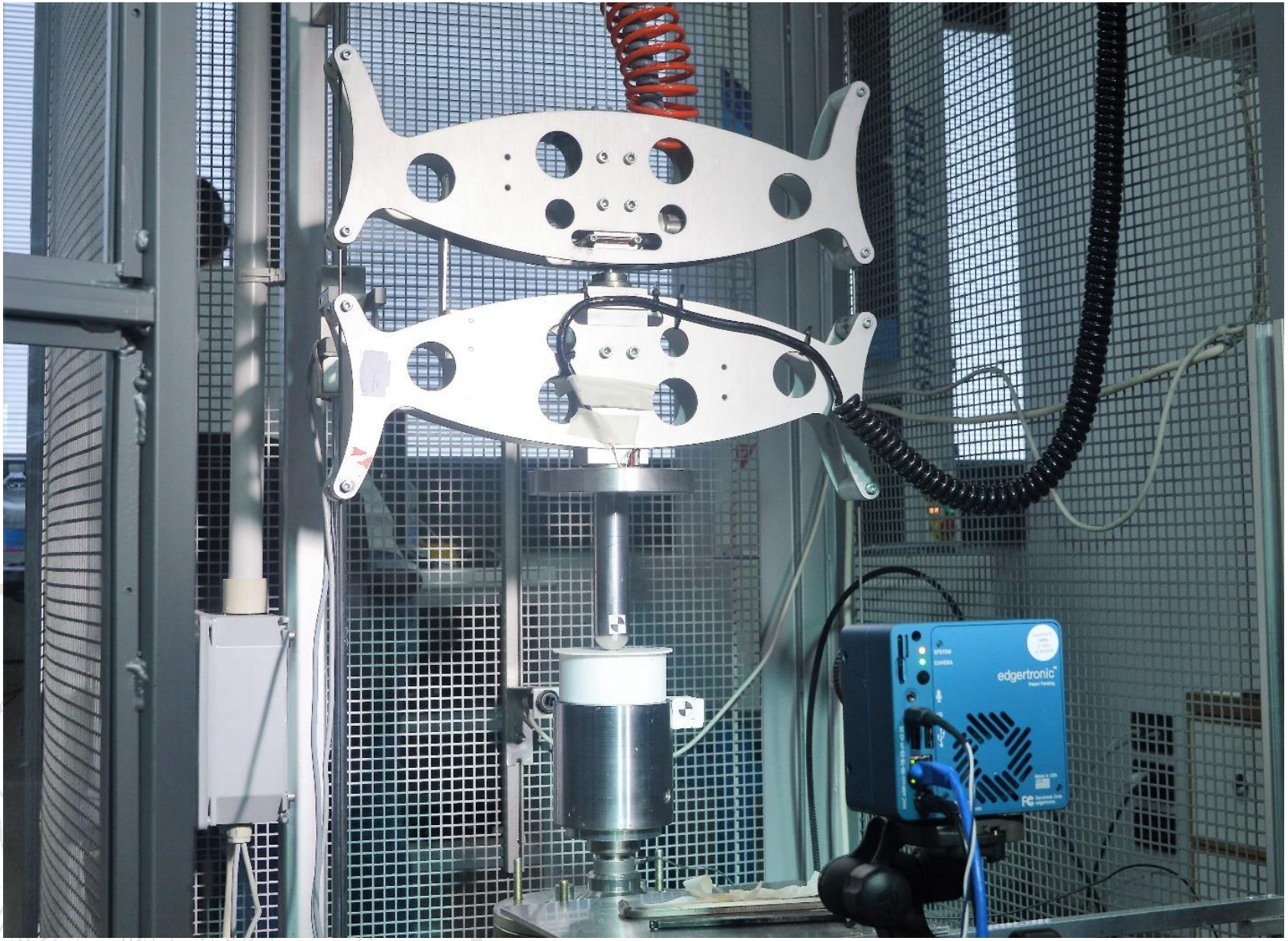
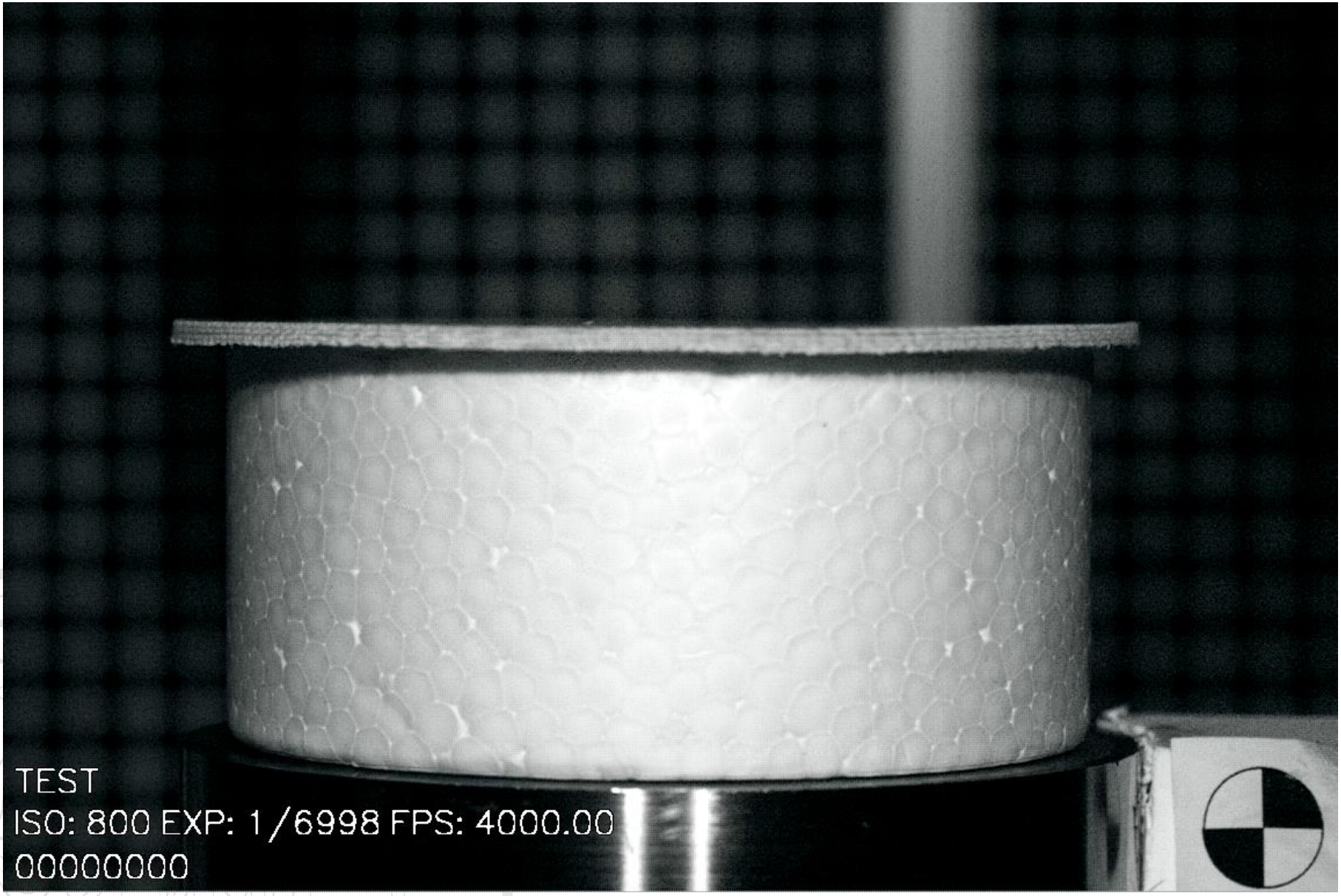


New materials for new generation of helmets: Lighter helmets

SPCETRA for outer shell of helmets



SPCETRA for outer shell of helmets



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Assessment of a neck protective device

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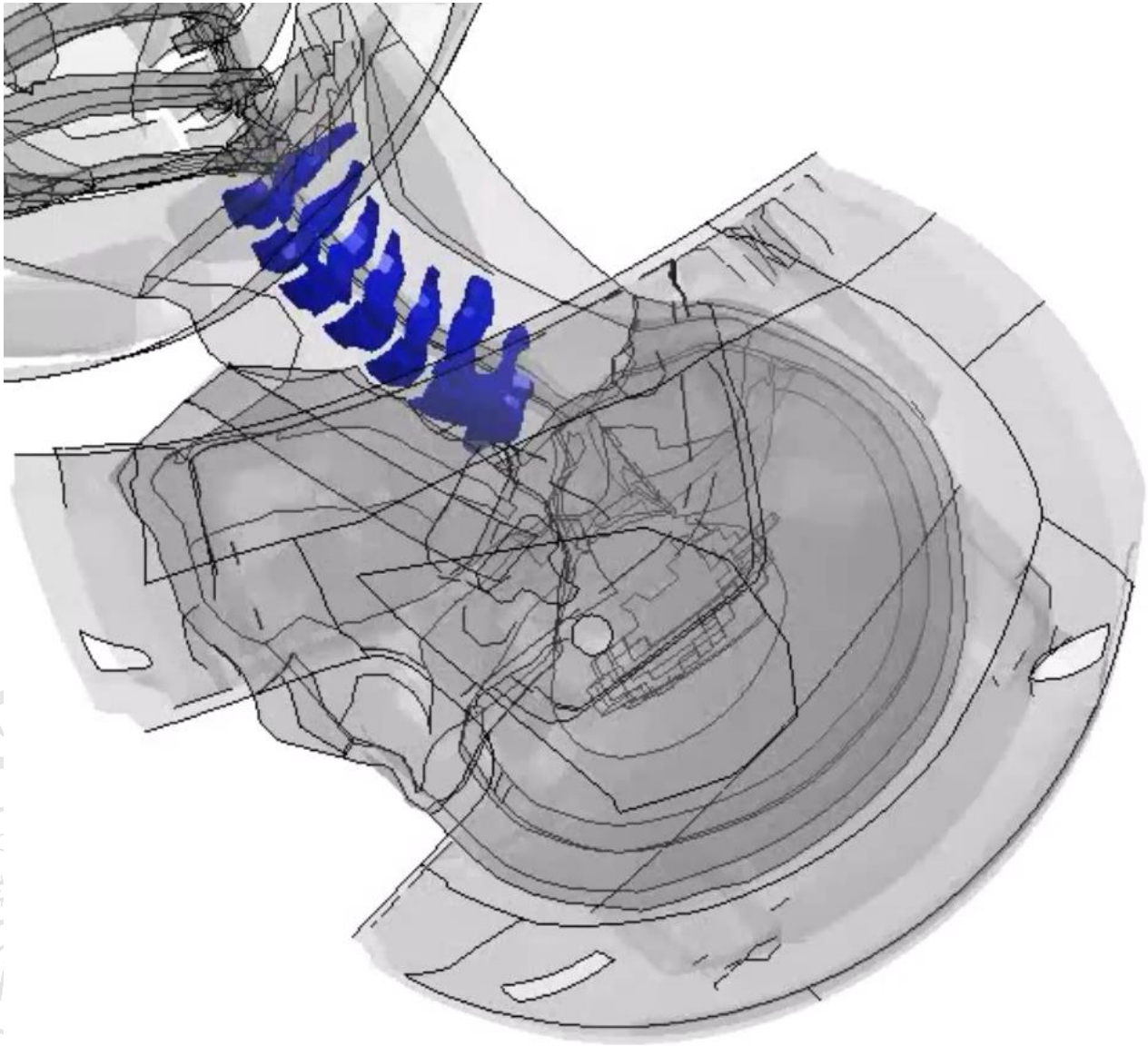
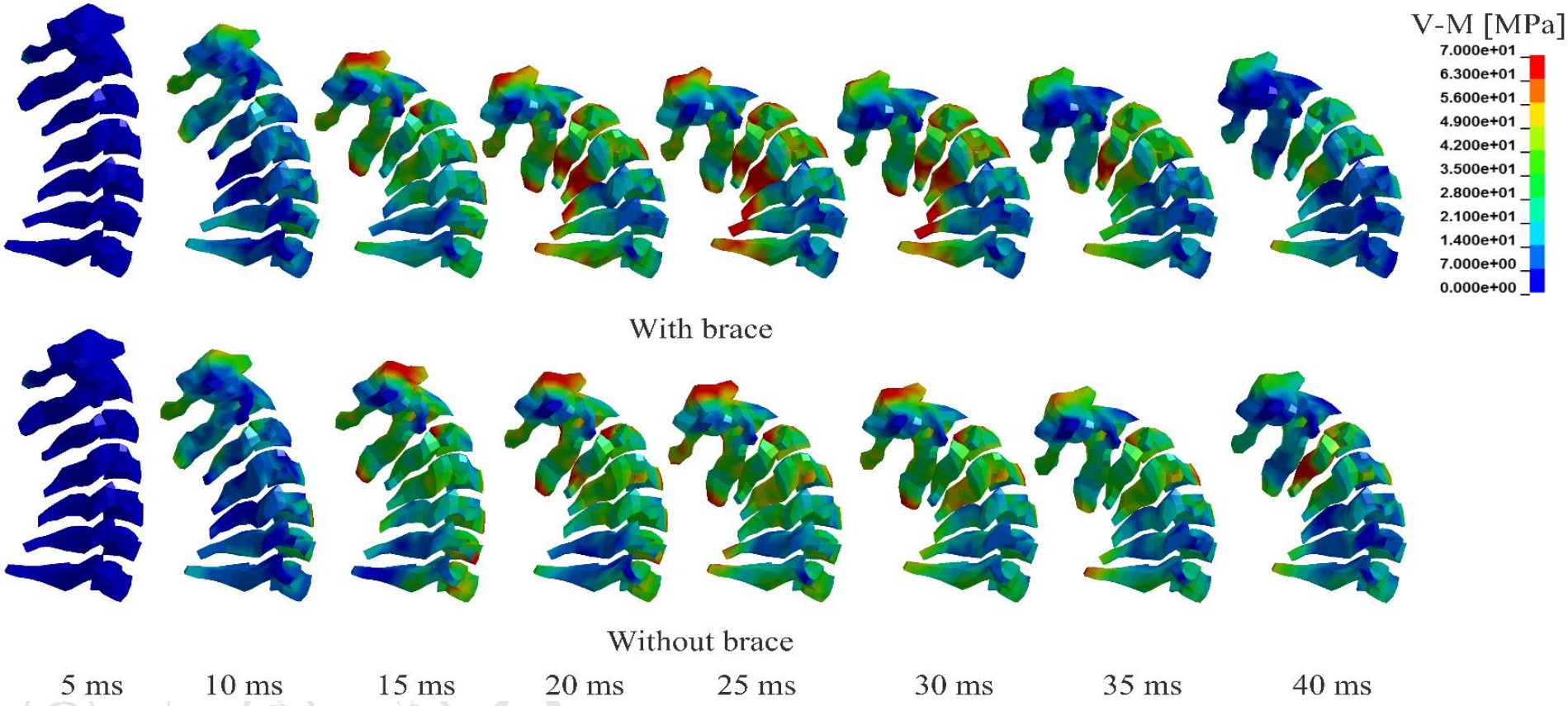


Assessment of a neck protective device



Conclusions

- Head protection:
  - Realistic material characterization provides experimental data for further FE analyses of helmet oblique impacts.
  - The developed approach could be adopted my manufacturers and experimental study will be the next step of this work.
  - Hierarchical lattice structures could reduce the risk of head injuries. The optimization of the lattice will be the next step.
- Neck Protection:
  - According to our result, such devices may increase the risk of cervical injuries, therefore design of such a device needs more researches on mechanisms of neck injury mitigation and developing a standard for design of such devices is crucial.`

Disseminations

Journal papers:

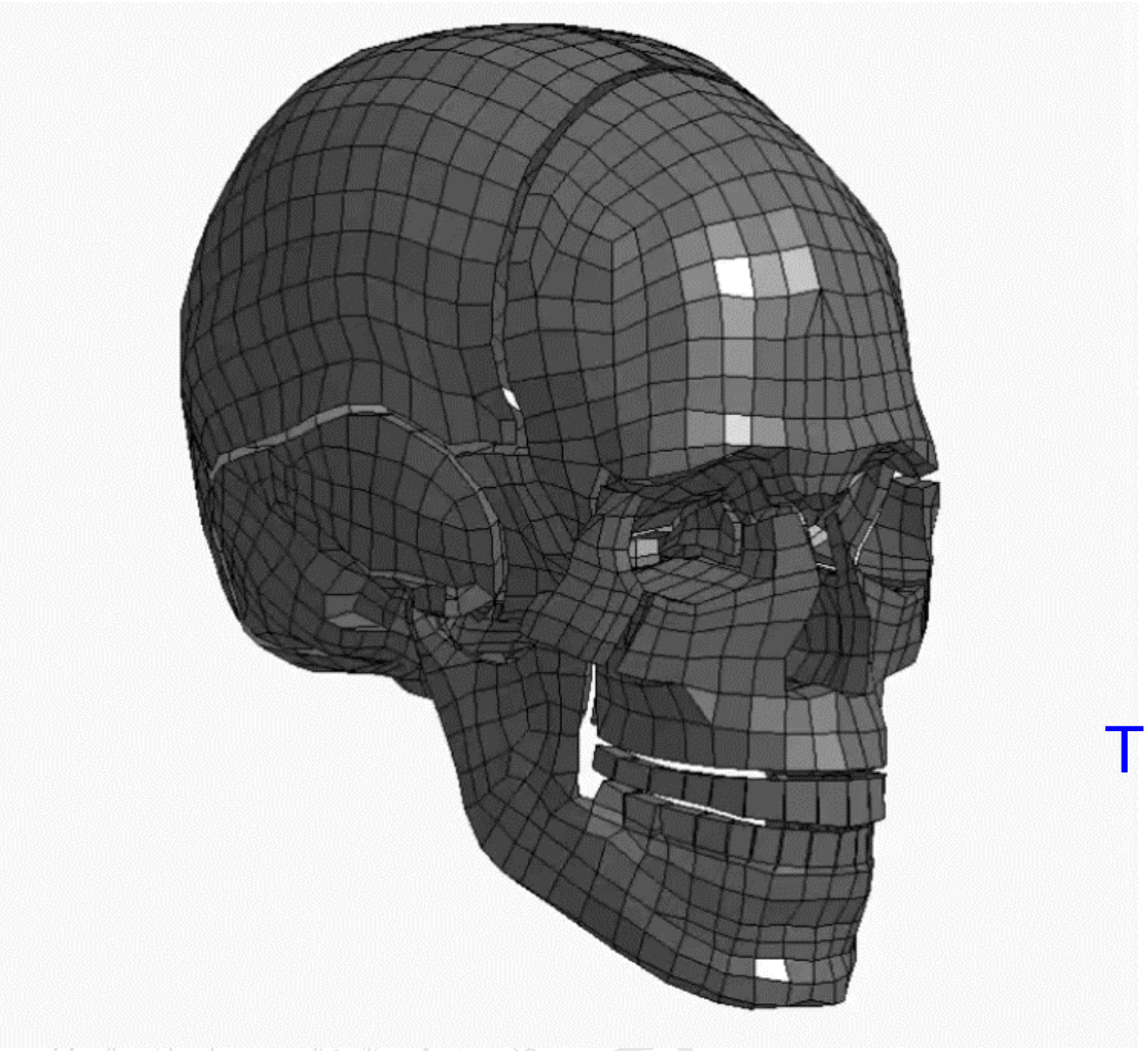
- S. Farajzadeh Khosroshahi, U. Galvanetto, M. Ghajari, 'Optimization of the Chin Bar of a Composite-Shell Helmet to Mitigate the Upper Neck Force', Applied Composite Materials, November 2016.
- M. Nasim, M. Brasca, S.F. Khosroshahi, U. Galvanetto, "Understanding the impact properties of polymeric sandwich structures used for motorcyclists' back protectors", Polymer Testing, 2017.
- S. Farajzadeh Khosroshahi, M. Ghajari, U. Galvanetto, "Assessment of a protective neck brace for motorcycle riders: A finite element study", [Manuscript].
- S. Farajzadeh Khosroshahi, S. Tsampas, U. Galvanetto, "Feasibility study of using a hierarchical lattice struructure as the helmet liner", [Manuscript].
- S. Farajzadeh Khosroshahi, R. Olsson, U. Galvanetto, "Biaxial behavior of EPS foams", [under preparation].

Conference presentations and proceedings:

- 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.
- 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.
- S. Farajzadeh Khosroshahi, M. Ghajari, U. Galvanetto, "Assessment of Motorcycle Helmet's Chin Bar Design Criteria with Respect to Basilar Skull Fracture Using FEM", LS-Dyna European Users Conference, Wurzburg, Germany, June 2015.

Others:

- S. Farajzadeh Khosroshahi, U. Galvanetto, "New Energy Dissipative Materials", Deliverable no. D.3.3, MOTORIST EU, 2016.
- S. Farajzadeh Khosroshahi, U. Galvanetto, "Use of new dissipative materials in PPE", Deliverable no. D.3.4, MOTORIST EU, 2017.



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