CEN/TC 158 Working Group 11

- Status report Nov 2017 (2012)
- New head form made of PU

Peter Halldin, Convenor CEN/TC 158/WG11

WG 11 members at last meeting

Peter Halldin, Convener	KTH, MIPS, Sweden
Björn Nilsson, Secretary	SIS, Sweden
Roy Burek	Charles Owen, UK
Alessandro Cernicchi	AGV, Italy
Jan Ivens	KUL, Belgium
Remy Willinger	UNISTRA, France
Robert Pilz	SCOTT, Switzerland
Wolfram Hell	Germany
Mike Aschmead	Cellbond, UK
Peter Frener	Germany
Pascal Bour	France
Guido De Bruyne	Lazer Sports, Belgium

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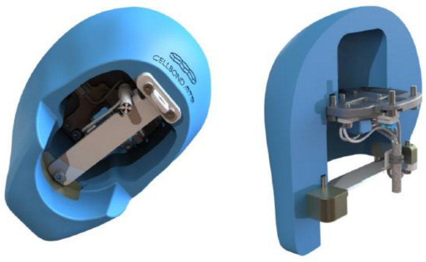
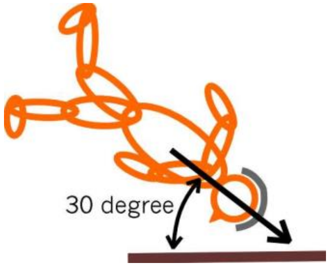
Outline

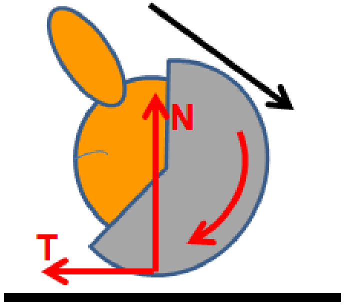
- Status report - PrEN13087-11
  Shock absorption including measuring rotational effects oblique or normal to the surface
- Specification of a new head form
- Test results from version One of the new head form
- Conclusion and next step



Objectives

- Define a method to measure rotational energy absorption in tangential impacts in <u>short duration impact situations</u> (5-10ms).
  - The test must be *simple, robust and cost effective*.
  - The first version of the test method is designed for *bike* and *equestrian* helmets.
  - Impact conditions based on *real accident* data

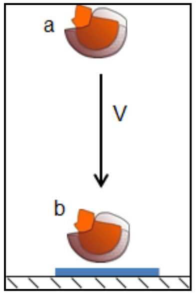




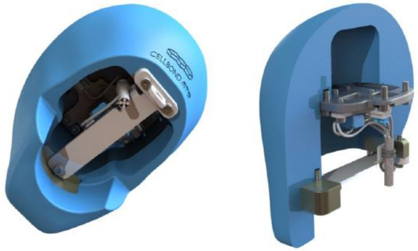
Proposal from CEN TC158-WG11

- Shock absorption test method A – Keep pure vertical drop against flat anvil or curbstone (EN1078, EN1384, EN1077) but add measurement of angular kinematics.

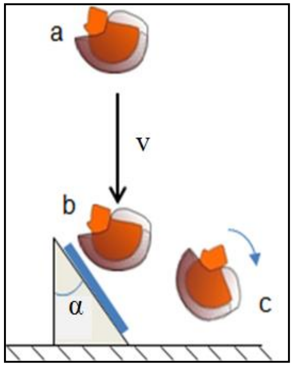
A



- Shock absorption test method B – Vertical drop towards an 45degree impact angle.
  - No neck (free falling head)
  - <u>Modified</u> EN960 head form
    - Size A, C, E, J, M, O
  - Head instrumentation: 9-acc-array or ARS
  - Impact surface: Rough grinding paper



B



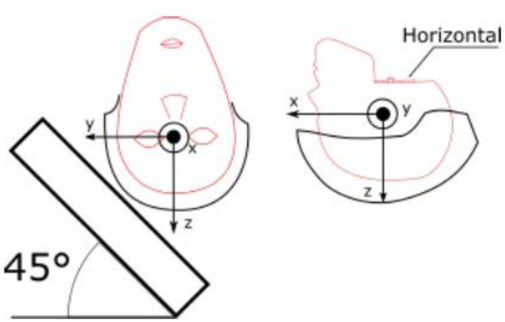
Proposal from CEN TC158-WG11

Impact directions

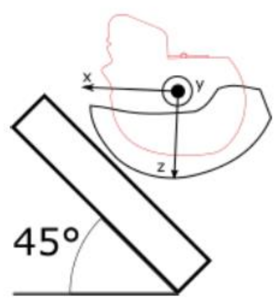
X-Rotation

Y-Rotation

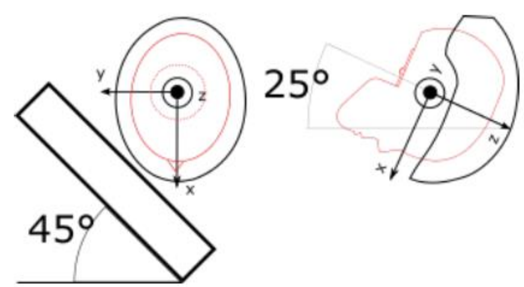
Z-Rotation



XRot

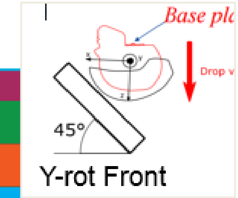


YRot

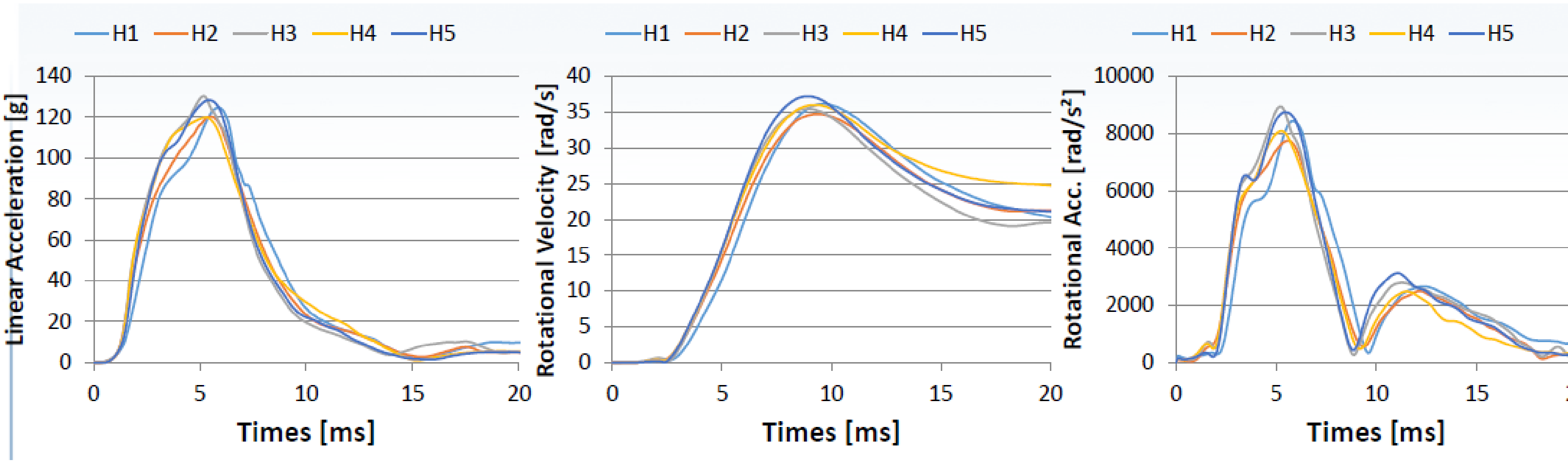


ZRot

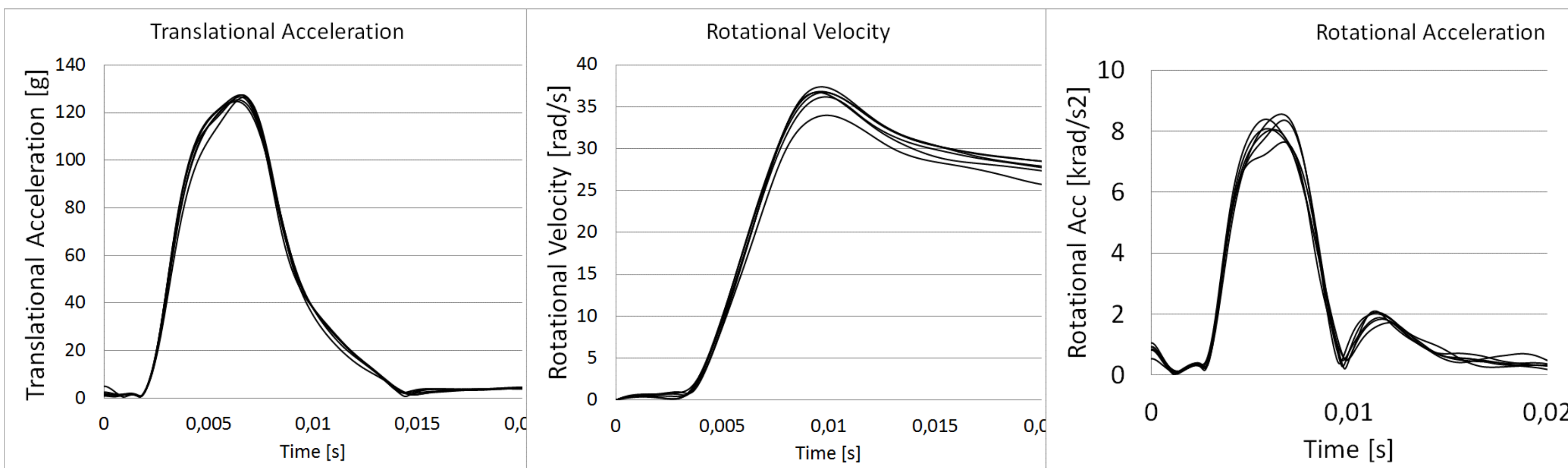
RR1 Yrot – UNISTRA & KTH



UNISTRA



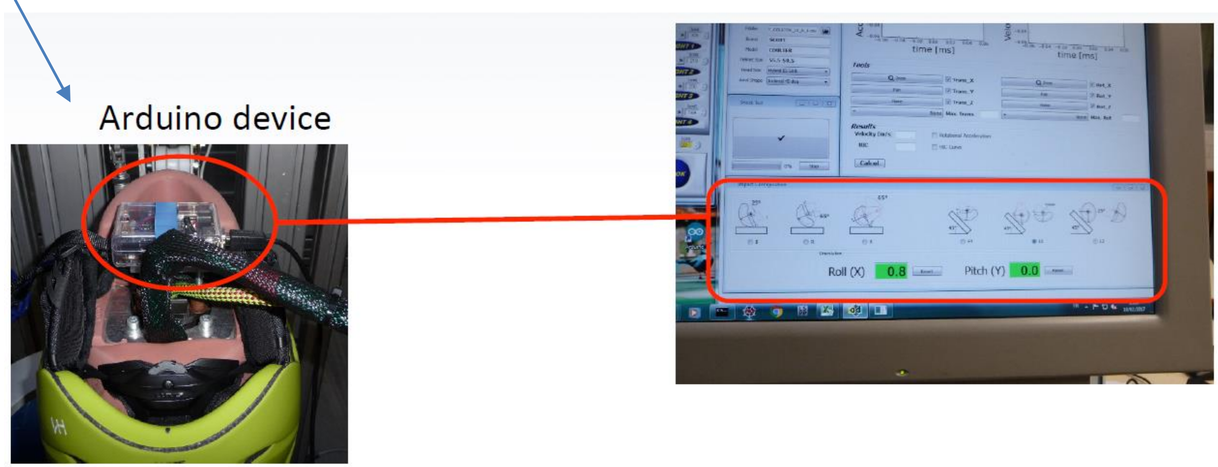
KTH



Controling the Spread

- Initial head position
- Fixation during vertical drop

Gyro



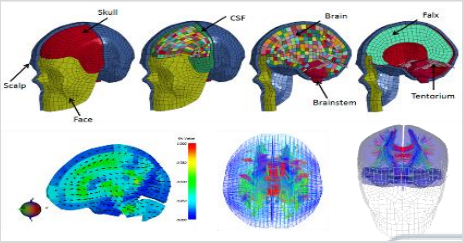
Proposal from CEN TC158-WG11

- A pass/fail criteria shall include all 6DOF accelerations over time (duration) into account. A Pass/Fail criteria shall therefore be either:
  - A: 6DOF (3 linear and 3 rotational) accelerations based pass fail criteria (HIP, HIC+BrIC or similar)
  - B: An injury risk assessment tool based on the computed strain from an FE head model
  - WG11 will give a recommendation for the both alternatives A and B in EN13087-11

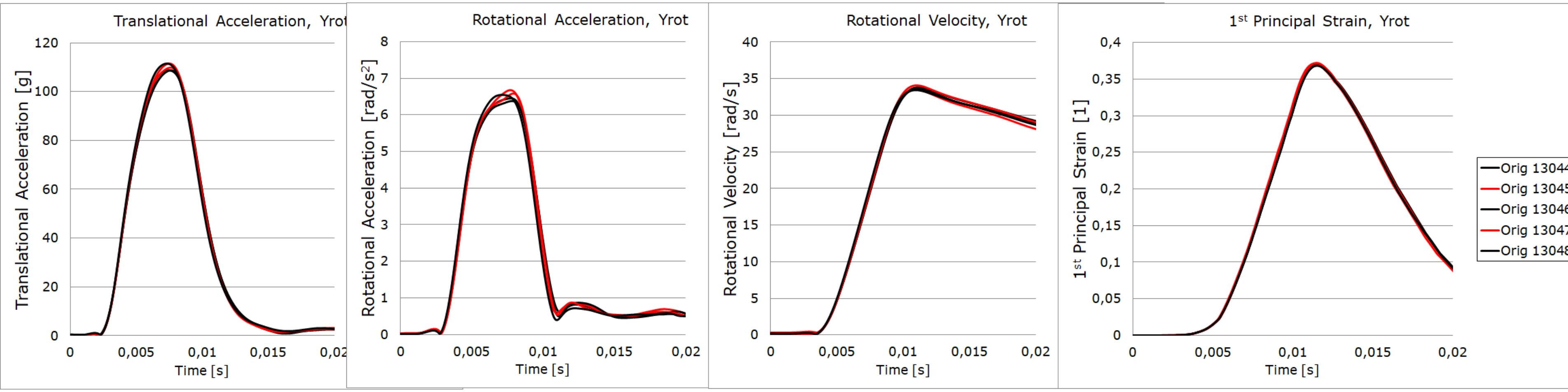
A

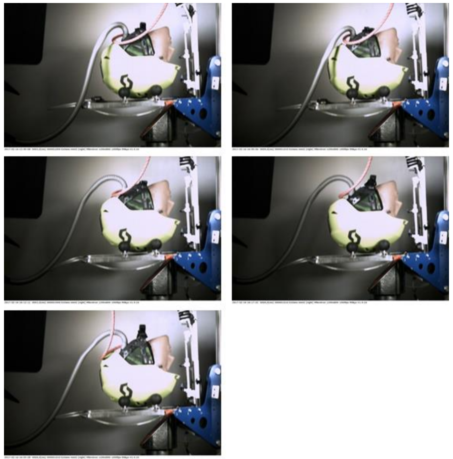
$$BrIC = \sqrt{\left(\frac{\omega_x}{\omega_{xC}}\right)^2 + \left(\frac{\omega_y}{\omega_{yC}}\right)^2 + \left(\frac{\omega_z}{\omega_{zC}}\right)^2}$$

B

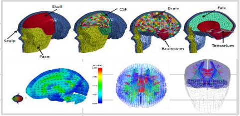


Example of test results from Round Robin test - Yrot impact direction





Impact	Name	Resultant Translational Acceleration [g]	Resultant Rotational Acceleration [krad/s^2]	Resultant Rotational Velocity [rad/s]	BRIC	MPS KTH	MAS KTH	MAS UNISTRA
Yrot	Orig 13044	111,5	6,7	33,5	0,62	0,37		
Yrot	Orig 13045	108,7	6,5	33,9	0,63	0,37		
Yrot	Orig 13046	109,8	6,6	34,1	0,63	0,37		
Yrot	Orig 13047	108,7	6,4	33,7	0,62	0,37		
Yrot	Orig 13048	111,4	6,5	33,4	0,62	0,37		
Mean		110,03	6,53	33,70	0,63	0,37	0,19	0,16
Standard Deviation		1,24	0,10	0,24	0,00	0,00	0,00	0,00
Spread (2*STD/Mean)		**2%**	**3%**	**1%**	**1%**	**1%**	**4%**	**4%**
Risk for Concussion					73%	80%	95%	85%



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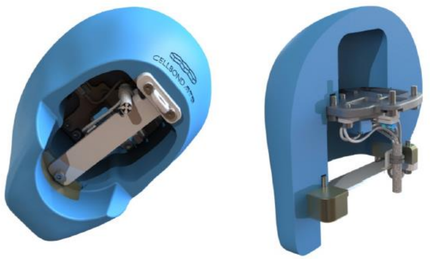

Specification of new head form for oblique impact testing

1. Mass: similar to EN960 head forms (20% increase compared to antropometric data)
2. Moment of Inertia (Ixx, Iyy, Izz): close to antropometric data from 42 human cadaver heads*. More will be added.

HEADFORM	HEAD CIRCUM (CM)	MASS* (KG)	MASS scaled 20% (KG)	Mass according to EN960	Ixx* (kgcm2)	Iyy* (kgcm2)	Izz* (kgcm2)
A	49,5	2,1	2,5	3,1	31	59	69
C	51,5	2,5	3,0	3,6	65	92	90
E	53,5	3,0	3,6	4,1	99	124	111
J	57,5	3,9	4,7	4,7	168	190	153
M	60,5	4,6	5,5	5,6	220	239	184
O	62,5	5,1	6,1	6,1	254	272	205

*Antropometric data from review by Thomas Connor, University College Dublin (CEN TC158 WG11- Document N228). The numbers in above Table is based on 42 cadaver heads (*Yoganandan et al. 2009, Chandler et al. 1975, Plaga et al. 2005, Beier et al. 1980*) and might be tuned if more data is found.

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3. Shape: similar to EN960 J head form. A, C, E, M and O might need minor changes.

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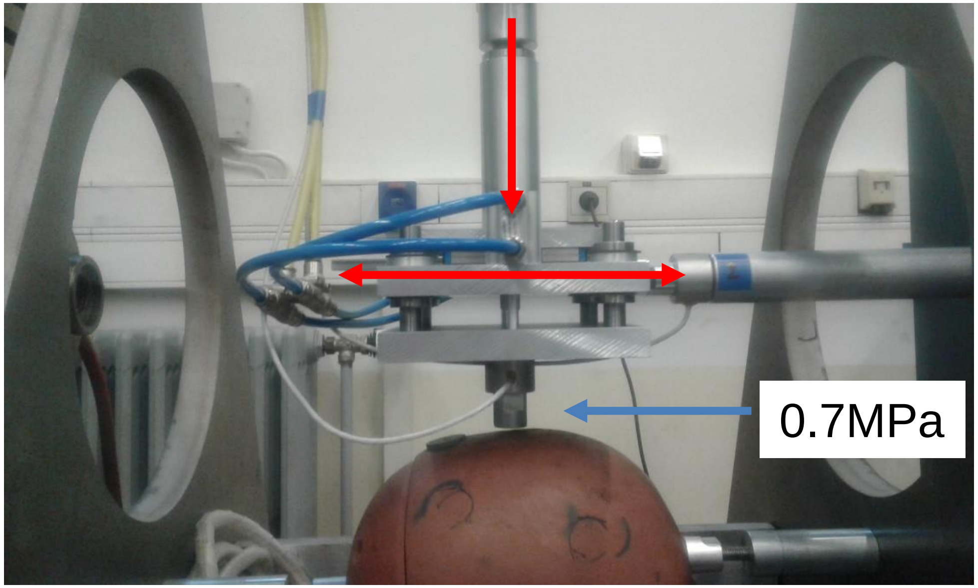
4. Coefficient of friction between helmet and head form:

Coefficient of friction measurements @University of Leuven



Comparing HIII, EN960 v.s. cadaver heads

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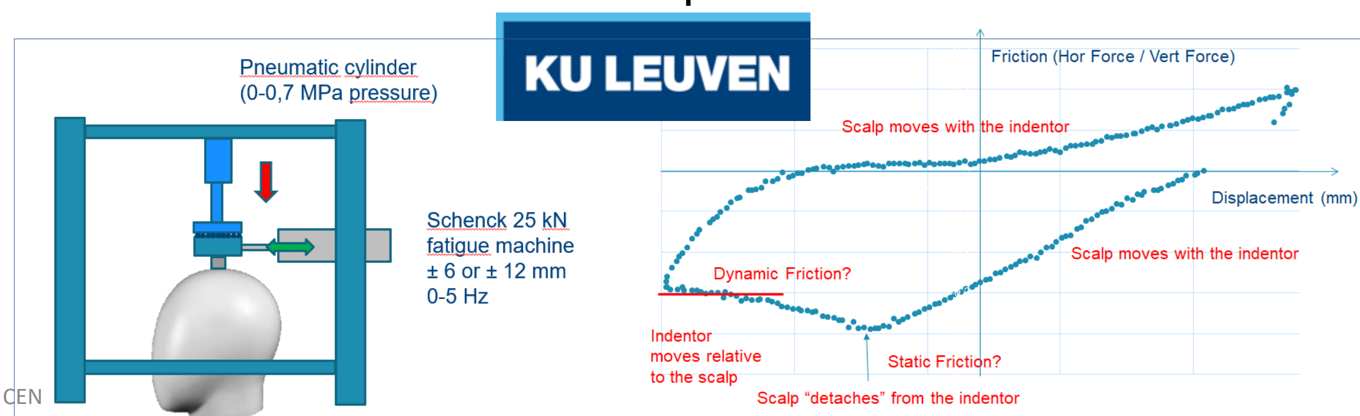
3. Shape: similar to EN960 J head form. A, C, E, M and O might need minor changes.
4. Coefficient of friction between helmet and head form: 0.3 (Based on Coefficient of friction experiments at KU Leuven 2017)



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4. Coefficient of friction between helmet and head form: 0.3 (Based on Coefficient of friction experiments at KU Leuven 2017)

- **None of the existing head forms (EN960 or HIII) meet the requirements (1-4 above).**
- **Therefore is a new head form developed within WG11.**

The new head form

- A new head form is developed within WG11 that meets requirements 1-4.
- The Head form will be made by Polyurethane and metal inserts. A first version of the size J is available*. CAD files will be available.
- Head form will be designed to carry different Instrumentation
  - 9-accelerometer-array or
  - 3 LINACC + 3 ARC or
  - Onboard system

*CEN-TC158 WG11_N0246_Size_J_Polyurethane_Headform_Cellbond_A

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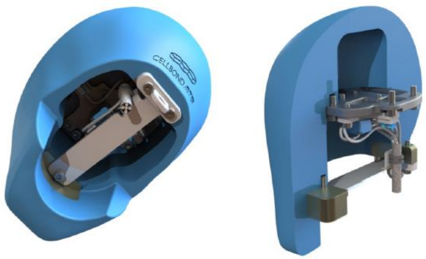
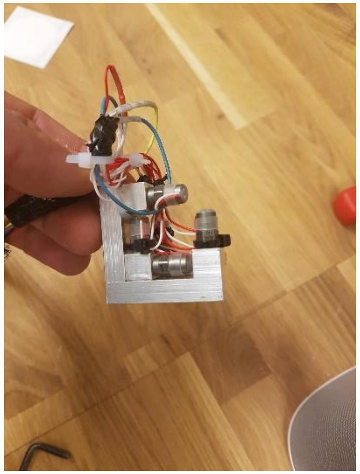
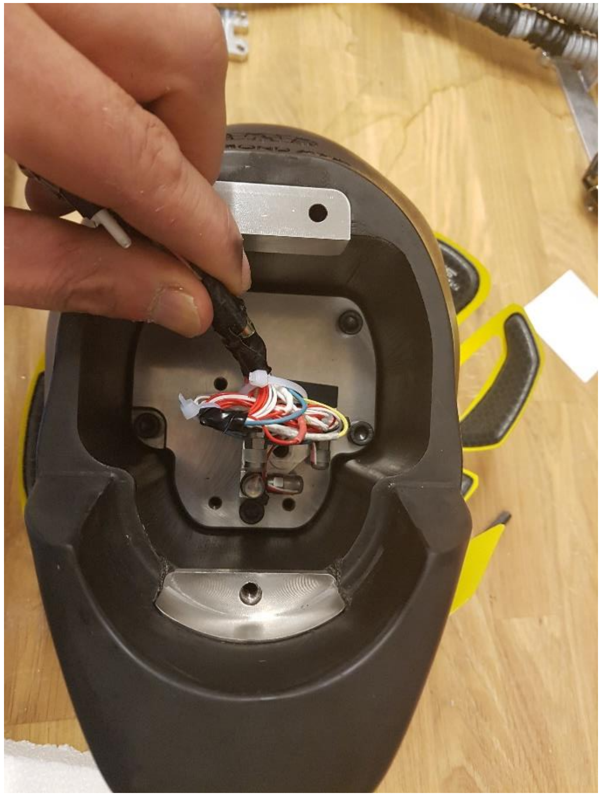


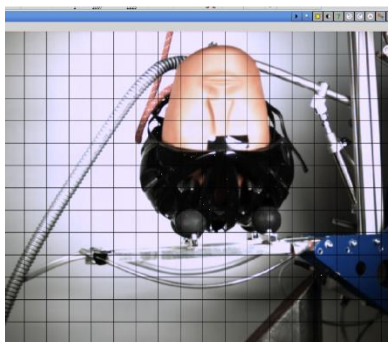
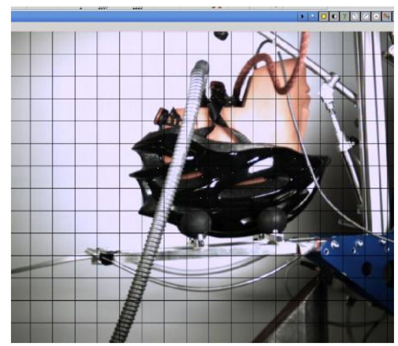
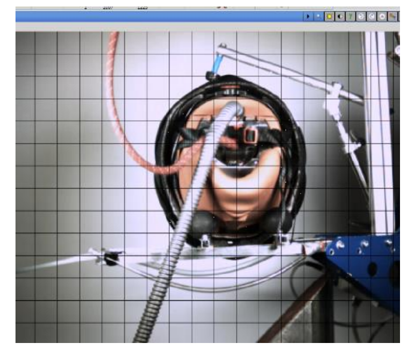
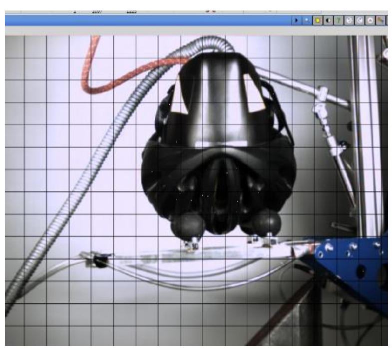
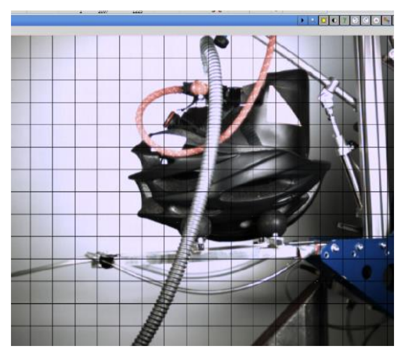
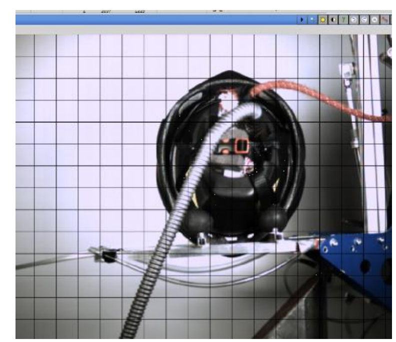
CB-PU head form prototype + 9-accelerometer-array





Control of head form position in helmet.

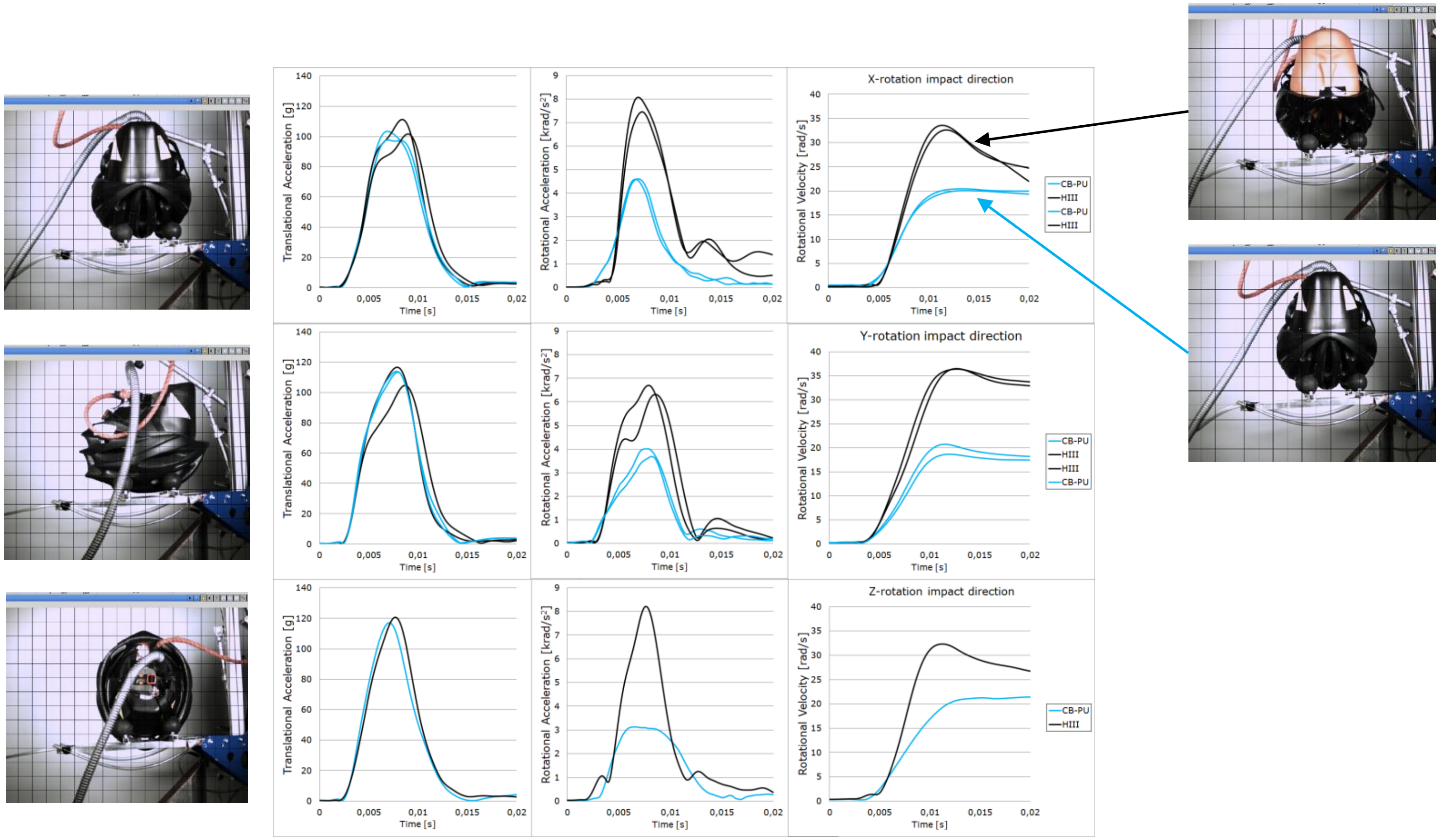
Pictures of the different impact locations

	Xrot	Yrot	Zrot
HIII head form			
Cellbond PU			

Movies from the different impact locations

	Xrot	Yrot	Zrot
HIII head form			
Cellbond PU			

Results comparing the HIII head with the CB-PU head form



Conclusions and comments

The PU head form results in significantly lower rotational kinematics

The significant difference is due to the difference in the head/helmet interface. The PU against comfort padding has a coefficient of friction of about 0.12 and 0.75 for the HIII head.

The PU head form was difficult to position in a controlled way due to its low coefficient of friction.

Next step WG11

- Modify the outer surface (5mm thick PU skin as showed in picture below) to increase the coefficient of friction from 0.12 to 0.3 according to experimental study at University of Leuven.

- Add a light weight chin for chin strap attachment
- Add rear neck piece for neck retention system attachment
- Finalize CAD Files for all head form sizes
- Final specification ready 2018 (V1 March, Final October)

Head shape improvements

Any questions could be sent to:

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