



# Legform Tests – Results from Round 1, EEVC legform

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Senior Researcher – 11 September 2013



# Legform tests

## Objectives

### 1

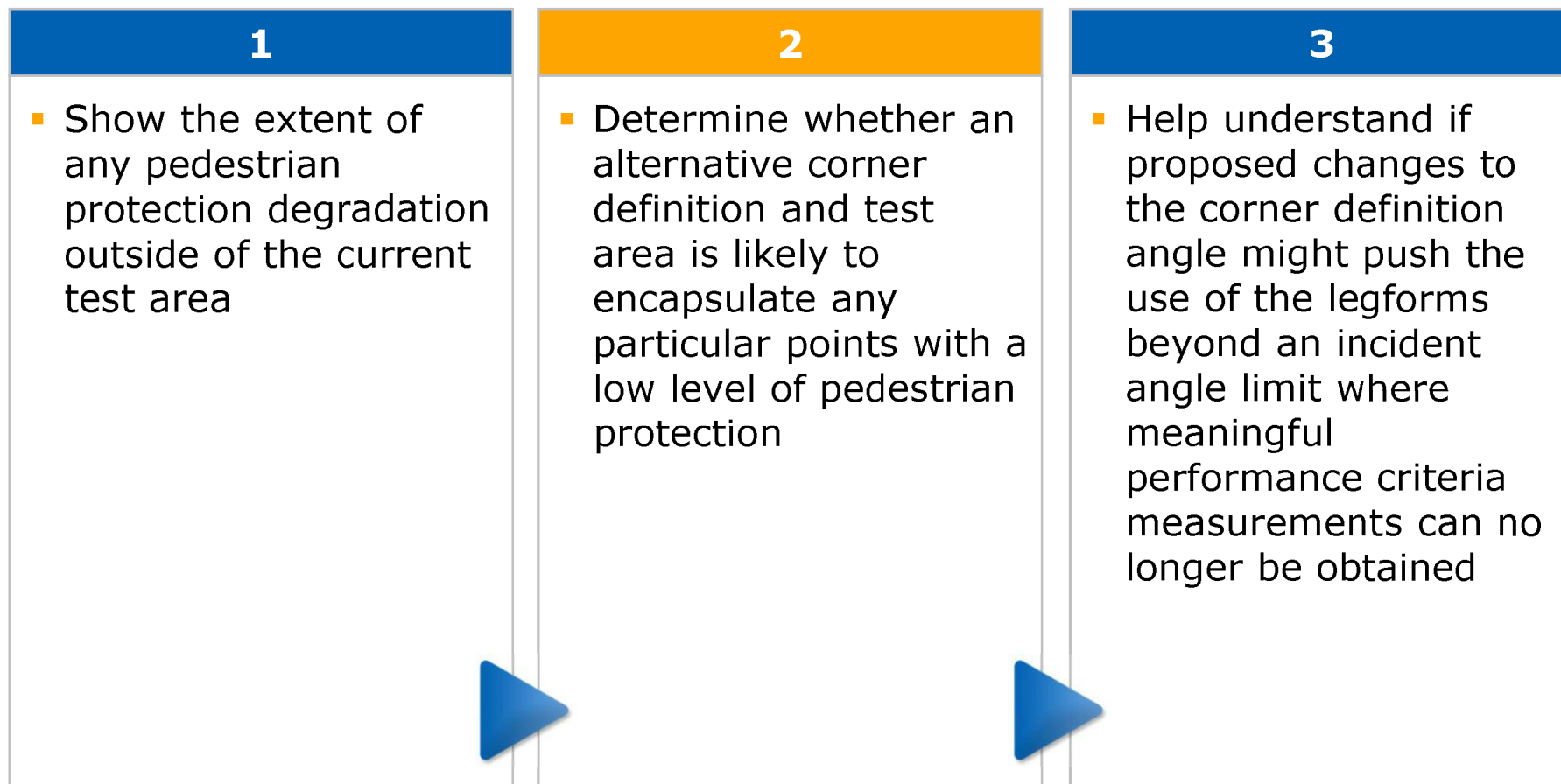
- Assess pedestrian protection levels across vehicle front
  - Could support justification for need to change bumper corner
  - Provide supporting information for the benefit estimate (i.e. predicted risk of injury around bumper corners)

### 2

- Determine practicality of extending bumper test area
  - Does impactor slide off vehicle giving very low values?
  - Does impactor rotate so as to invalidate measurements?

# Legform

## Purpose of tests outside of current bumper corner



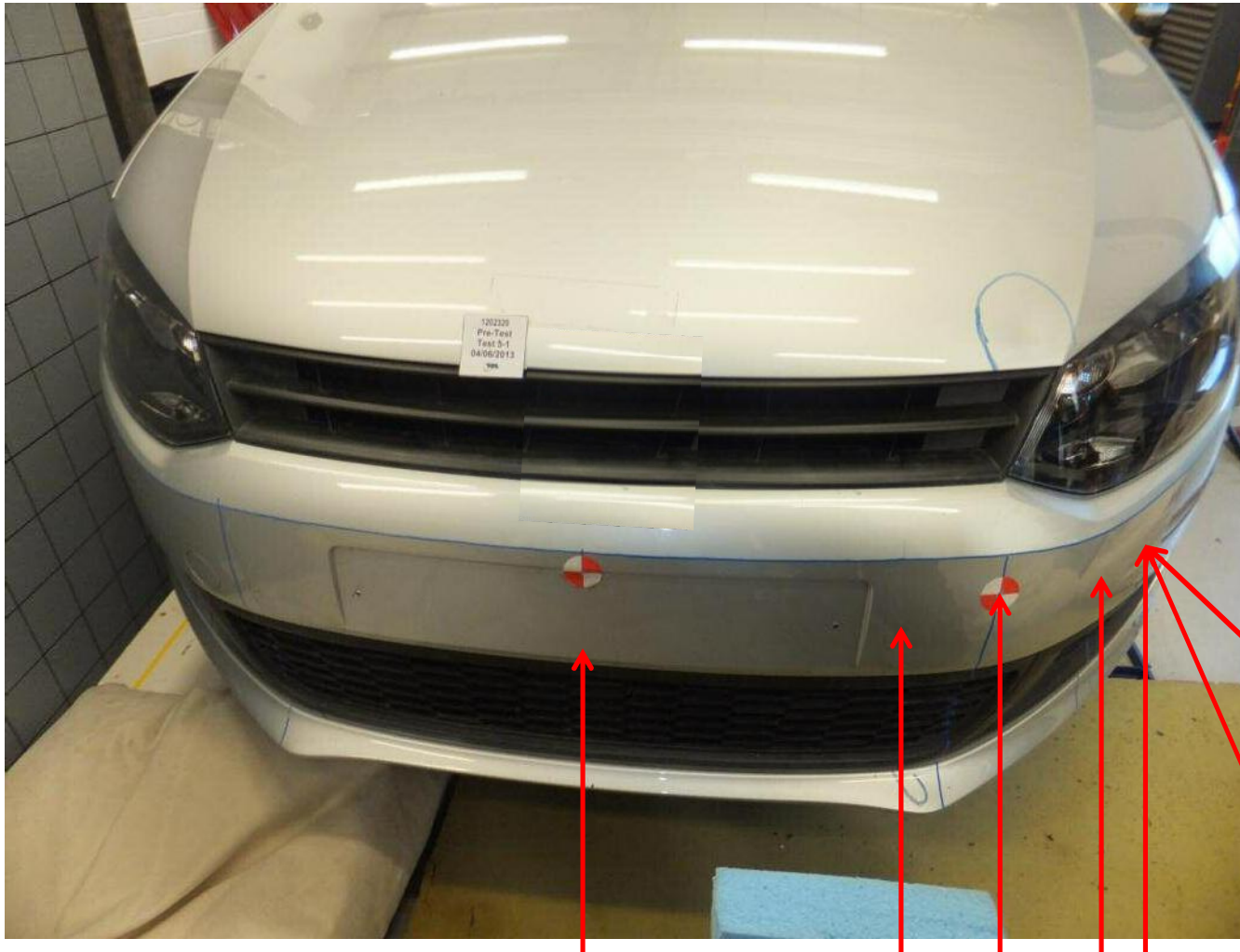
## Legform tests – Round 1 (= EEVC legform)

Described from middle to outside

- 1 Centre of bumper
- 2 60 degree minus legform radius (current test extreme)
- 3 60 degree, no radius allowance (30 degrees incident angle)
- 4 Edge of underlying bumper beam (Euro NCAP extreme)
- 5 45 degrees
- 6 45 degrees car rotated through 15 (30 degrees incident)
- 7 45 degrees car rotated through 30 (15 degrees incident)

# Legform tests – Round 1

## Alignment on Vehicle 1



# Legform tests – Round 1

## Alignment on Vehicle 2



## Legform tests – Round 1

Alignment on Vehicle 3



## Legform tests – Round 1

Need to reduce speed with rotated car

### 45 degree point, 15 degree car

- Keep normal speed consistent with original
- $V = 9.1 \text{ m/s}$

### 45 degree point, 30 degree car

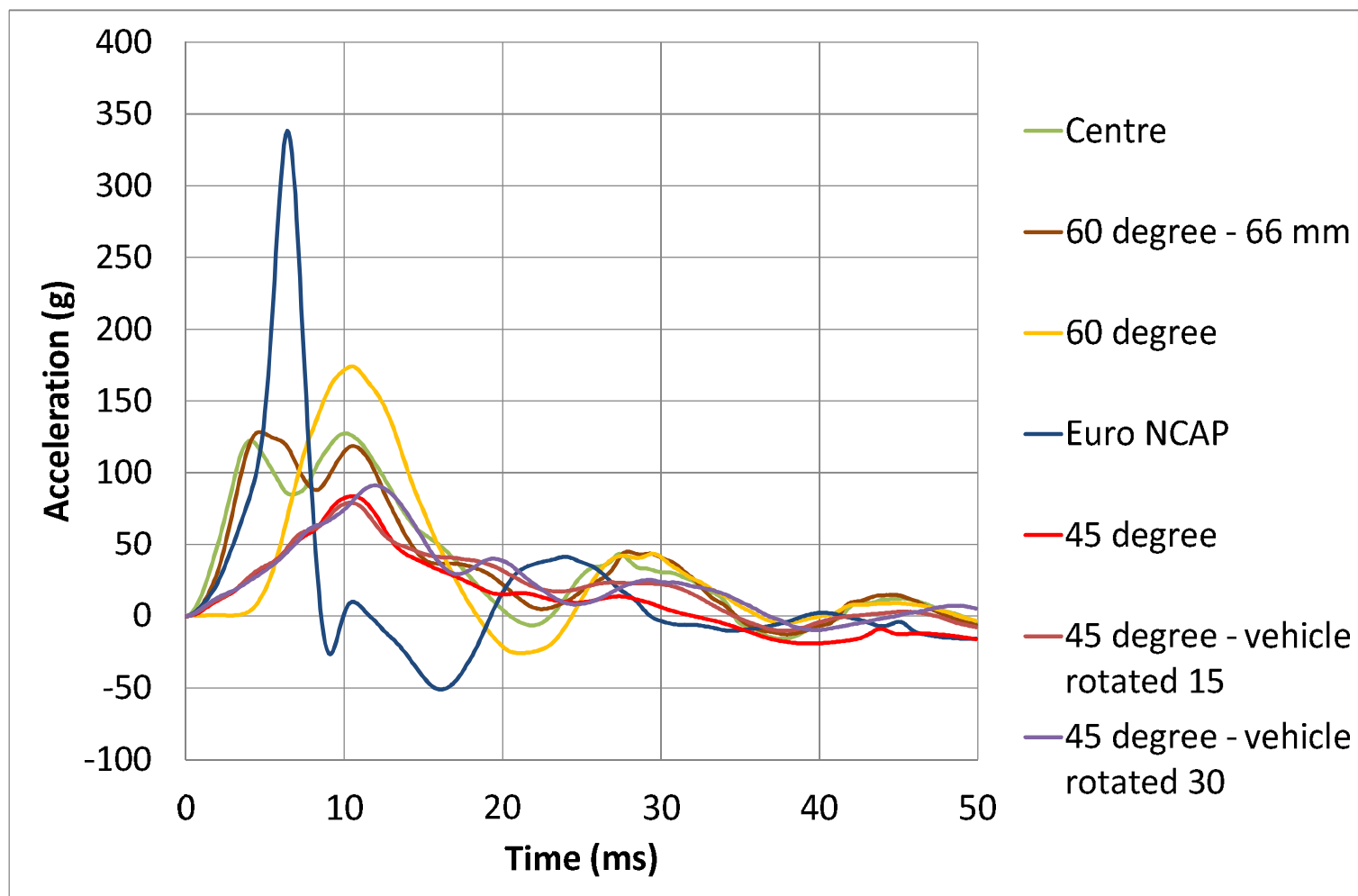
- Keep normal speed consistent with original
- $V = 8.1 \text{ m/s}$

Based on geometry – not empirical data



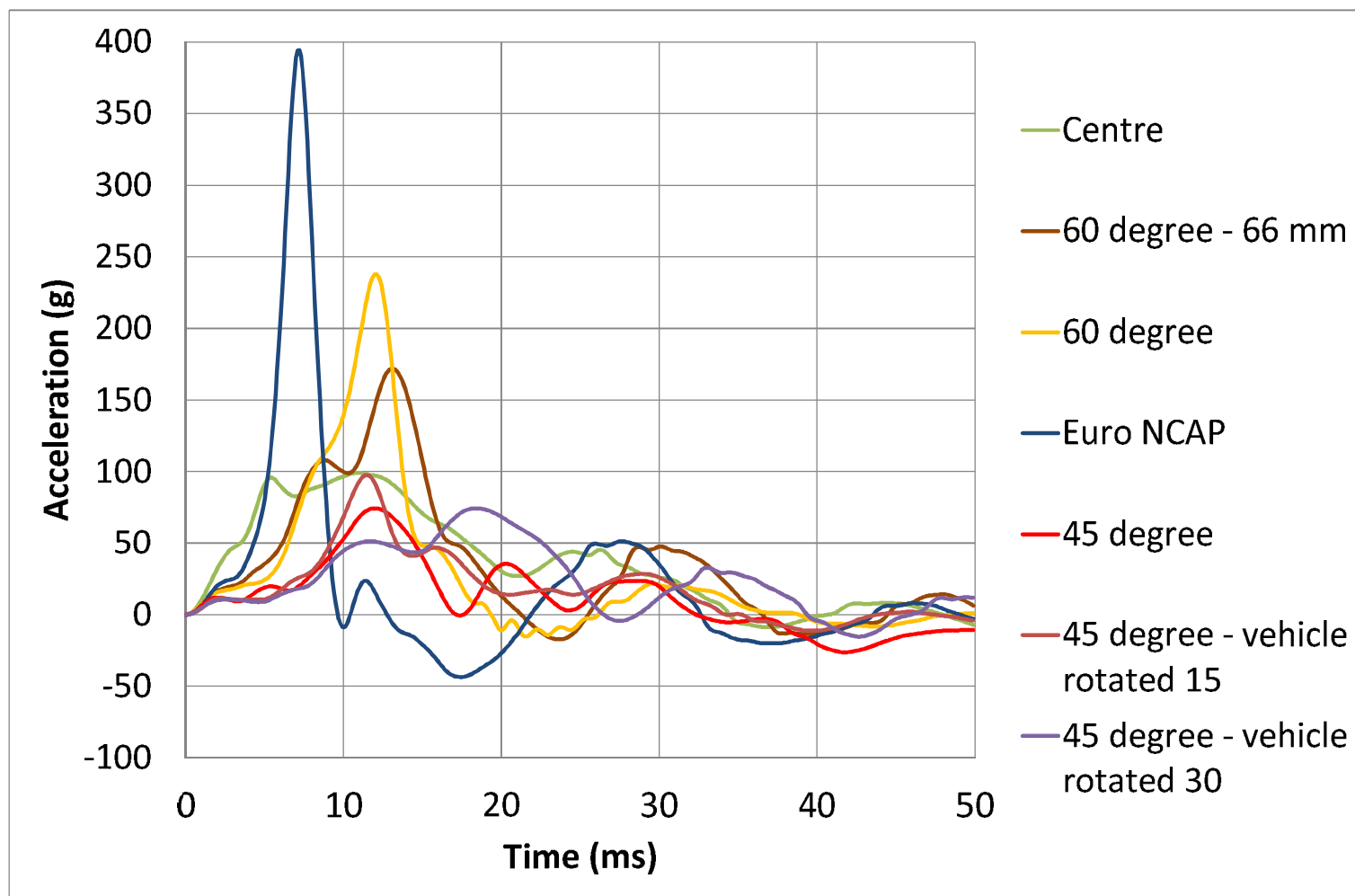
# Vehicle 1

## Acceleration



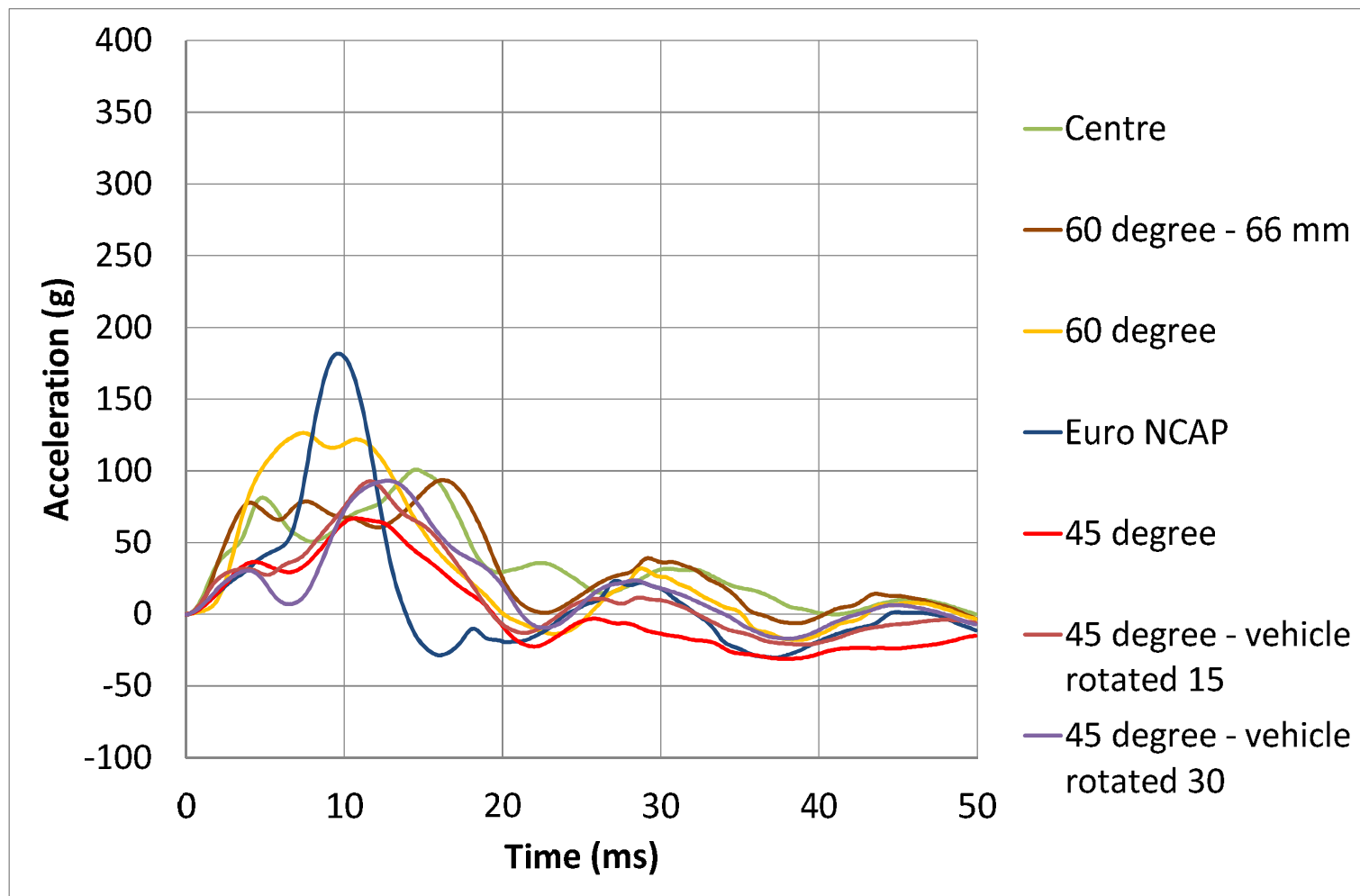
## Vehicle 2

### Acceleration



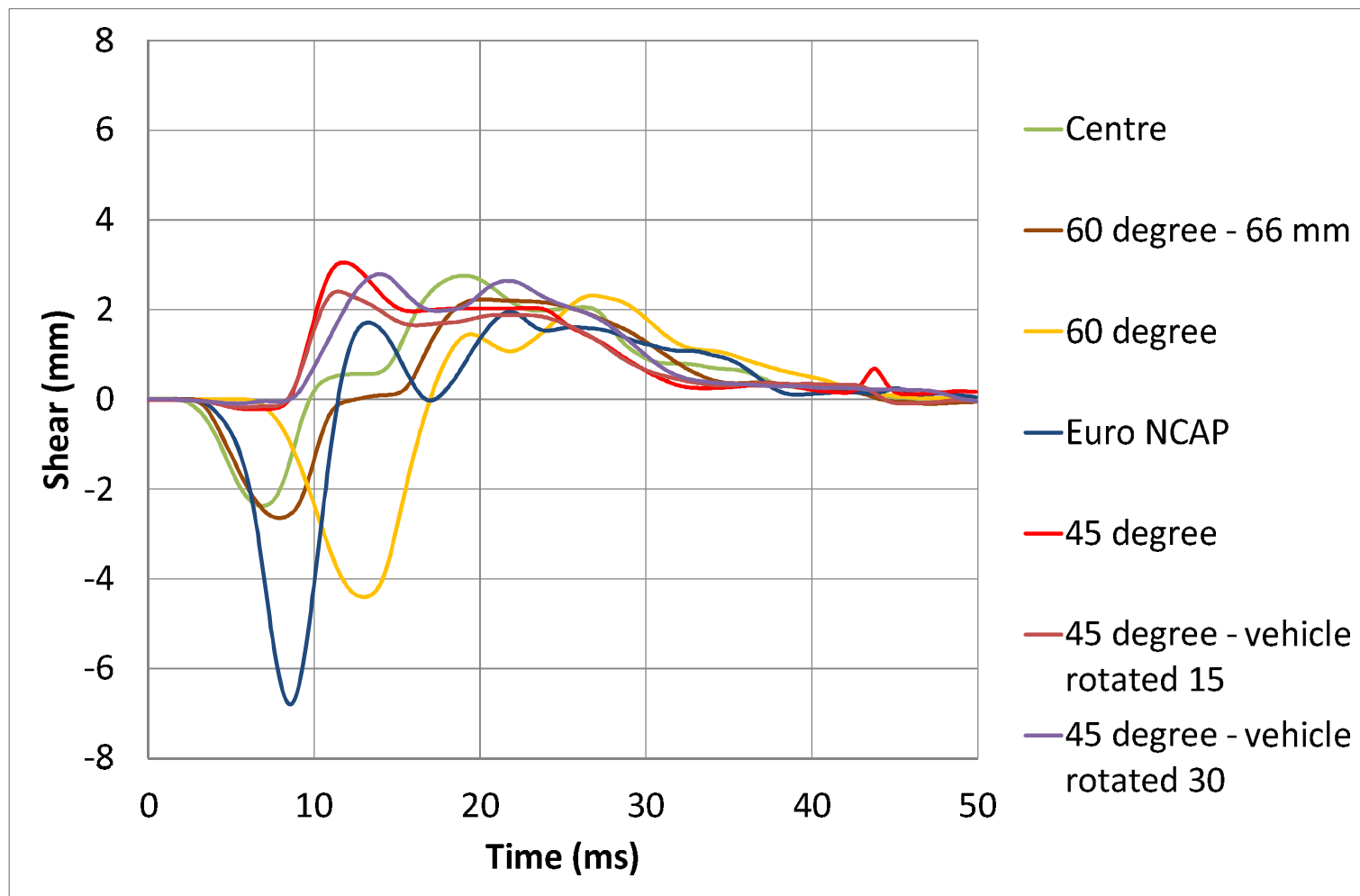
## Vehicle 3

### Acceleration



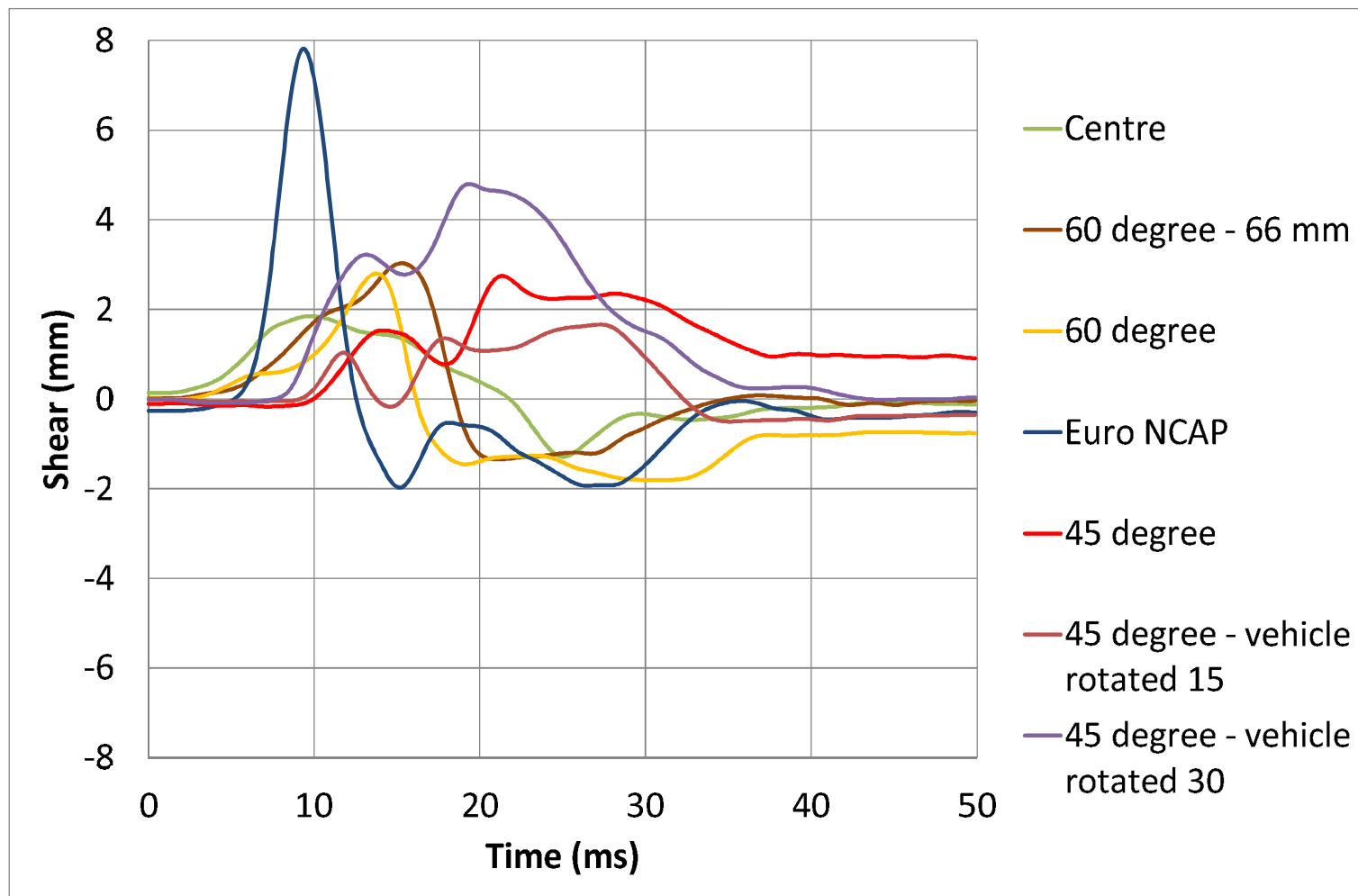
# Vehicle 1

## Shear



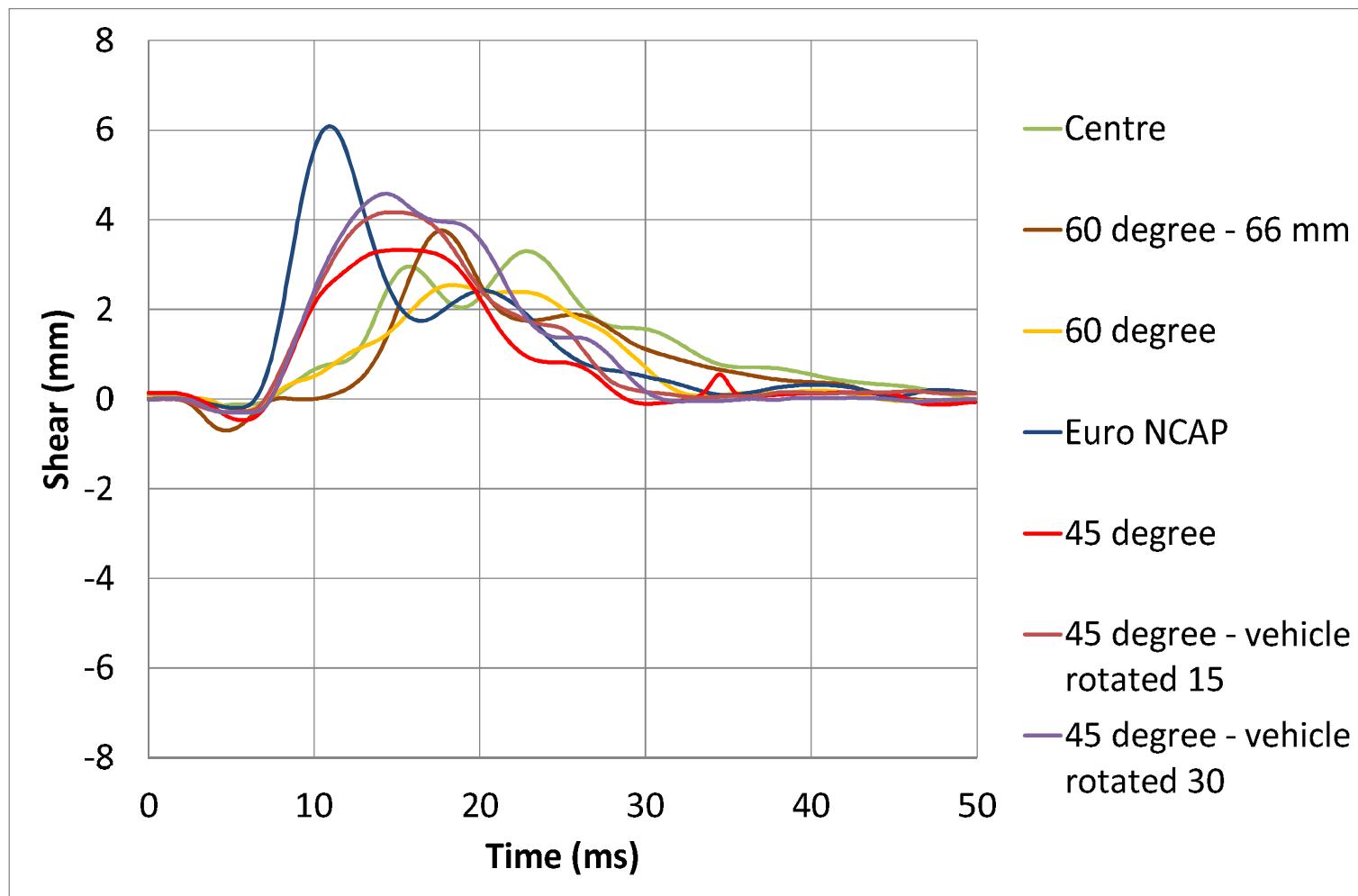
## Vehicle 2

### Shear



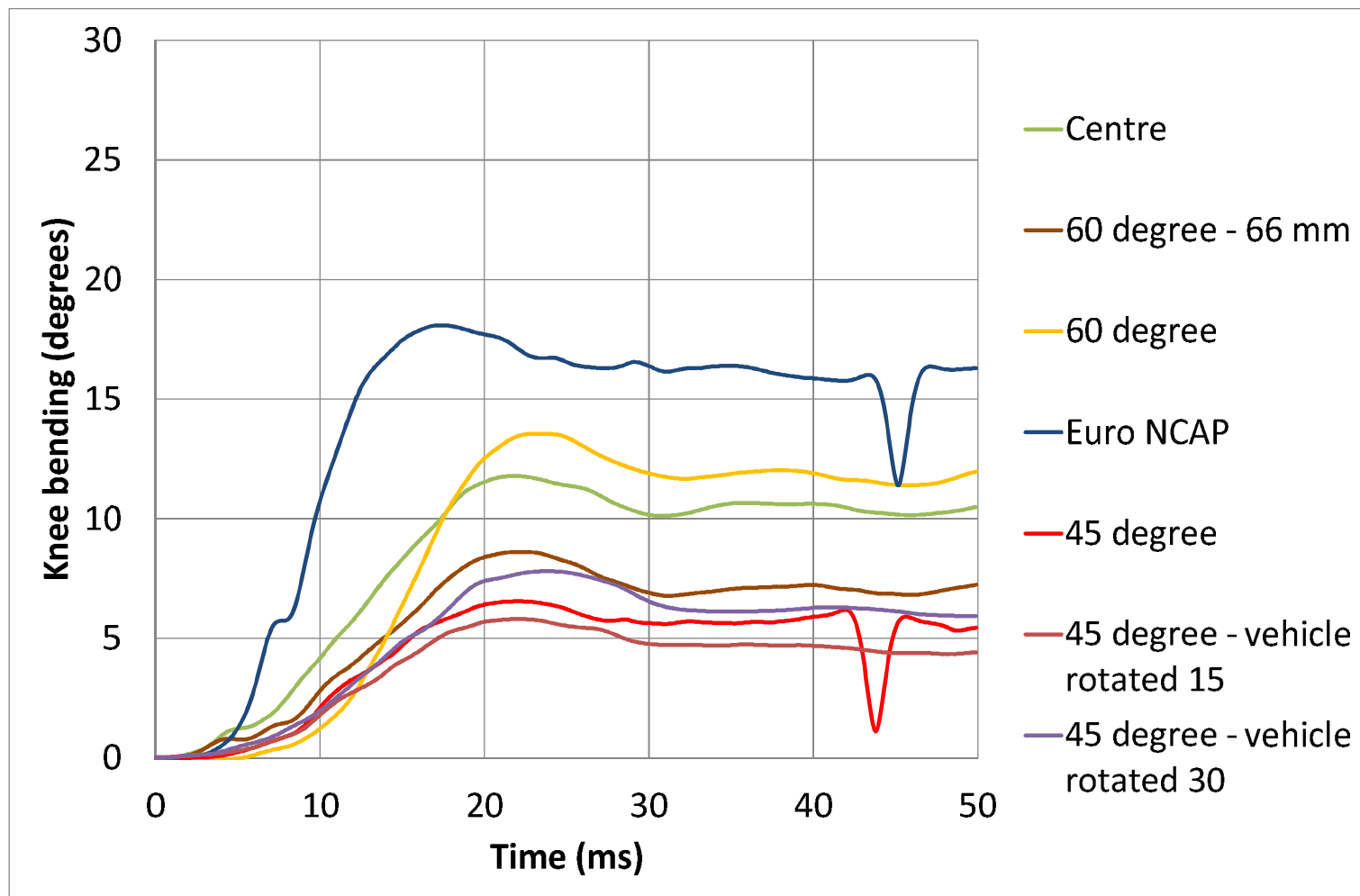
## Vehicle 3

### Shear



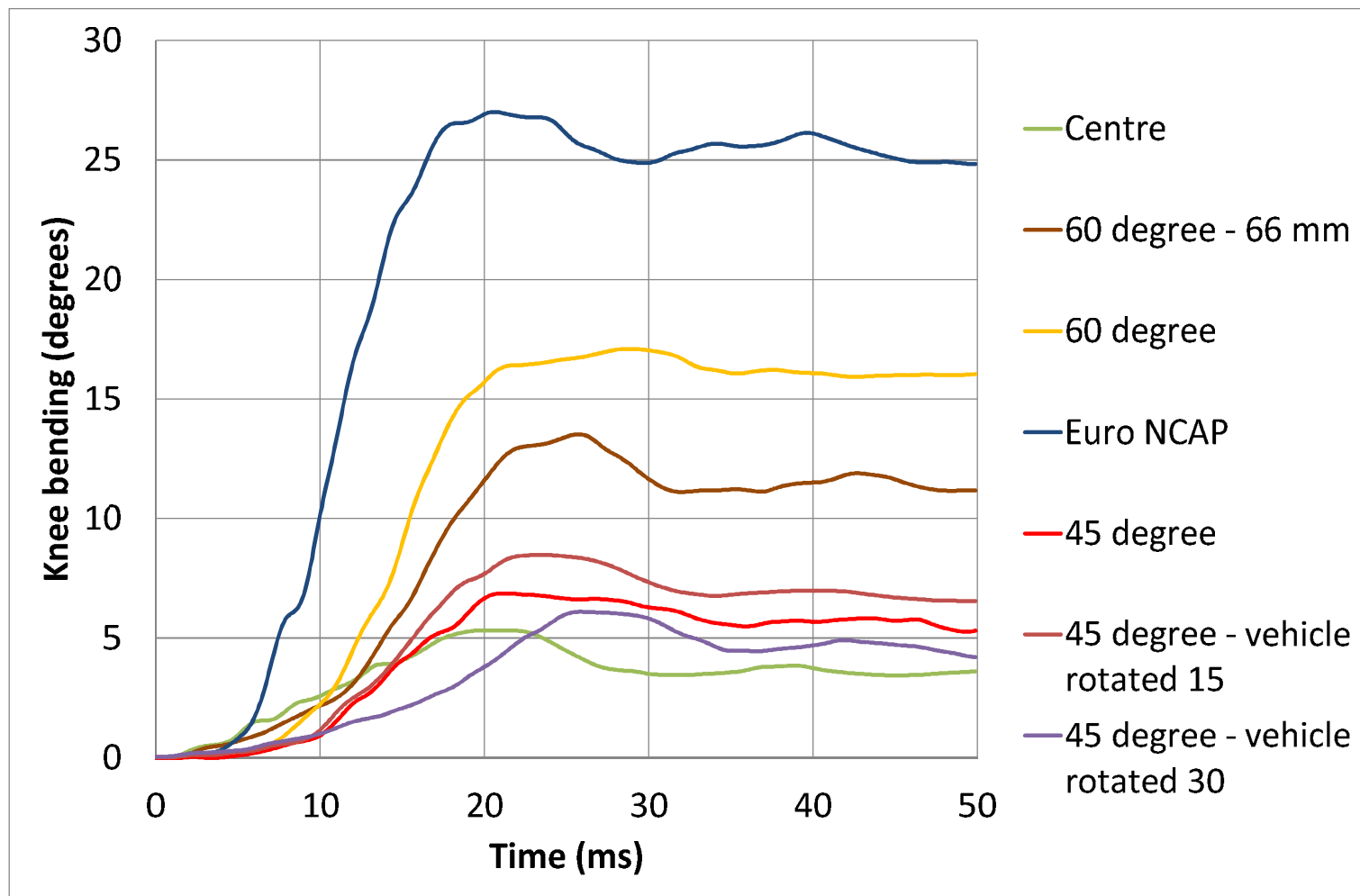
# Vehicle 1

## Bending



## Vehicle 2

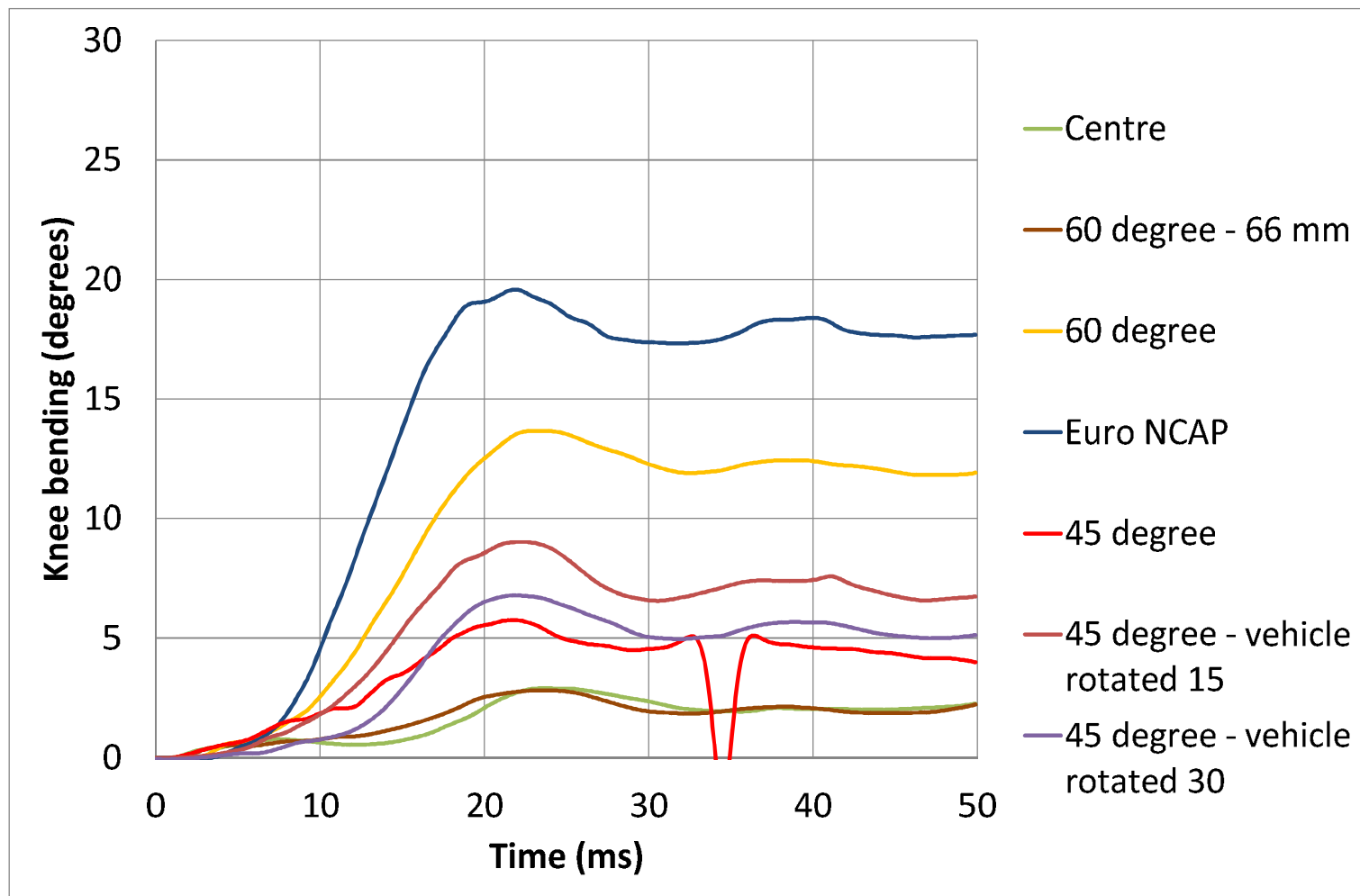
### Bending





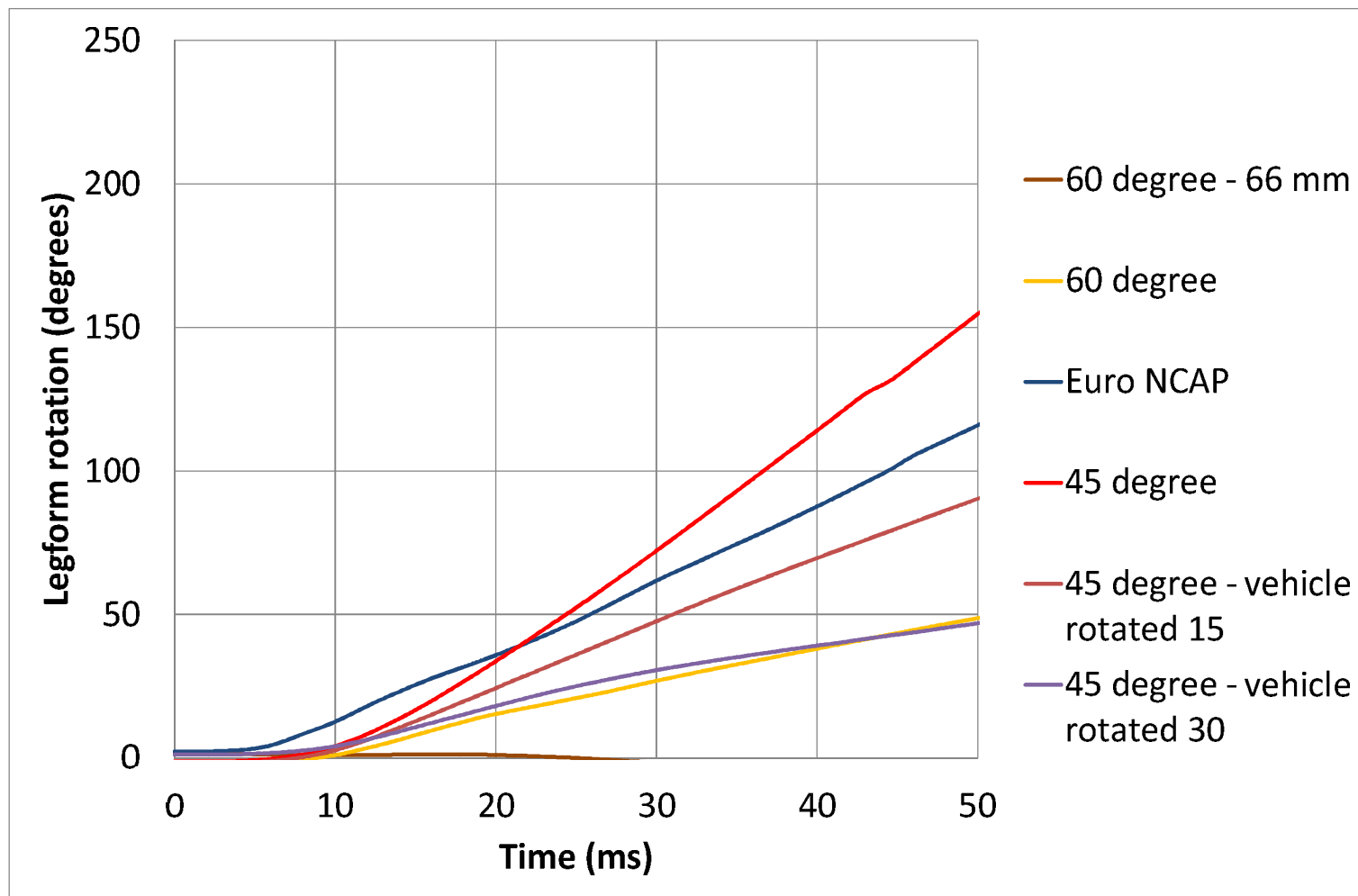
## Vehicle 3

### Bending



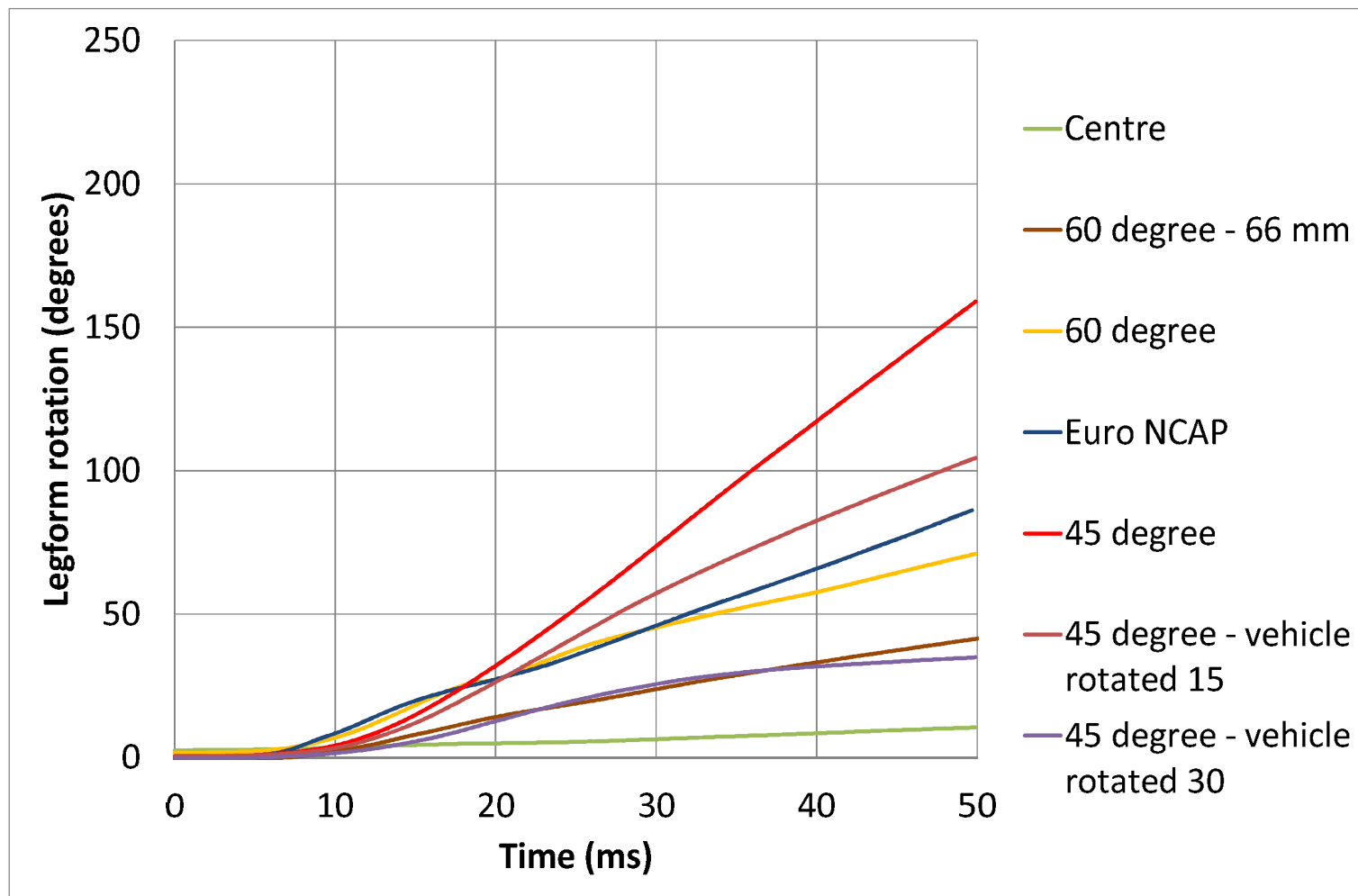
## Vehicle 1

Angle of rotation – via angular rate sensor



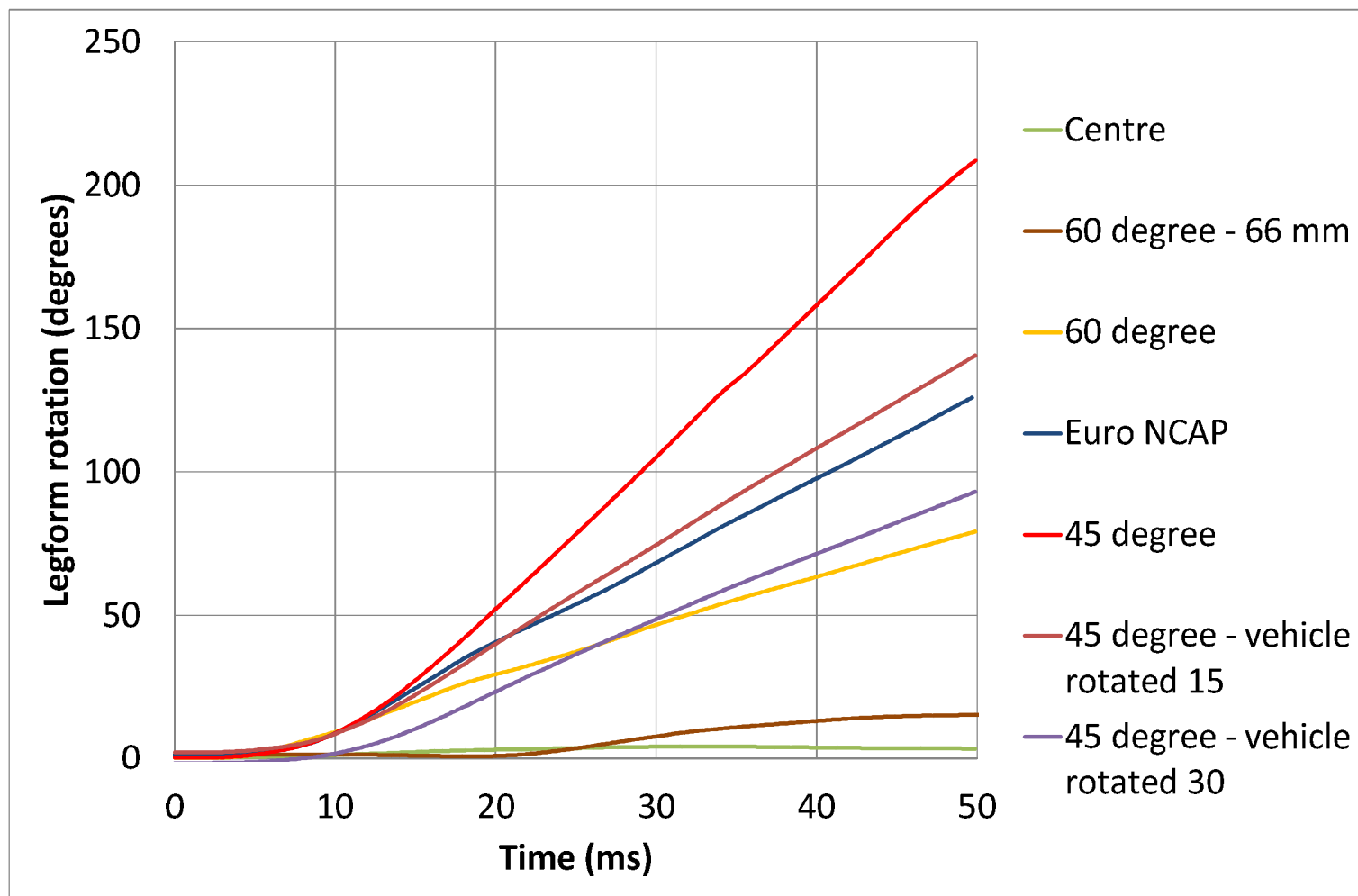
## Vehicle 2

Angle of rotation – via angular rate sensor



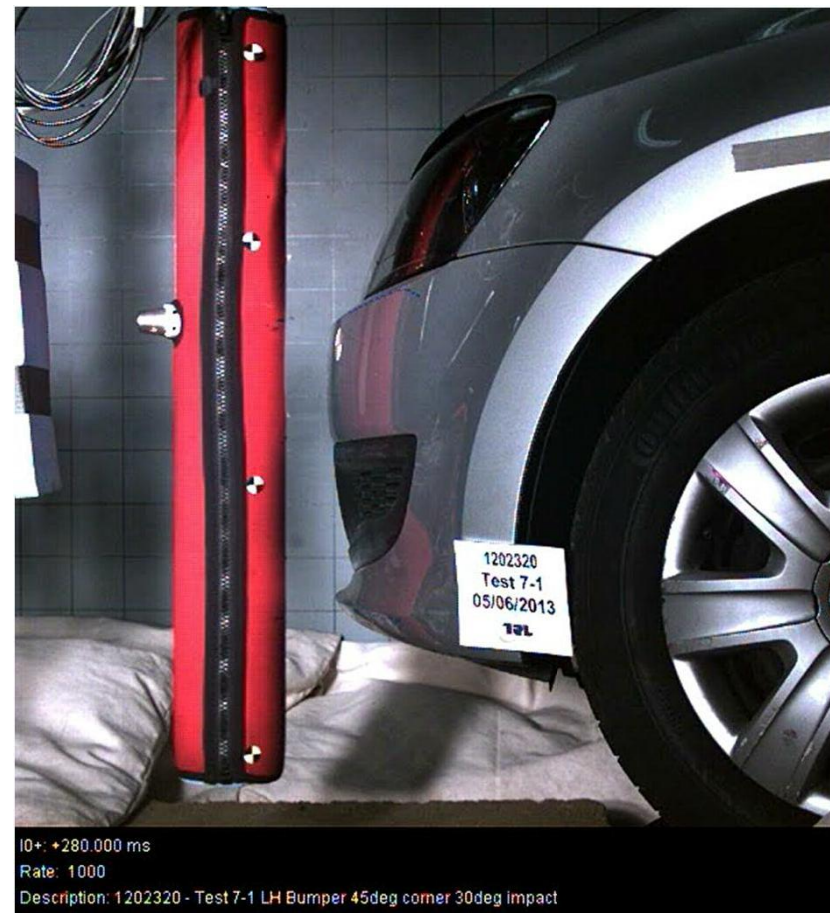
## Vehicle 3

Angle of rotation – via angular rate sensor



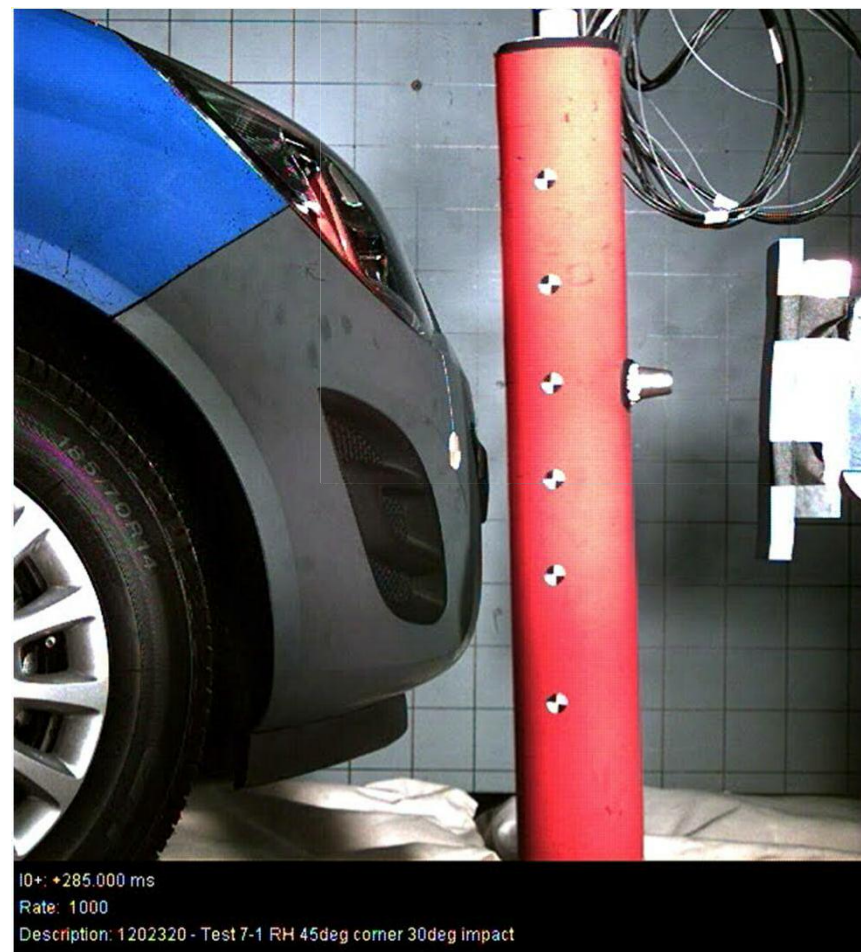
# Vehicle 1

## Angle of rotation – visual



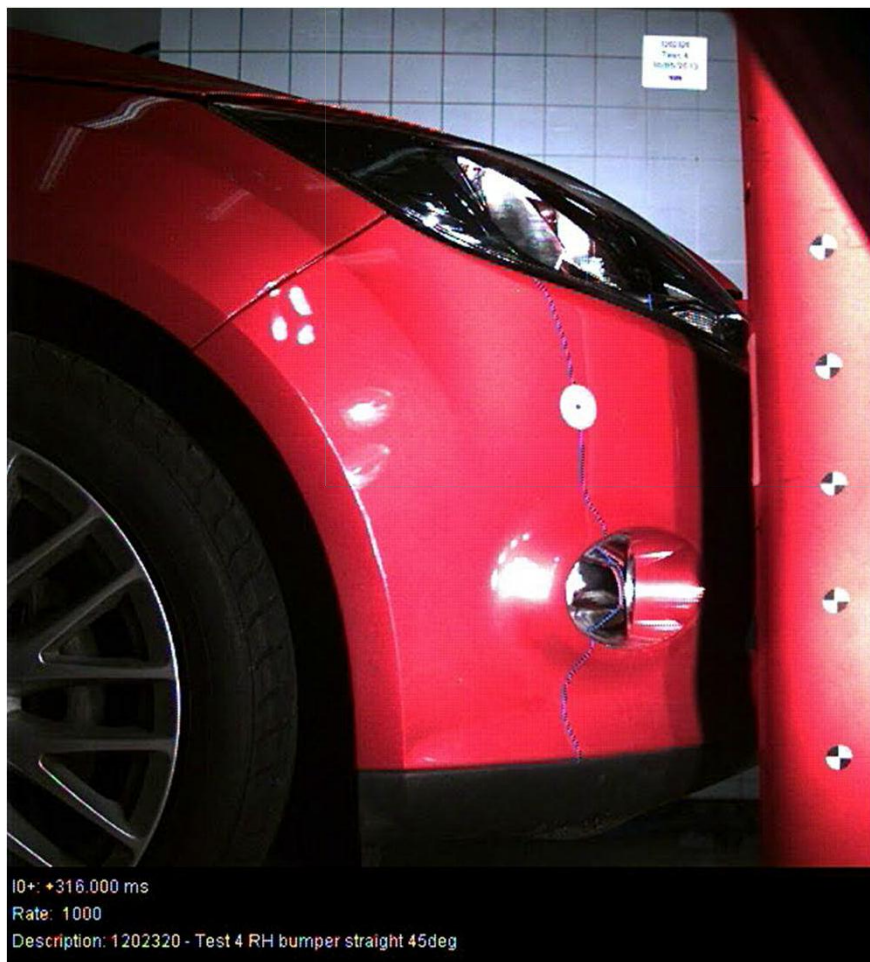
## Vehicle 2

Angle of rotation – visual



## Vehicle 3

Angle of rotation – visual







# Vehicle 1

Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	127.3 g	2.8 mm	11.8°
	Angle			
60 degrees – 66 mm	Value	128.3 g	-2.6 mm	8.6°
	Angle	1.3°	1.1°	0.6°
60 degrees	Value	174.1 g	-4.4 mm	13.6°
	Angle	1.5°	4.8°	18.8°
Euro NCAP	Value	338.3 g	-6.8 mm	18.1°
	Angle	5.0°	9.6°	30.3°
45 degrees – straight car	Value	83.7 g	3.1 mm	6.6°
	Angle	5.0°	7.8°	41.0°
45 degrees – 15 deg car	Value	79.1 g	2.4 mm	5.8°
	Angle	3.3°	5.1°	29.0°
45 degrees – 30 deg car	Value	91.1 g	2.8 mm	7.8°
	Angle	6.3°	9.2°	23.4°

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Exceeding lower threshold proposed for GTR

Exceeding thresholds

## Vehicle 2

Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	<b>99.1 g</b>	<b>-1.8 mm</b>	<b>5.3°</b>
	Angle	3.7°	3.4°	5.0°
60 degrees – 66 mm	Value	<b>172.0 g</b>	<b>-3.0 mm</b>	<b>13.5°</b>
	Angle	4.4°	5.7°	10.1°
60 degrees	Value	<b>237.9 g</b>	<b>-2.8 mm</b>	<b>17.1°</b>
	Angle	10.8°	15.3°	43.7°
Euro NCAP	Value	<b>394.4 g</b>	<b>-7.8 mm</b>	<b>27.0°</b>
	Angle	2.5°	6.9°	27.9°
45 degrees – straight car	Value	<b>74.3 g</b>	<b>2.7 mm</b>	<b>6.9°</b>
	Angle	7.5°	37.4°	36.6°
45 degrees – 15 deg car	Value	<b>97.6 g</b>	<b>1.7 mm</b>	<b>8.5°</b>
	Angle	5.2°	49.3°	37.0°
45 degrees – 30 deg car	Value	<b>74.3 g</b>	<b>4.8 mm</b>	<b>6.1°</b>
	Angle	10.2°	11.7°	21.1°

## Vehicle 2

Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	99.1 g	-1.8 mm	5.3°
			3.4°	5.0°
60 degrees – 66 mm	Value	172.0 g	-3.0 mm	13.5°
	Angle	4.4°	5.7°	10.1°
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Exceeding lower threshold proposed for GTR

Exceeding thresholds

## Vehicle 3

Peak values and legform angle

Description		Acceleration	Shear	Bending
<b>Centre</b>	Value	100.8 <i>g</i>	3.3 mm	2.9°
	Angle	2.3°	3.4°	3.5°
<b>60 degrees – 66 mm</b>	Value	93.5 <i>g</i>	3.8 mm	2.8°
	Angle	4.4°	5.7°	10.1°
<b>60 degrees</b>	Value	126.4 <i>g</i>	2.5 mm	13.7°
	Angle	5.1°	26.7°	34.4°
<b>Euro NCAP</b>	Value	181.8 <i>g</i>	6.1 mm	19.6°
	Angle	7.4°	10.8°	45.2°
<b>45 degrees – straight car</b>	Value	67.0 <i>g</i>	3.3 mm	5.7°
	Angle	11.0°	28.7°	61.5°
<b>45 degrees – 15 deg car</b>	Value	92.8 <i>g</i>	4.2 mm	9.0°
	Angle	12.3°	21.3°	48.2°
<b>45 degrees – 30 deg car</b>	Value	93.0 <i>g</i>	4.6 mm	6.8°
	Angle	5.9°	8.9°	28.1°

## Vehicle 3

Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	<b>100.8 g</b>	<b>3.3 mm</b>	<b>2.9°</b>
	Angle	2.3°	3.4°	3.5°
60 degrees – 66 mm	Value	<b>93.5 g</b>	<b>3.8 mm</b>	<b>2.8°</b>
	Angle	4.4°	5.7°	10.1°
60 degrees	Value	<b>126.4 g</b>	<b>2.5 mm</b>	<b>13.7°</b>
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Exceeding thresholds proposed for GTR			10.8°	45.2°
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# Legform tests – Round 1

## Angle at peak value

### Tolerance

- "At the time of first contact the impactor shall have the intended orientation about its vertical axis, for the correct operation of its knee joint, with a tolerance of  $\pm 5^\circ$ ."
- $5^\circ$  is unlikely to cause substantial error in linear measurements...

### Geometry

- $\cos 5 = 0.996$
- $\cos 10 = 0.985$
- $\cos 15 = 0.966$
- $\cos 20 = 0.940$

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<b>Euro NCAP</b>	Value	181.8 <i>g</i>	6.1 mm	19.6°
	<b>Angle</b>	<b>7.4°</b>	<b>10.8°</b>	<b>45.2°</b>
<b>45 degrees – straight car</b>	Value	67.0 <i>g</i>	3.3 mm	5.7°
	<b>Angle</b>	<b>11.0°</b>	<b>28.7°</b>	<b>61.5°</b>
<b>45 degrees – 15 deg car</b>	Value	92.8 <i>g</i>	4.2 mm	9.0°
	<b>Angle</b>	<b>12.3°</b>	<b>21.3°</b>	<b>48.2°</b>
<b>45 degrees – 30 deg car</b>	Value	93.0 <i>g</i>	4.6 mm	6.8°
	<b>Angle</b>	<b>5.9°</b>	<b>8.9°</b>	<b>28.1°</b>

## Vehicle 3

Peak values and legform angle

Description		Acceleration	Shear	Bending
<b>Centre</b>	Value	100.8 <i>g</i>	3.3 mm	2.9°
	<b>Angle</b>	<b>2.3°</b>	<b>3.4°</b>	<b>3.5°</b>
<b>60 degrees – 66 mm</b>	Value	93.5 <i>g</i>	3.8 mm	2.8°
	<b>Angle</b>	<b>4.4°</b>	<b>5.7°</b>	<b>10.1°</b>
<b>60 degrees</b>	Value	126.4 <i>g</i>	2.5 mm	13.7°
	<b>Angle</b>	<b>5.1°</b>	<b>26.7°</b>	<b>34.4°</b>
<b>Euro NCAP</b>	Value	181.8 <i>g</i>	6.1 mm	19.6°
	<b>Angle</b>	<b>7.4°</b>	<b>10.8°</b>	<b>45.2°</b>
<b>45 degrees – straight car</b>	Value	67.0 <i>g</i>	3.3 mm	5.7°
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# Legform tests – Round 1

Initial thoughts

## Some injurious points

- At the extreme of the Euro NCAP range



# Legform tests – Round 1

## Initial thoughts

Timing of peak	Value of peak
<ul style="list-style-type: none"><li>▪ The timing of peak values varies between the criteria</li><li>▪ Acceleration less susceptible to angular effects than bending</li></ul>	<ul style="list-style-type: none"><li>▪ Large incident angles creat large legform rotations at time of peak values in criteria</li><li>▪ When moving to the edges, a limit of incident angle (and test speed) may be necessary to generate measurements equivalent to centre of bumper tests</li></ul>

## Legform tests – Round 2

### Plan for forward tests

#### Investigating options

- Need to decide on tests for next phase

#### Availability of legform

- Humanetics have offered to provide a Flex-PLI
  - Other offers from test labs.
- Thank you!

#### Next phase

- Weeks 38 and 39
- Suggestions welcome!



## Legform tests – Round 2

Scheme for tests with Flex-PLI

- 1 Position along bumper to give 15 degree incident angle
- 2 Euro NCAP extreme position no vehicle rotation
- 3 Euro NCAP extreme position vehicle rotated to remove oblique component
- 4 45 degree position with car rotated 15 degrees
- 5 45 degree position with car rotated 30 degrees

# Thank you... Questions?

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