Improvement of the frontal thorax airbag test procedure for assessing the protection of motorcyclists in a more realistic impact scenario

IMPROVEMENT OF THE FRONTAL THORAX AIRBAG TEST PROCEDURE FOR ASSESSING THE PROTECTION OF MOTORCYCLISTS IN A MORE REALISTIC IMPACT SCENARIO

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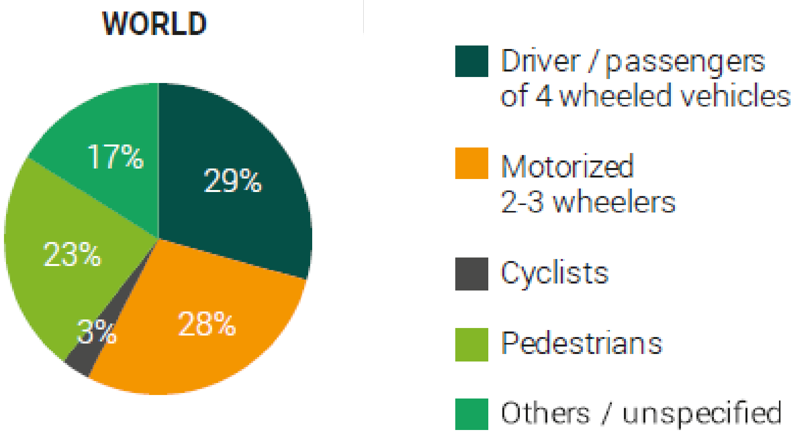
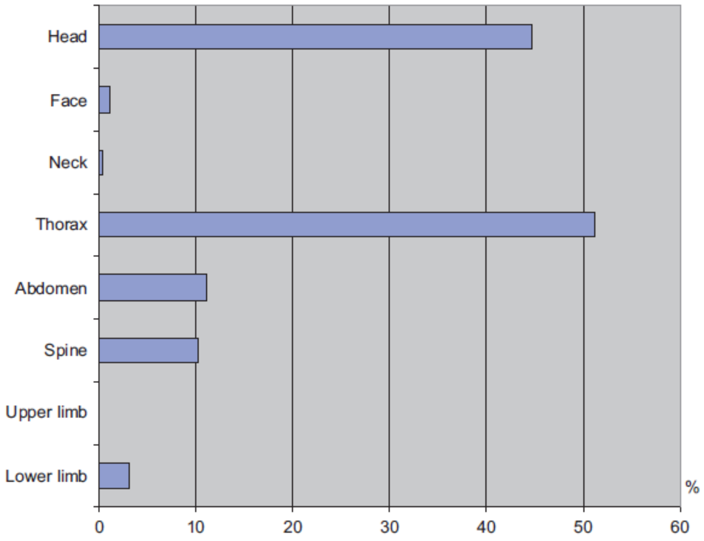
Introduction

- Powered Two-Whelers are one of the most dangerous mode of transportation. Higher risk of fatal accident (Bauer et al. 2014)
- Motorcyclists and moped users account 28% of all world traffic accidents. (WHO,2018). 17 % in the European Union (ERSO, 2018).
- Germany: 619 riders dead and 10220 PTW severe injured in 2018 (DESTATIS, 2018).



Introduction

- Low extremities the most frequently injured. Thorax and head, the most severely body regions injured (MOSAFIN, 2012).
- Thorax is the forth most frequent body region injured but the one with the highest rate of MAIS 3+ injures (more than 50%) (MAIDS, 2008).
- More than 50% of potential fatal injuries (AIS 4+) located in the thorax (Serre et al. 2012).



Introduction

- Personal Protective Equipment (PPE)
  - Cushion pad: non-inflatable protector
  - Airbag: inflatable protector

www.dainese.com

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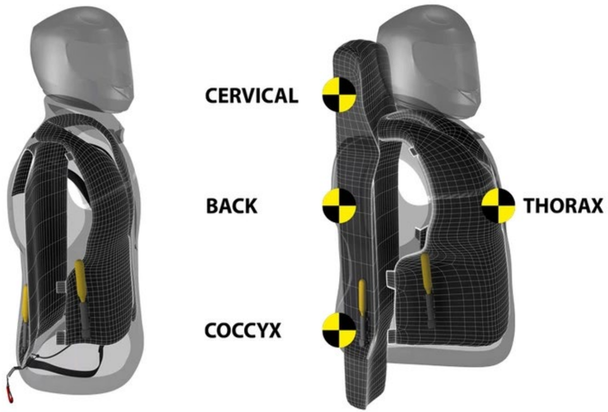
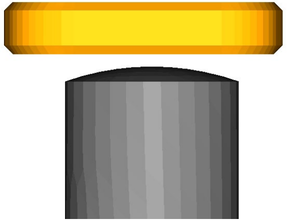


www.motoairbag.de

INTRODUCTION

EN1621-4:2012

- Protection of an inflatable device trigged mechanically.
  - Impact force attenuation.
  - Intervention time: activation time + inflation time.
  - Duration of the inflated status.



5 kg striker

4.5 m/s

Steel anvil

$$t_a = d + \frac{l_m - l_i}{s} \times 1000\,;$$

	Level 1	Level 2
Overall Mean value	≤ 4,5 kN	≤ 2,5 kN
Single strike	≤ 6 kN	≤ 3 kN

INTRODUCTION

EN1621-4:2012

- Low biofidelity.
- Low correspondency with realitiy: 50 J impact energy level considerably less than realistic accident impact energy (Ballester et al. 2019, Wei et al. 2020).
- Unknown origin of the impact thresholds.
- Limitations to distinguish the optimal thickness/pressure combination (Aranda et al. 2020).
- Autonomous-triggering devices not considered.

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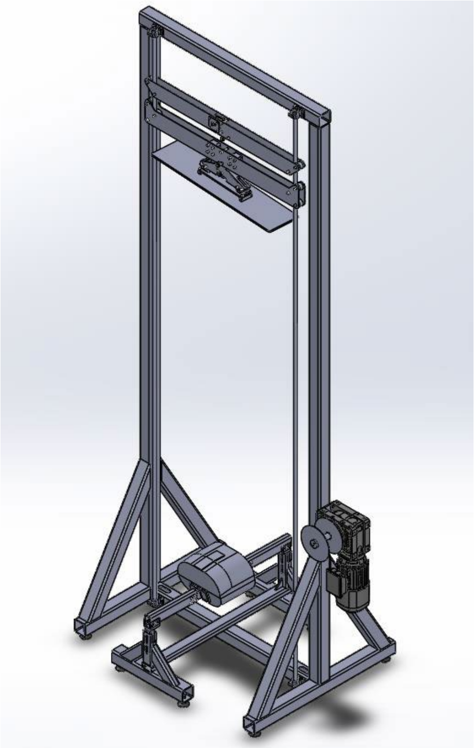
TEST METHOD 1

- Robust
- Simple
- Repeatable
- More biofidelic
- More realistic

→

- Drop-Tower
- Guided Free-Fall
- Striker: modular mass
- Human surrogate
- Airbag inflated



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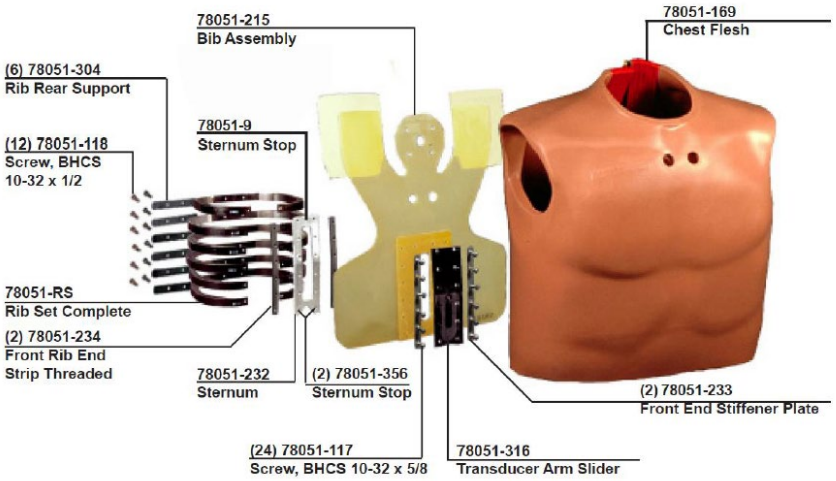
TEST METHOD 1

- Human Surrogate: Torso of the 50th percentile Hybrid III Dummy



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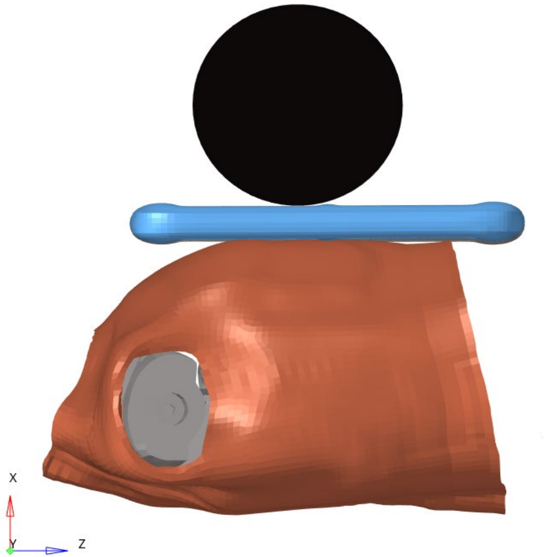


TEST METHOD 1 – Impact Conditions from Accident Data

1) **Condition A**
   Velocity: 3 m/s
   Rigid plane
   Moving mass ≈ 75 kg (50th percentile male)

→ Covers 75% cases reported by UGE, in accordance with LMU study

2) **Condition B**
   Velocity: 7 m/s
   Rigid cylinder radius 5 to 10 cm.
   Moving mass ≈ 75 kg (50th percentile male)

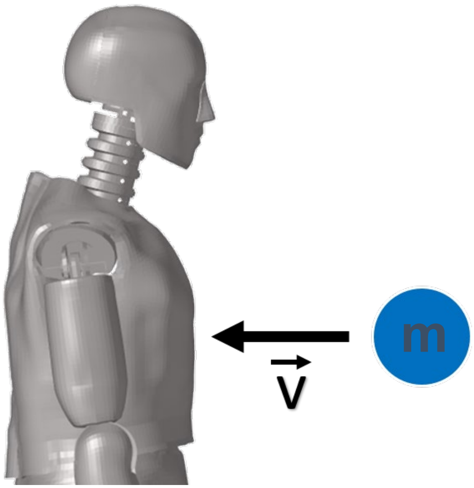
→ Covers 75% of rider to car impacts by UGE.
→ Major cluster in LMU severe/fatal cases

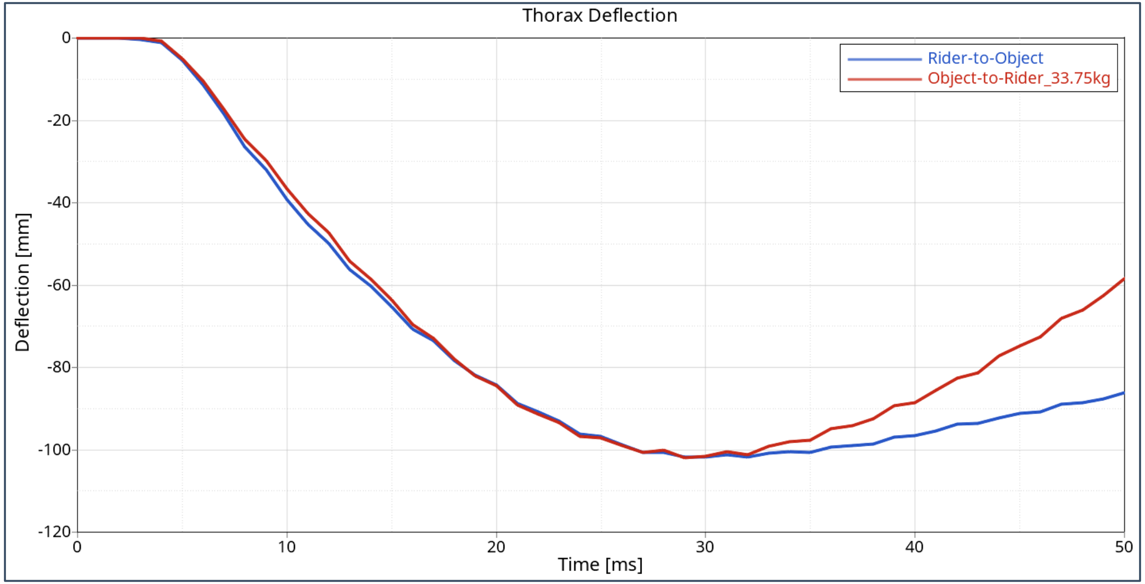
3) **Long term update (not now)**
   Velocity: between 13 and 17 m/s
   Rigid impactor between 5 and 25 cm radius
   Moving mass ≈ 75 kg (50th percentile male)

→ Important cluster in LMU severe/fatal cases

TEST METHOD 1 – Equivalent Mass

- More realistic
  Rider-to-object vs Object-to-rider → mass of the striker?





TEST METHOD – Test impact conditions: adaptation

- Thorax deflection for equivalent mass at 7 m/s: 102 mm.
- Limit of Hybrid III dummy torso without breaking it: 60 to 70 mm.

Impact conditions	Deflection (mm)
35 kg, 4 m/s	64
35 kg, 3.5 m/s	56,7
10 kg, 7 m/s	56
15 kg, 7 m/s	67,3

TEST METHOD 1 - Performance

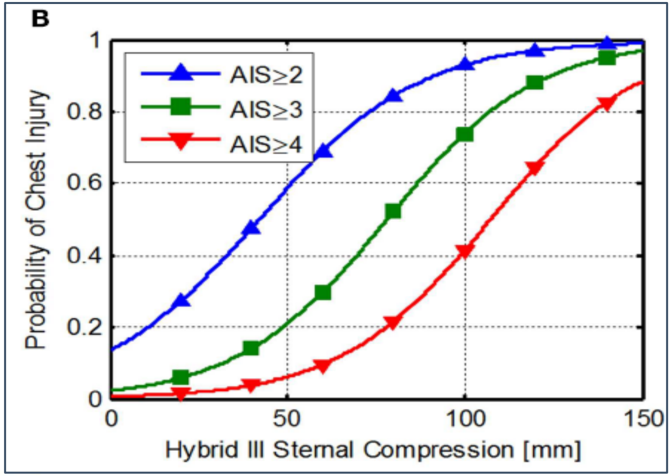
- Protection performance according to biomechanical parameter and criteria.
  - Compression Criteria
    - Based on Kroell et al. 1972, 1974.
    - Thorax deflection.
    - Skeletal Injuries.
  - Viscous Criteria
    - Based on Viano et al. 1988.
    - Viscous response
    - Soft tissue injuries

$$AIS = -3{,}78 + 19{,}56C$$

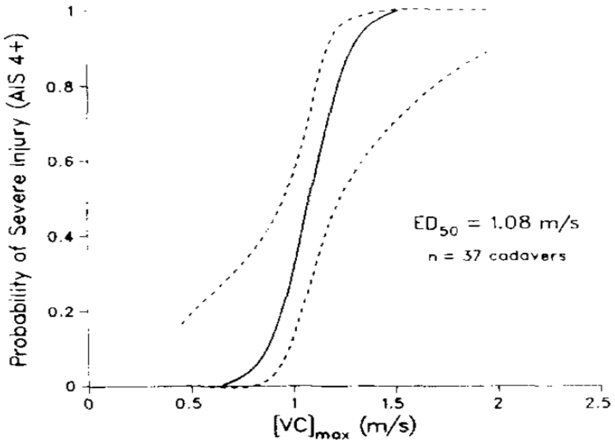
$$VC = V(t) \times C(t) = \frac{d[D(t)]}{dt} \times \frac{D(t)}{b}$$

TEST METHOD 1 - Performance

- Protection performance based on according to biomechanical parameter and criteria.
  - Compression Criteria



  - Viscous Criteria $VCext = 1.3 \times VCint$



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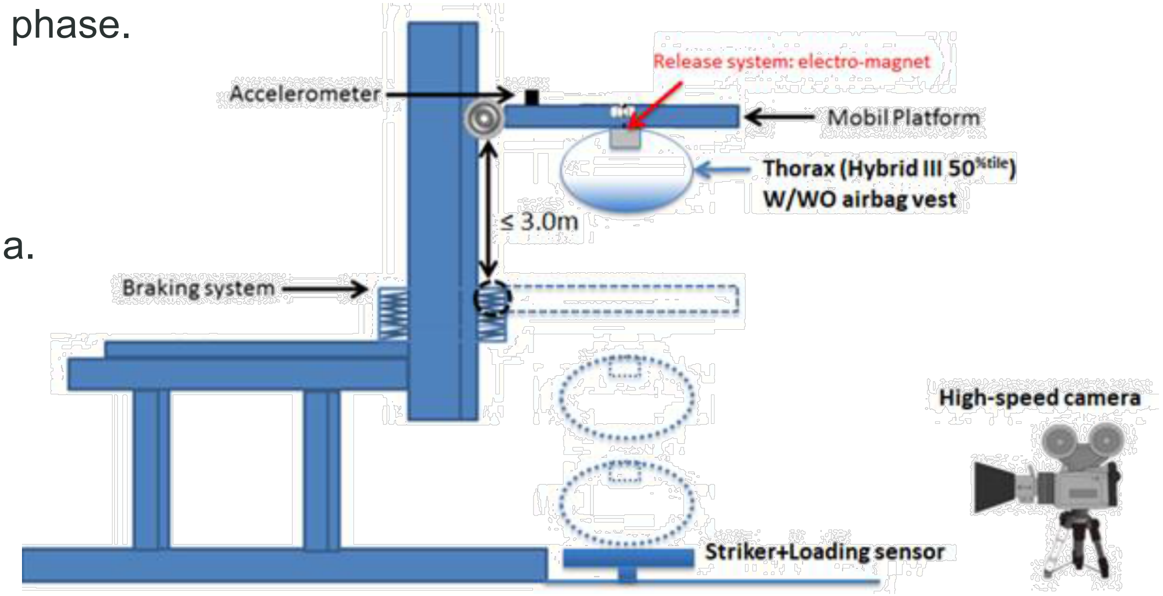
TEST METHOD 2

- Evaluation of airbag protection performance including inflation phase.
- Mechanical and electronical activation.
- Rider-to-object configuration.
- Based on biomechanical criteria.



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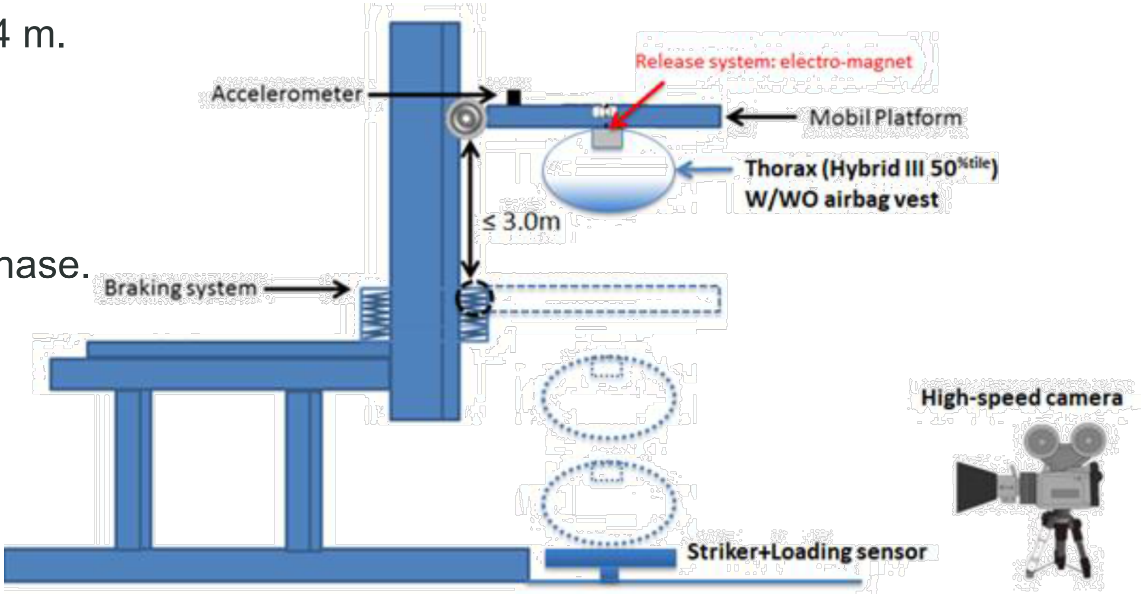
TEST METHOD 2

- Drop-Tower System.
- Different height positions up to 4 m.
- Hybrid III Dummy torso.
    - Thorax deflection.
    - Viscous response
- High-speed Camera: Inflation phase.
- Flat striker (21.5x27.5x1.5 cm)
- Load cell



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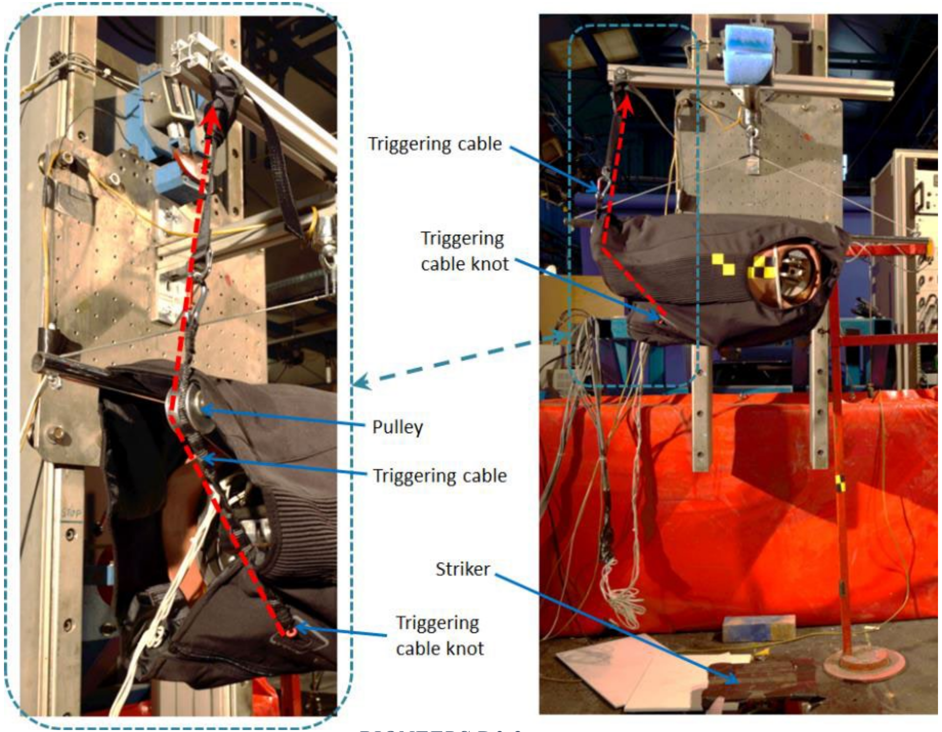
TEST METHOD 2

- More realistic (rider-to-object configuration) but also more complex.
- The mass of Hybrid III dummy torso around 19 kg might not be close to the mass involved in a real accident.



PIONEERS D3.2

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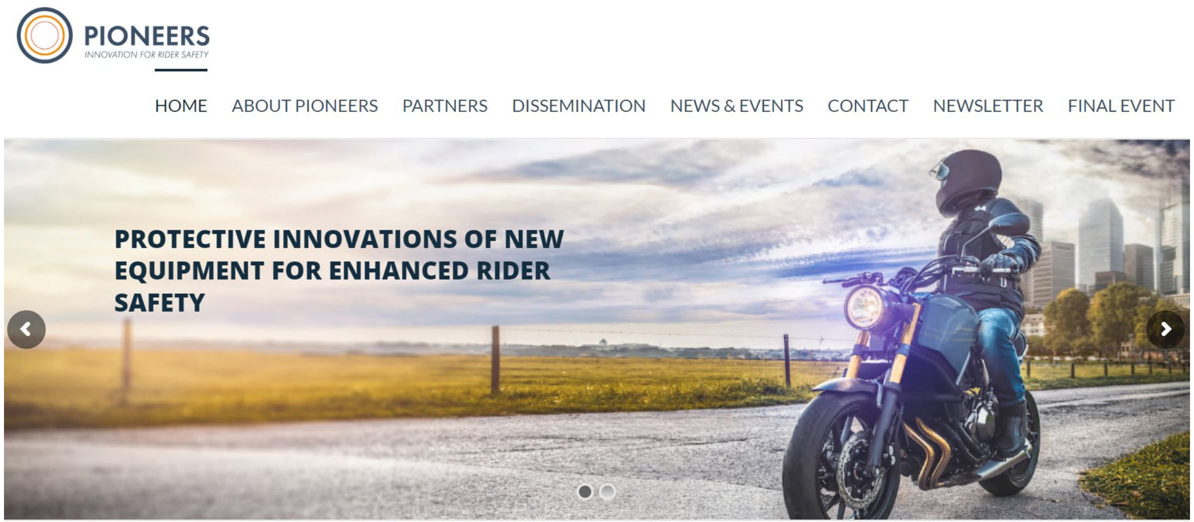
SUMMARY AND CONCLUSION

- The doubts emerged about the current standard procedure together with its limitations motivated the research of a new test procedure for the performace evaluation of thorax airbags.
- PIONEERS proposed two approaches. Performance evaluation based on biomechanical criteria and parameters.
    - Complement to EN1621-4 to improved evaluation of protection perfomance in a short/midterm.
    - Procedure to evaluate inflatable devices in a long-term able to combine the evaluation of the protection perfomance of a real impact scenario with the assessment of the inflation phase.

PIONEERS - Protective Innovations of New Equipment for Enhanced Rider Safety



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Applus+ IDIADA, alpinestars, bast, BOSCH Invented for life, DAINESE, DUCATI, LMU Ludwig-Maximilians-Universität München, MOTOAIRBAG, NeuRA Discover. Conquer. Cure., PIAGGIO GROUP, RACC, REV'IT!, Technische Universität Darmstadt, Università degli Studi Firenze, Université Gustave Eiffel, Université de Strasbourg

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Thank you four your attention

Questions?

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