DG ENTR Lot 1 Framework
New UN Regulation on CRS

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UN Informal Group on CRS 15th Jan 2013

Terms of Reference for Phase 2 of UN Reg. 129

Adopted text based on GRSP-49-01-Rev.1

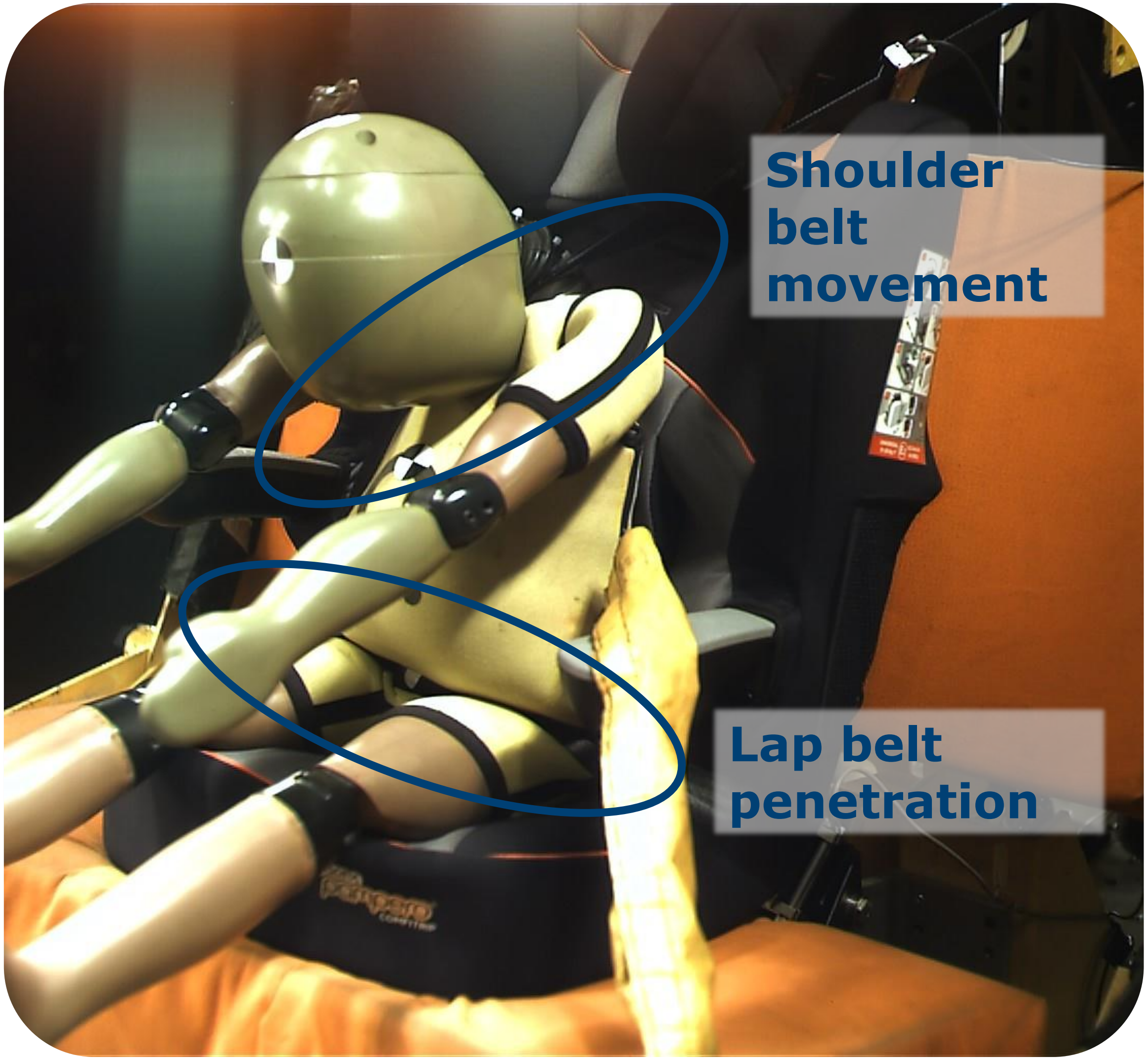
- Phase 2 will develop definitions, performance criteria and test methods for **non-integral CRS** with ISOFIX attachments
- In Phase 2, the **test pulse** for frontal impact (increased severity and CRS integrity) will be reviewed in light of recent accident data
- In Phase 2, the strict application of recognised and accepted **injury criteria** related to the new generation of baby/child crash test Q-dummies, as supported through EEVC and other EU research programmes, will be reviewed in the light of recent accident data

Project objectives

- To support the Commission during Phase 2 of draft new Regulation on “Enhanced Child Restraint Systems”
- To contribute to evidence base for technical aspects of new Regulation; including assessments of
  - Definitions, performance criteria and test methods for **non-integral CRS** with ISOFIX attachments
  - The **test pulse** for frontal impact
  - How best to apply recognised and accepted **injury criteria** related to the Q-Series
  - Other issues identified by the Commission related to validation of the Regulation (**side impact test procedure**)

Non-integral CRS: Performance criteria and test methods

Dummy & seat belt interaction undermines the assessment of non-integral CRS

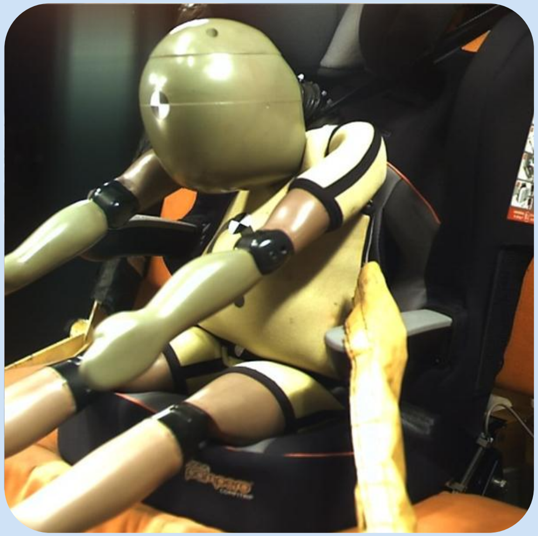


CRS don't need to control belt path

Will the regulation improve CRS performance?

Can we find a pragmatic solution?

Pelvis inserts restrict belt intrusion in the Q3



Without pelvis inserts

With pelvis inserts

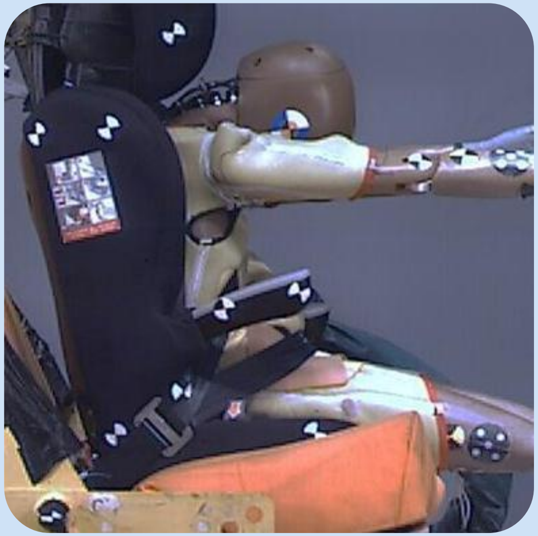
IFSTTAR pelvis inserts

Beillas & Alonzo , 2010

No misuse – abdomen loading not expected

Belt intrusion is less pronounced in the Q10, but hip shields are still beneficial

Without hip shields



With hip shields

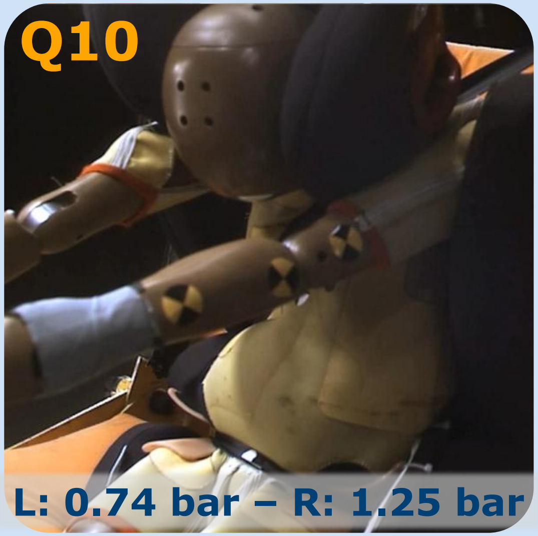
Humanetics hip shields

Lemmen *et al.*, 2013

No misuse – abdomen loading not expected

However - lap belt interaction is similar regardless of CRS design features

No belt guides on CRS

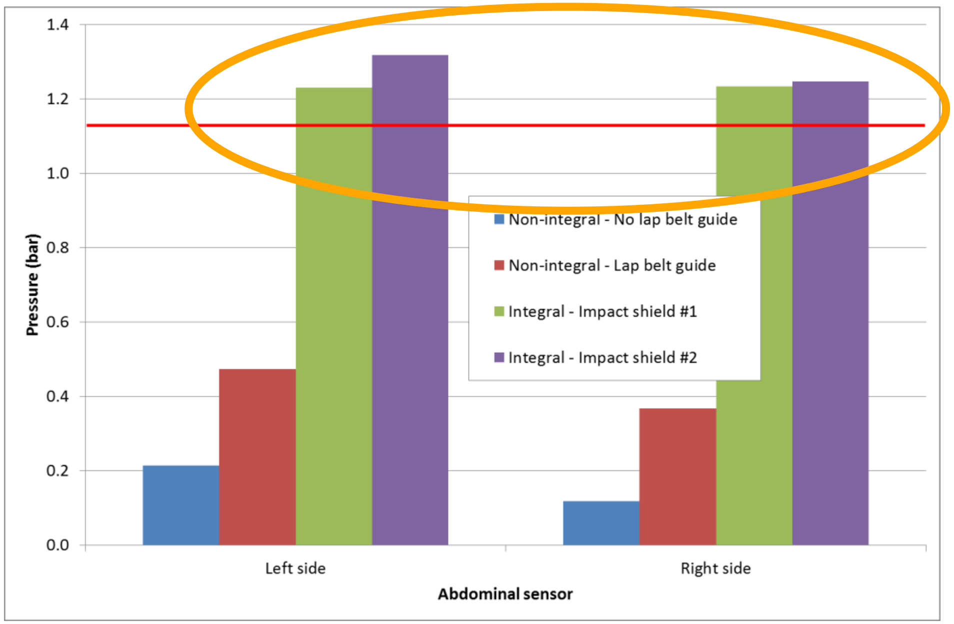


Belt guides on CRS

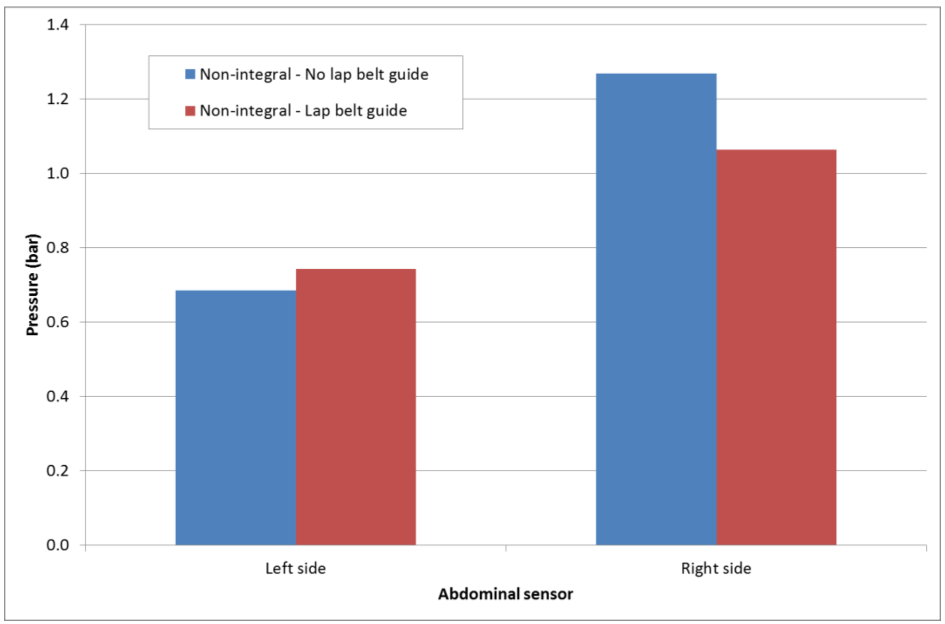
Belt guides assumed to be beneficial in real world

Belt guides not needed to control belt path in R129 test

The benefit of abdomen pressure measurement may be in assessing impact shield CRS rather than non-integral CRS



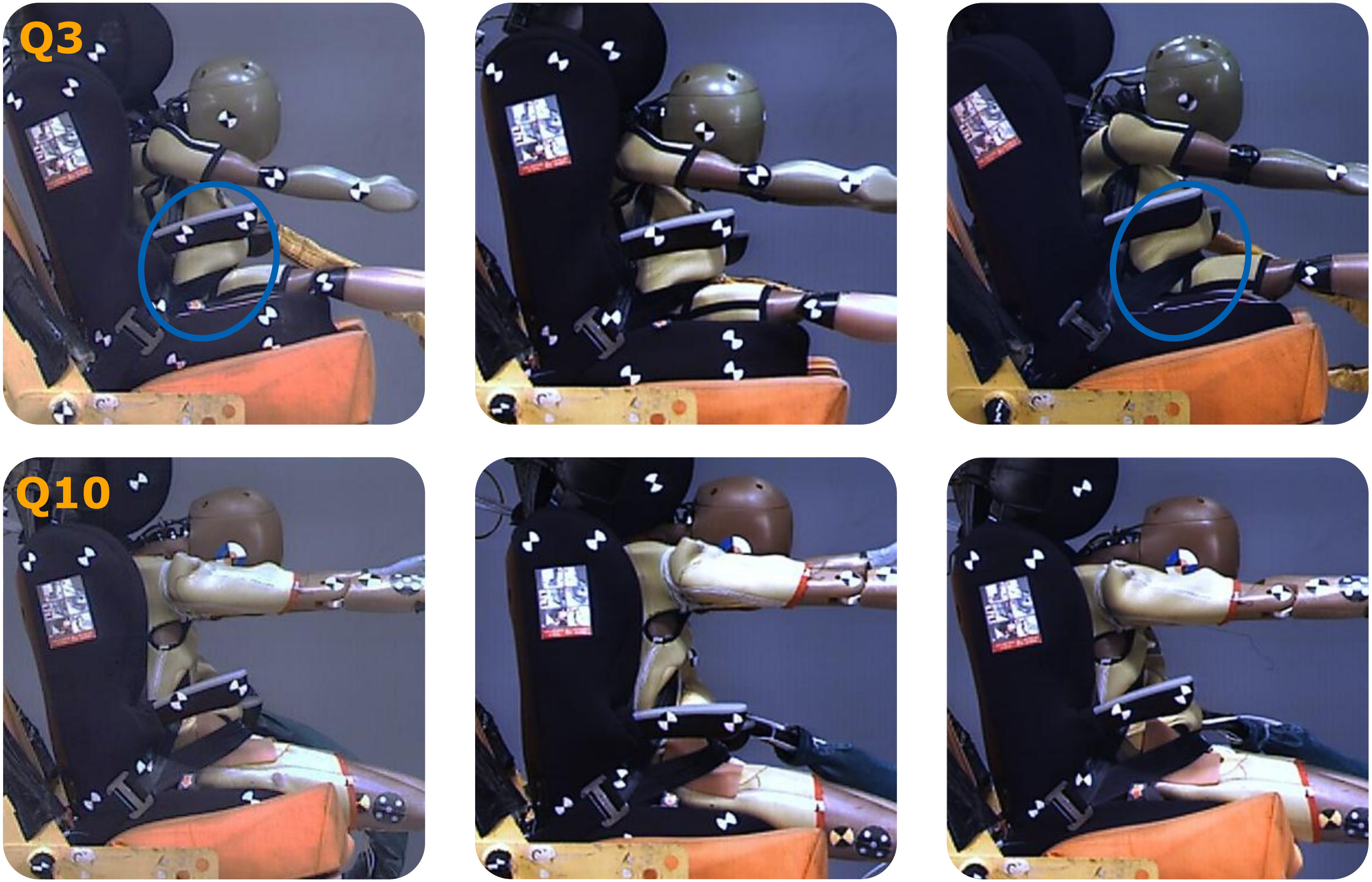
Q3 abdomen pressure



Q10 abdomen pressure

Impact shields exceeded Q3 performance limit proposed in literature

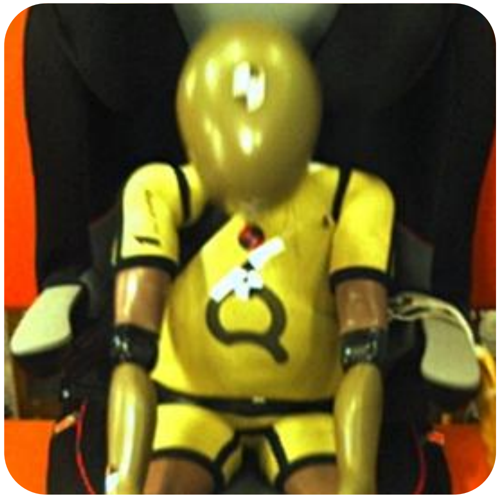
We should look at the test procedure as a whole, not just the dummy....



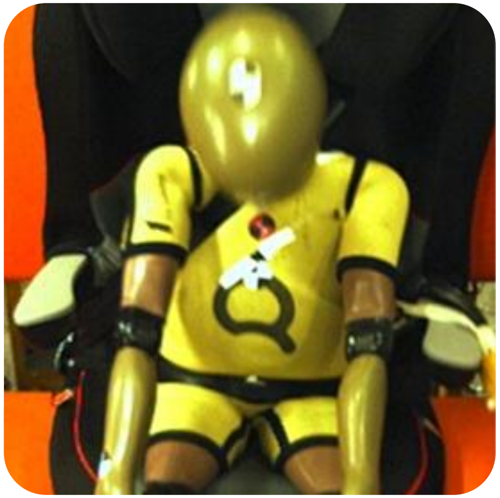
Baseline | **5° seat cushion** | **'UMTRI seating'**

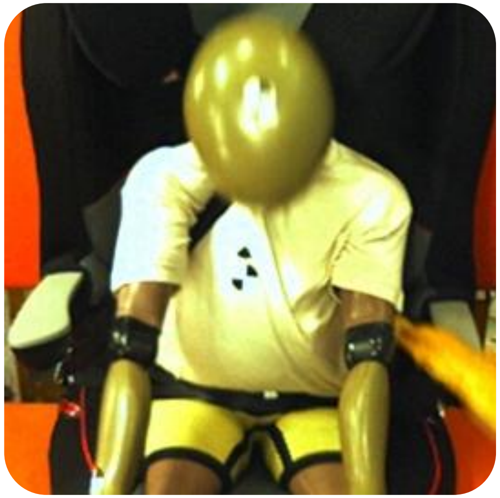
Upper anchorage position & suit friction had little effect on diagonal belt slip with Q3

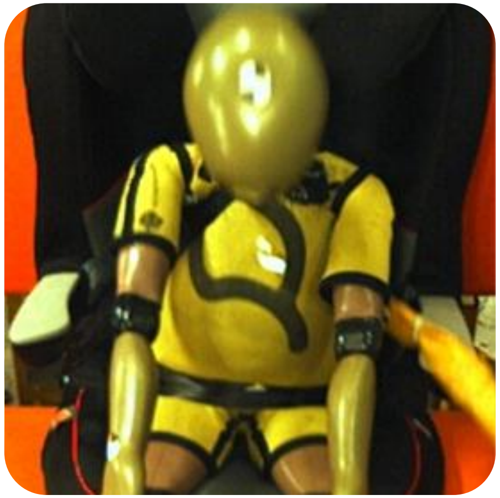

Standard upper anchorage


Downward 75 mm


Outboard 50 mm

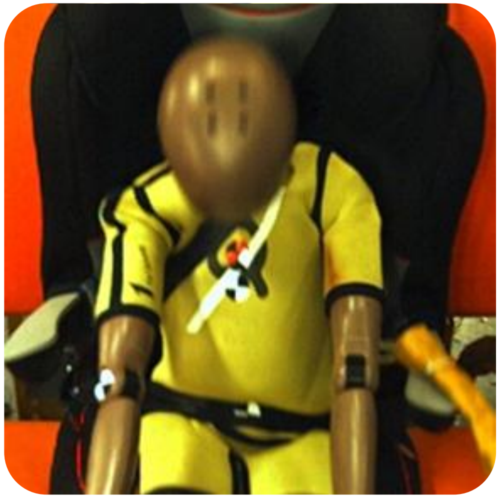

Outboard 100 mm and downward 75 mm


T-shirt over suit (standard anchorage)


Friction surface on suit (standard anchorage)

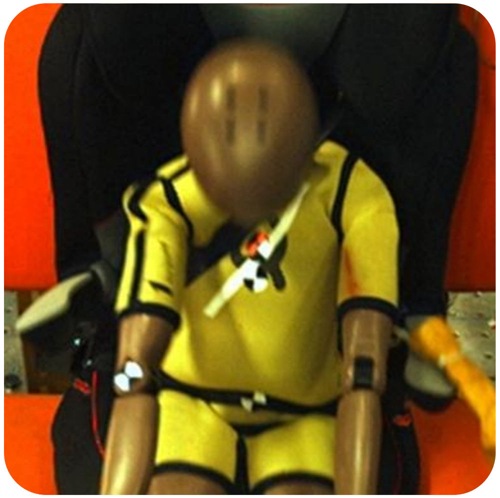
There was also little effect with the Q6

Standard upper anchorage



Downward 75 mm

Outboard 100 mm

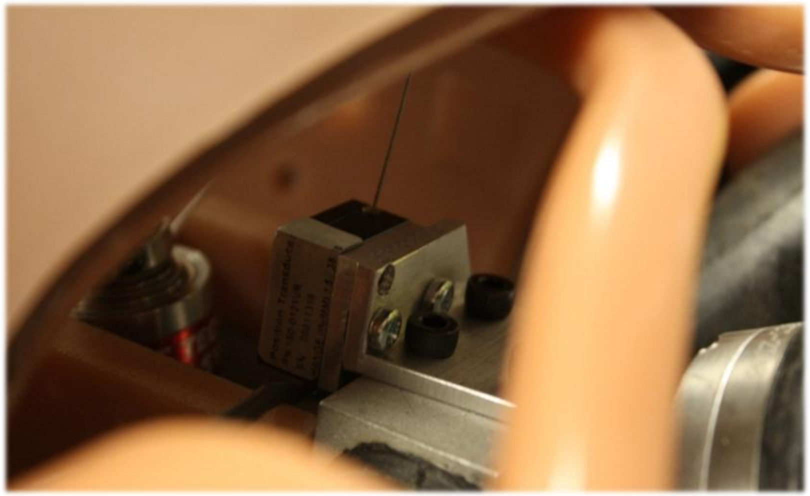


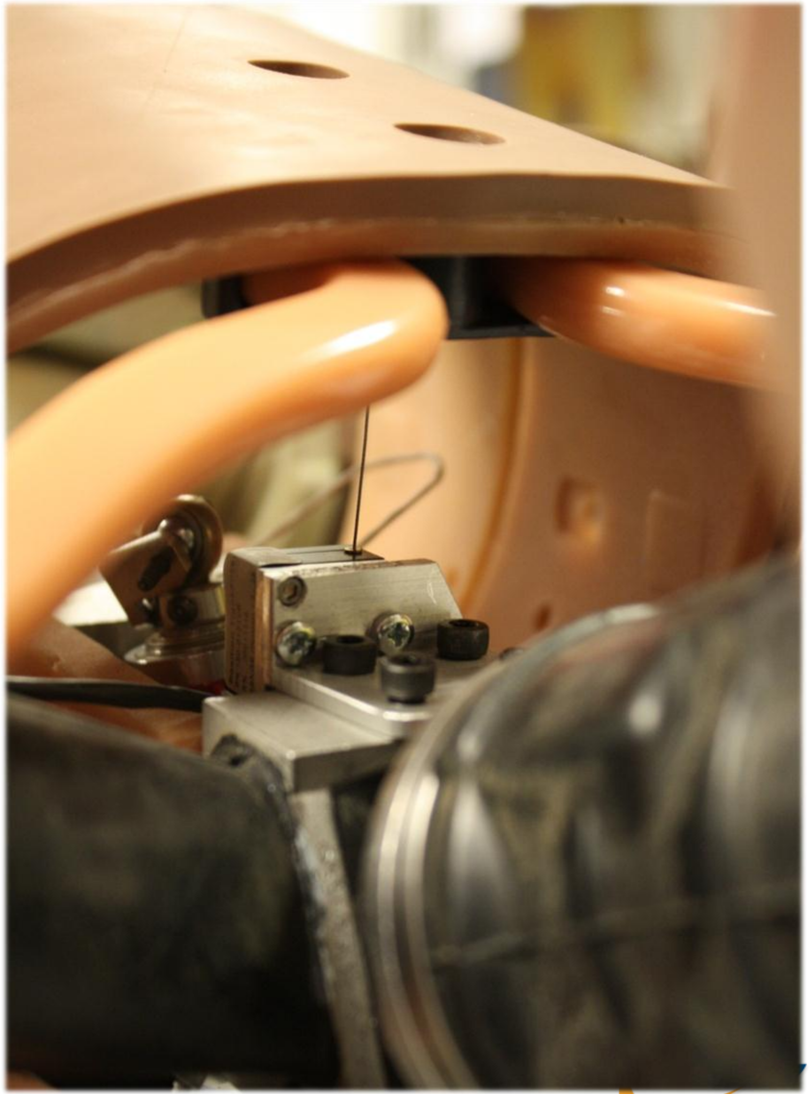
Outboard 100 mm and downward 75 mm

T-shirt over suit (standard anchorage)

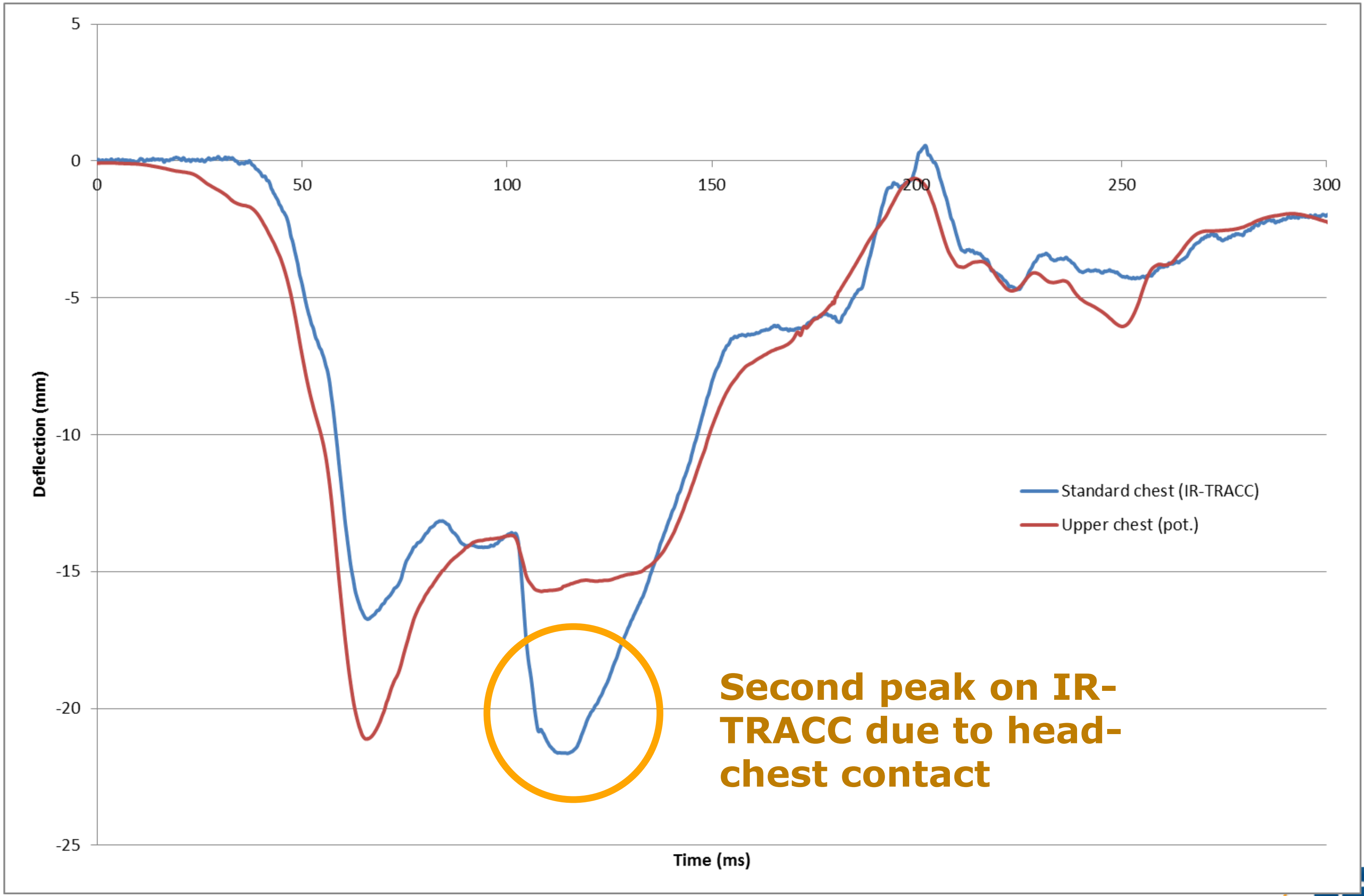
If we can't influence belt path, perhaps we can measure deflection close to the belt…

We placed a string pot. on the surface of the Q6 thoracic spine connected to the clavicle retainer

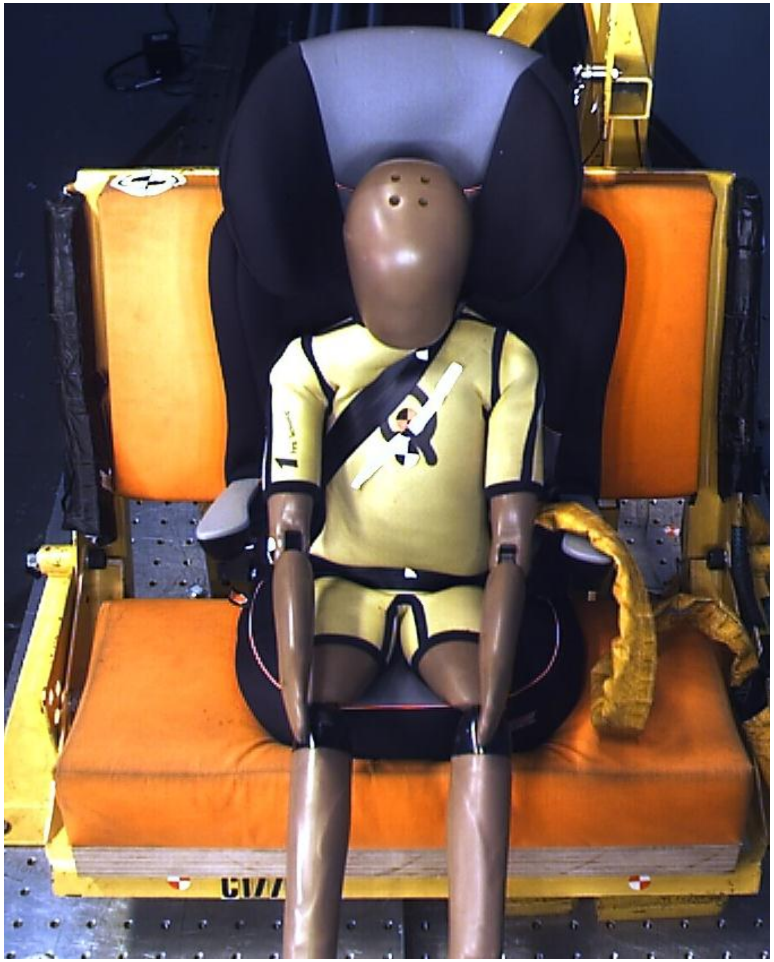




The new sensor provided a more meaningful measurement of chest deflection under belt loading



Peak clavicle deflection occurred relatively early; peak chest deflection occurred later, under chin loading



t = 64 ms
(first peak)

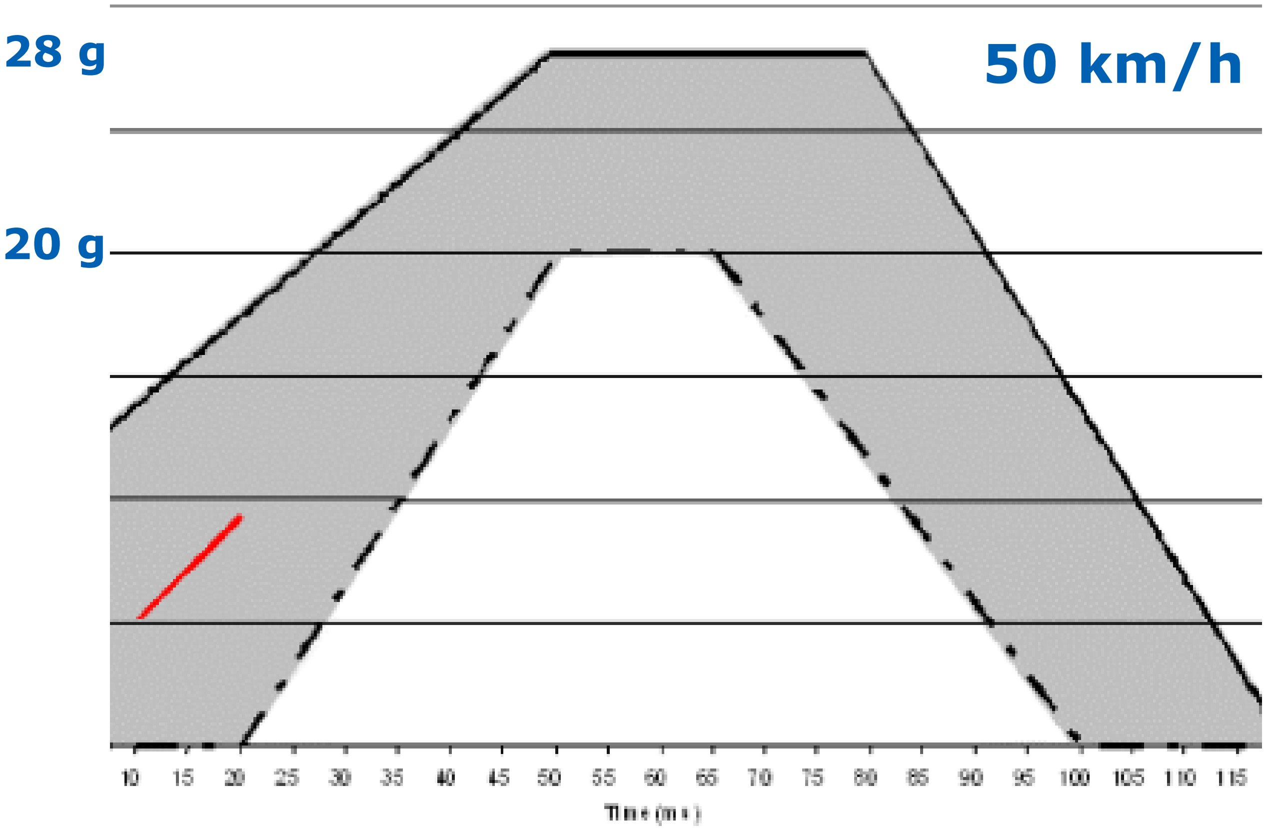
t = 112 ms
(second peak)

Non-integral CRS – Outstanding items

The draft amendment for Phase 2 makes no assessment of abdomen protection and chest protection is assessed by acceleration only

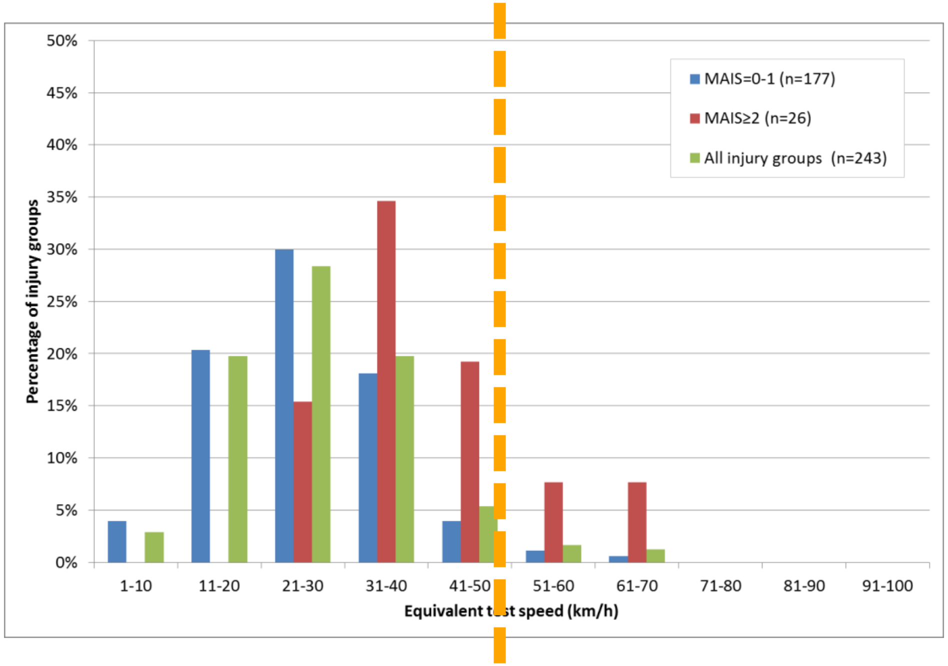
- Essentials for robust assessment of abdomen protection
  - Pressure sensors (yes/no?)
  - Belt intrusion accessories (pelvis inserts?)
  - Test procedure sensitive to CRS (bench / set-up changes?)

- Essentials for robust assessment of chest protection
  - Performance measure (acceleration or deflection?)
  - Test procedure sensitive to CRS (extra deflection sensor?)

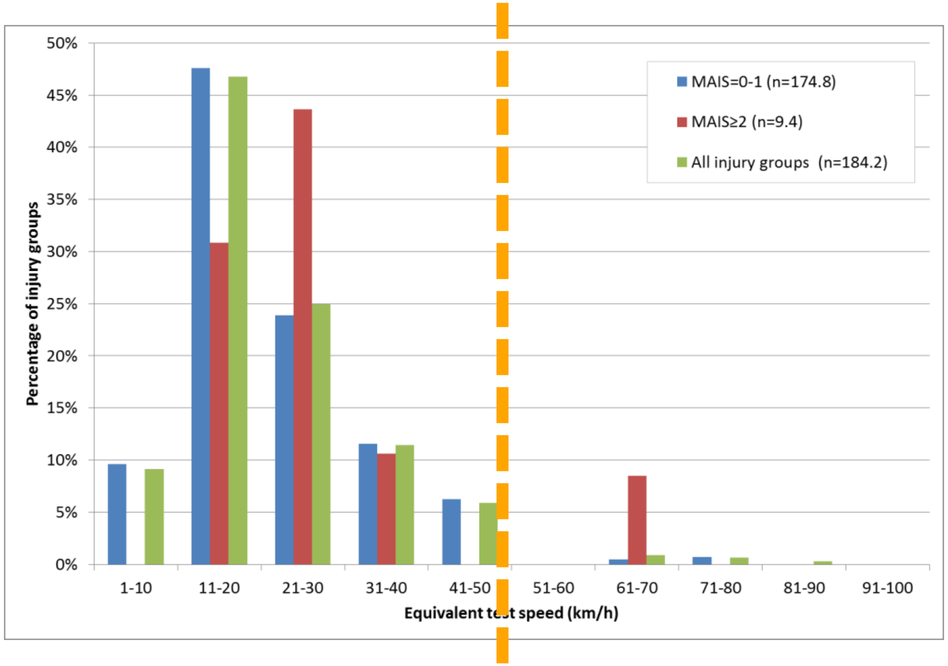


The test pulse for front impact

The 50 km/h impact speed is consistent with the majority collisions that children are involved in



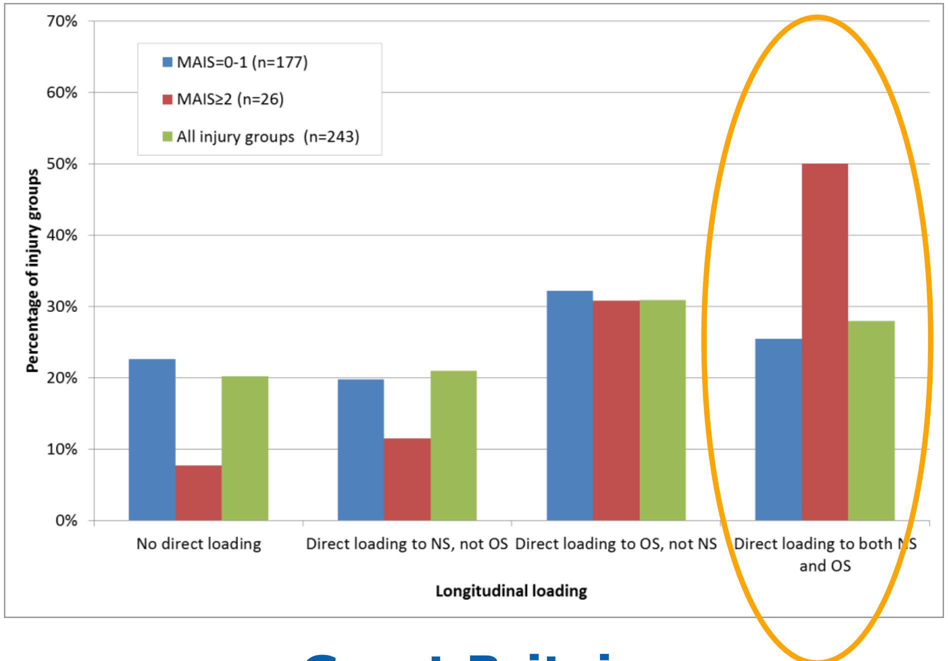
Great Britain



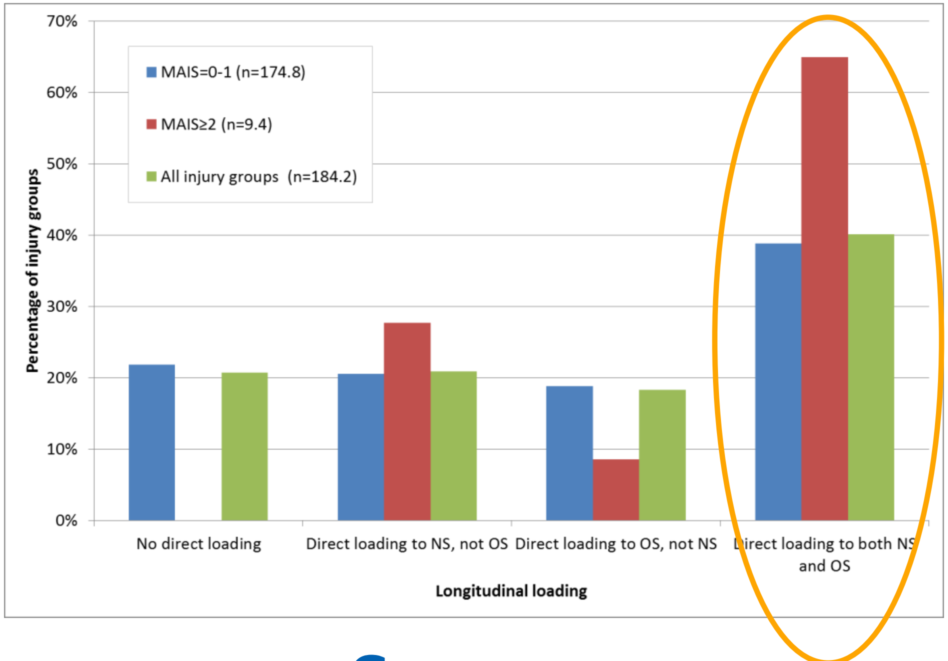
Germany

(Assuming that lower speed collisions are also covered adequately by a test at 50 km/h)

Full-width collisions are a significant proportion & are over-represented for more serious injuries



Great Britain

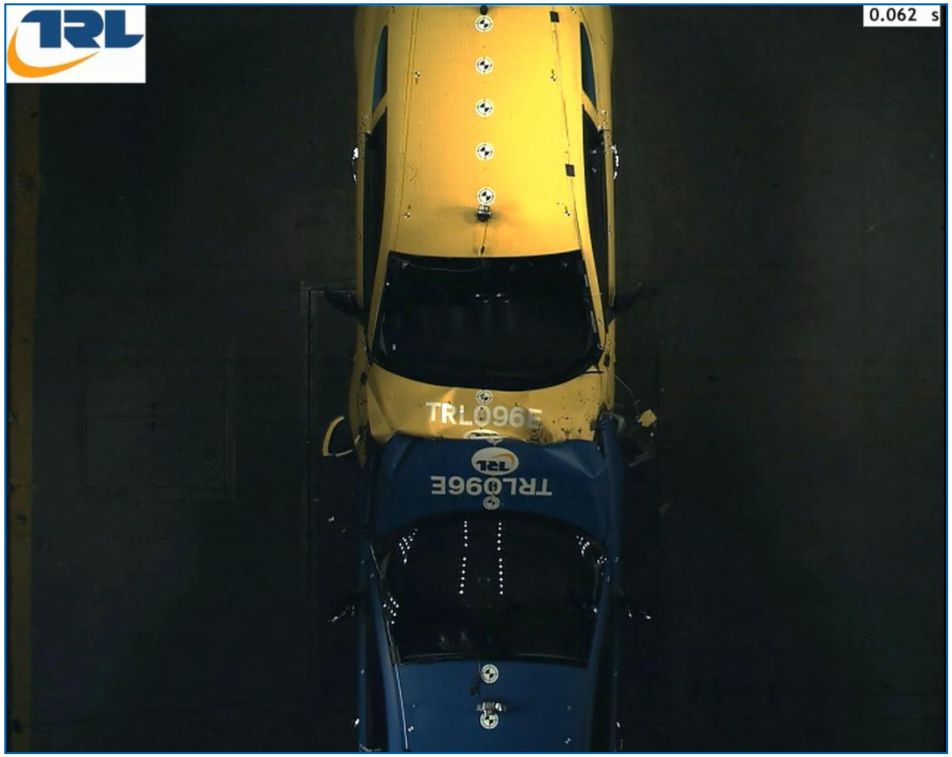


Germany

It seems appropriate for the deceleration corridor to be representative of full-width collisions

A 'full-width pulse' is also the worst-case for testing restraint systems…

How does the front impact test pulse compare to a real front impact collision?



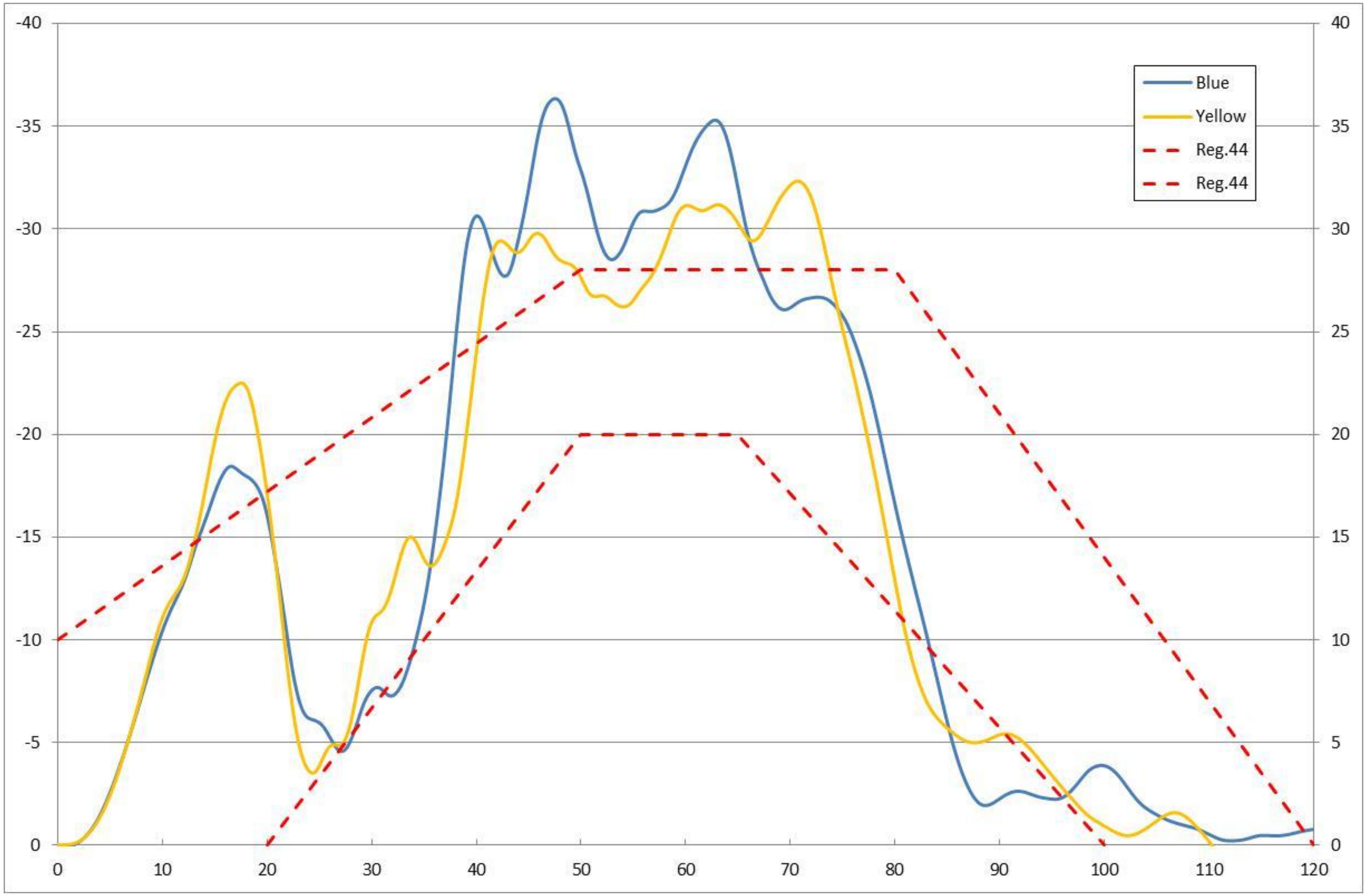
Moving car to moving car:
50 km/h – full-width

(Alfa Romeo Mito – supermini)

Yellow car: Q6 dummies

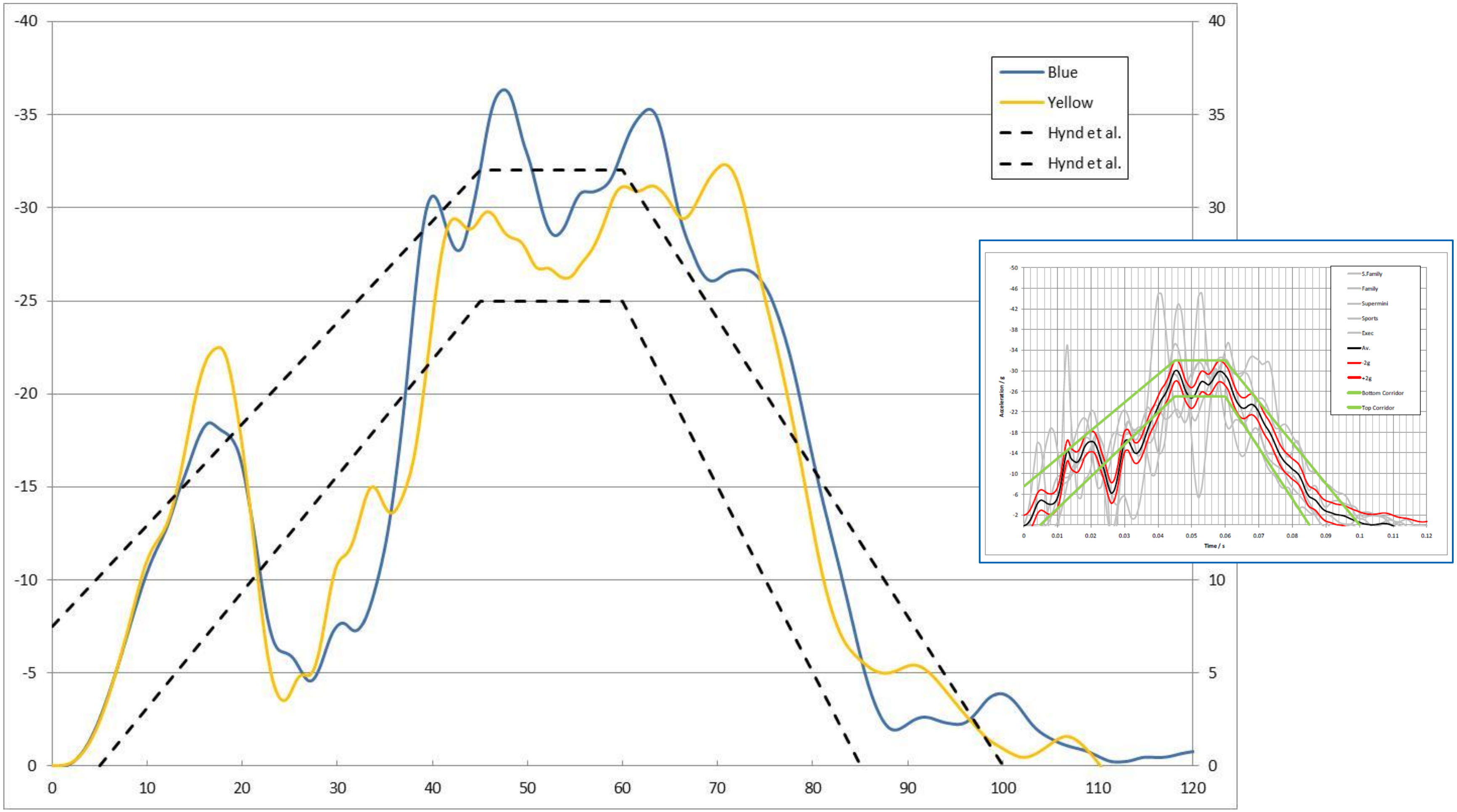
Blue car: Q3 dummies

The cars in our experiment were stiffer than the cars used to derive the front impact corridor



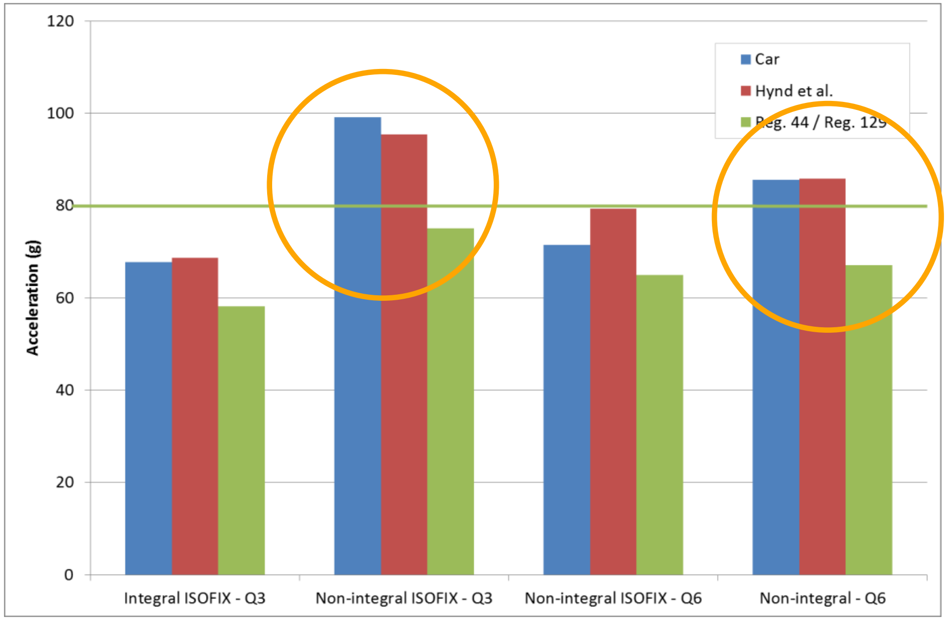
The corridor did not reflect the characteristics of a modern (supermini) car

The cars were similar in stiffness to a corridor proposed by Hynd et al.

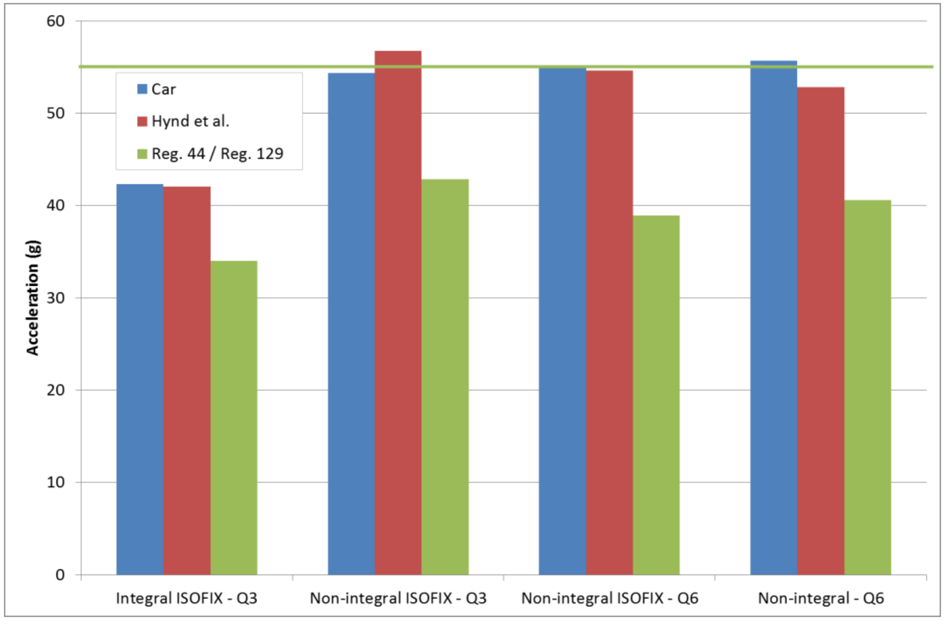


This corridor was more representative of modern cars than the UN R129 corridor

The Hynd et al. corridor led to head and chest acceleration that were similar to the car



Head acceleration (3ms value)



Chest acceleration (3 ms value)

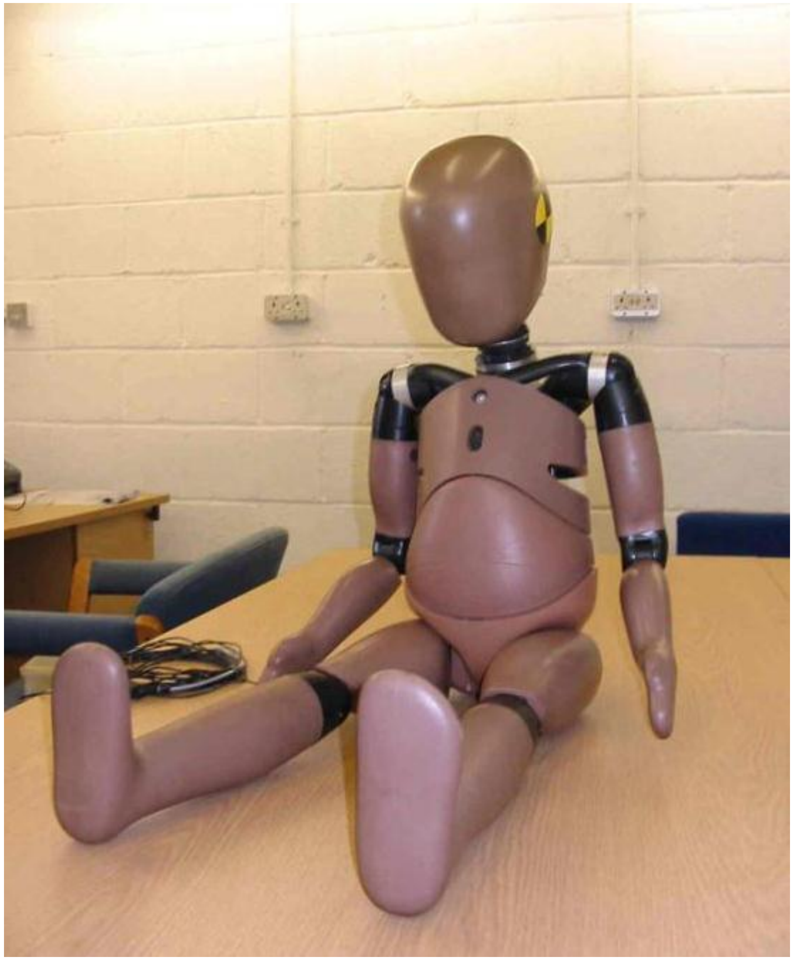
Thresholds were exceeded in the car and with the Hynd pulse, but not with the UN R129 pulse

Front impact pulse – Outstanding items

The draft amendment for Phase 2 makes no changes to the front impact pulse, but modern vehicles are stiffer than those used to derive the pulse

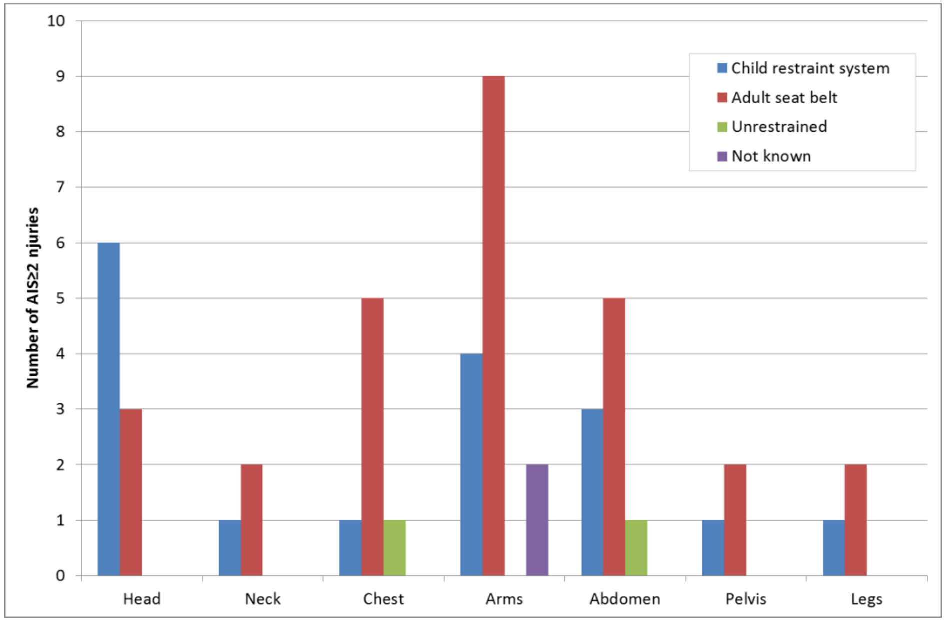
- Essentials for robust assessment of front impact protection
  - Representative pulse for collision type: full-width
  - Representative pulse for car type: supermini
  - Pulse that reproduces real vehicle dummy loads in these conditions

  - **The current pulse doesn't tick these boxes**

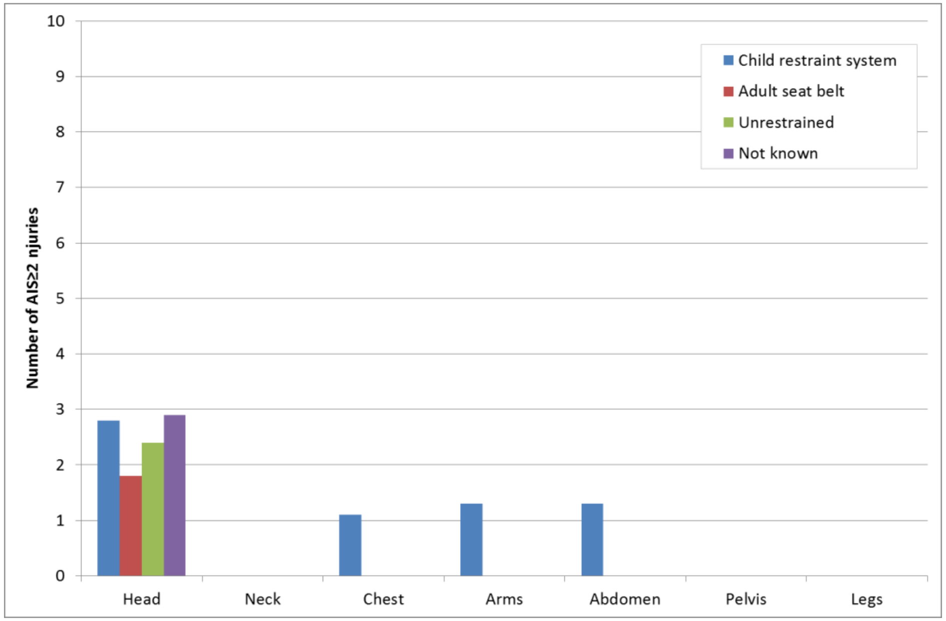


Applying injury criteria for the Q-Series

There are relatively few injuries to children at AIS≥2 in our representative samples



Great Britain



Germany

Statistical analysis is impossible; but there is reasonable evidence to focus on head, chest and abdomen

Representative samples may not be representative for specific casualty populations

Evidence-based thresholds are available to assess CRS in front impact

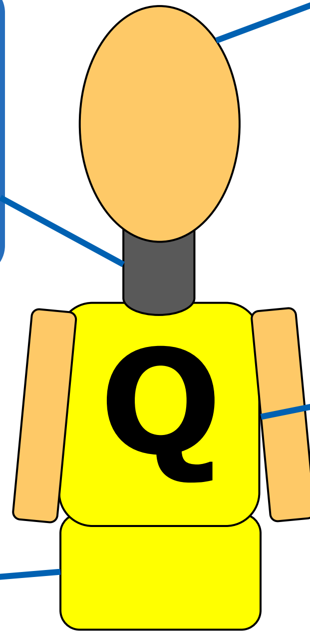
Sources: EEVC WG12/18; CASPER; EPOCh

No UN R129 limits – monitored only

Essential to prevent load transfer

UN R129 limits broadly consistent with literature

Risk level varies with occupant size



No UN R129 limits (Phase 1); Q3 & Q6 limits in literature

Further work needed to complete limits for other Q-Series

Pragmatic UN R129 limit for chest acceleration only

Deflection would detect concentrated loads - limits needed

Head limits only for side impact

Scaled chest deflection limits are available, but have not gained acceptance

Sources: EEVC WG12/18; EPOCh (Q10)

	Q1	Q1.5	Q3	Q6	Q10
20% risk of AIS≥3 injury	40	38	36	33	-
50% risk of AIS≥3 injury	59	56	53	49	56

Greatest tolerance for smallest size – plausible for rib fracture only

Abdominal pressure limits also available, but need to be extended to Q1.5 and Q10

Chest and abdomen injury criteria task force underway – accident reconstruction and risk curve development

TRL derived interim thresholds for chest deflection (data scaling only)

Geometric scaling only – formula proposed by Mertz et al. (2003)

	Q1	Q1.5	Q3	Q6	Q10
50% risk of AIS≥3 injury	23.7	24.6	26.5	29.3	33.5
AIS≥4	30.5	31.6	34.1	37.7	43.1

Geometric and material properties – formula proposed by EEVC WG12/18

	Q1	Q1.5	Q3	Q6	Q10
50% risk of AIS≥3 injury	16.6	18.4	22.5	28.2	32.7

These thresholds are offered to provide additional insurance for task force activities

Injury criteria - Outstanding items

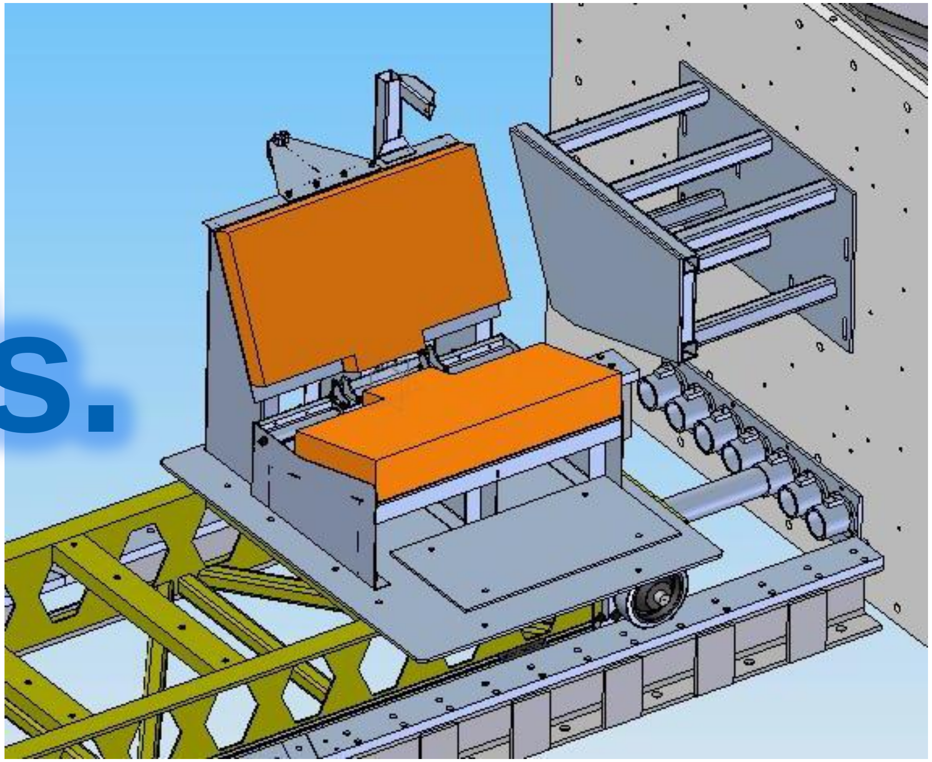
UN Regulation 129 specifies performance criteria for the head and chest only in front impact, and for the head only in side impact

- Essentials for robust assessment of injury risk
  - Measurement parameters that target key body regions
  - Evidence-based injury criteria and thresholds
  - **UN Regulation 129 achieves these criteria, but some body regions are omitted (neck, abdomen) and some limits are pragmatic rather than evidence-based (chest acceleration)**

The side impact test conditions

How does the side impact test procedure compare to a real side impact collision?

Vs.

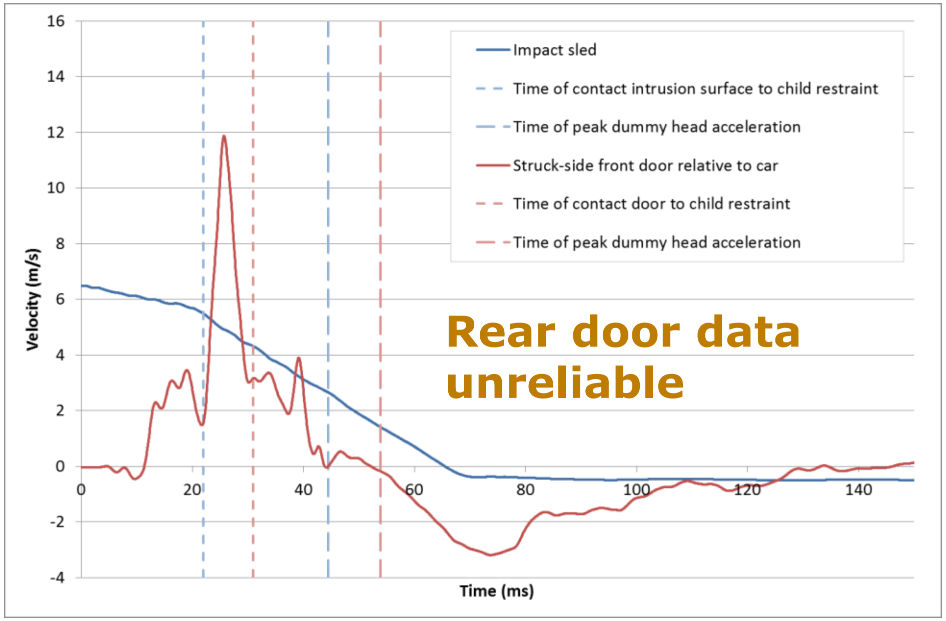


Moving car to stationary car: 50 km/h – UN R95

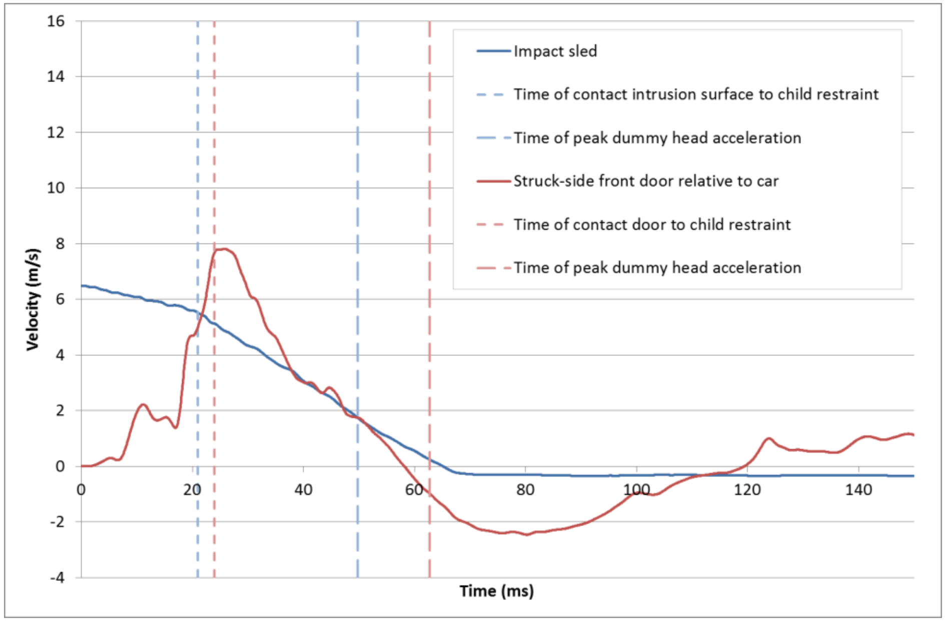
(Opel Corsa – supermini)

Fixed intrusion panel: 25 km/h

The side impact test procedure reproduced the average intrusion velocity and displacement of the front door



Rear seat (Q1.5 rear facing)



Front seat (Q3 forward facing)

The procedure reproduced the intrusion characteristics over the critical phase of head loading

Albeit with less than ideal instrumentation

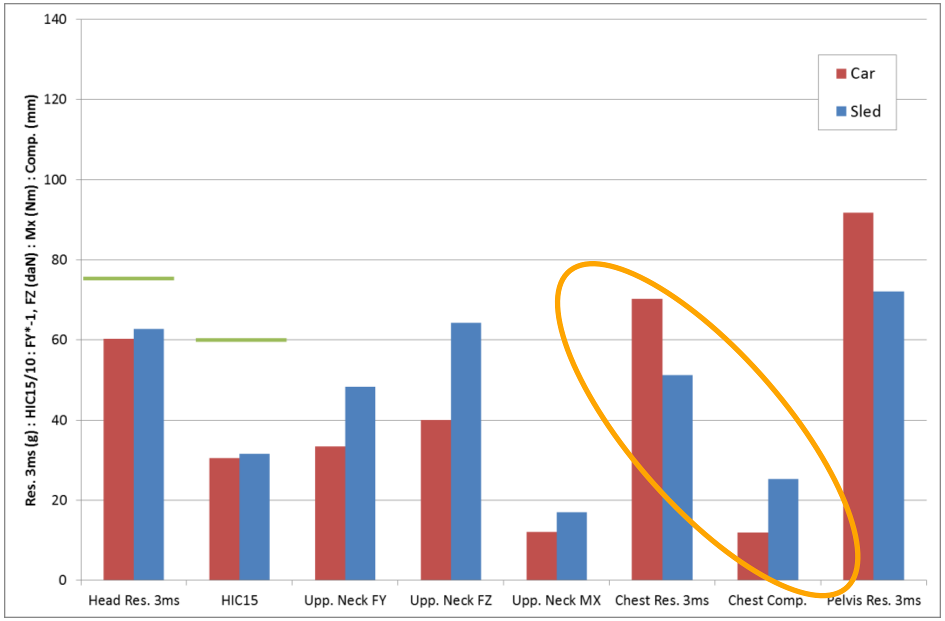
The side impact test procedure reproduced the head kinematics from car-to-car experiment reasonably well

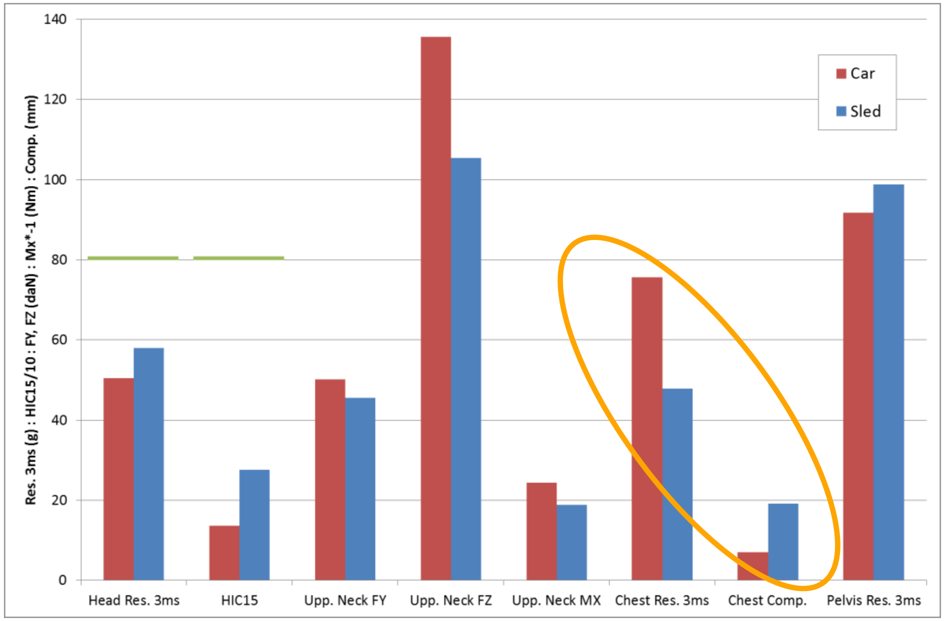
Rear-facing integral ISOFIX child restraint in rear seat – Q1.5

Forward-facing integral ISOFIX child restraint in front seat – Q3

Q3 head more exposed in the car than on the sled

The side impact test procedure reproduced the dummy measurements (for regulated parameters)





Q1.5 - rear-facing child restraint **Q3 - forward-facing child restraint**

The procedure was less capable of reproducing the dummy loads at other body regions

Especially in the chest…

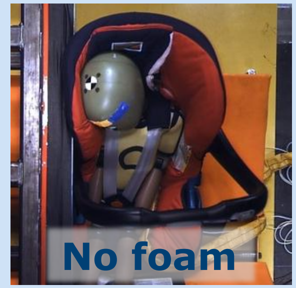
Does the side impact test discriminate between different CRS?

Rear-facing integral ISOFIX child restraint

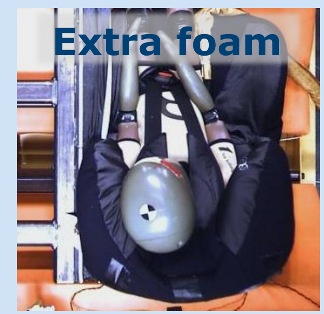
Forward-facing integral ISOFIX child restraint

Head kinematics and interaction with side wings were consistent with the changes made to CRS

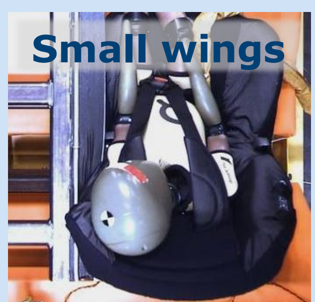
Q1.5 head containment - rear-facing integral ISOFIX child restraint

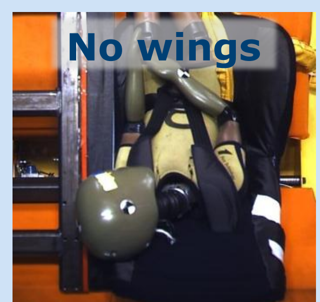


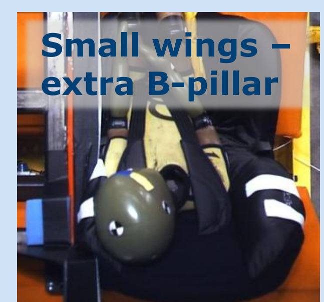
Q3 head containment - forward-facing integral ISOFIX child restraint



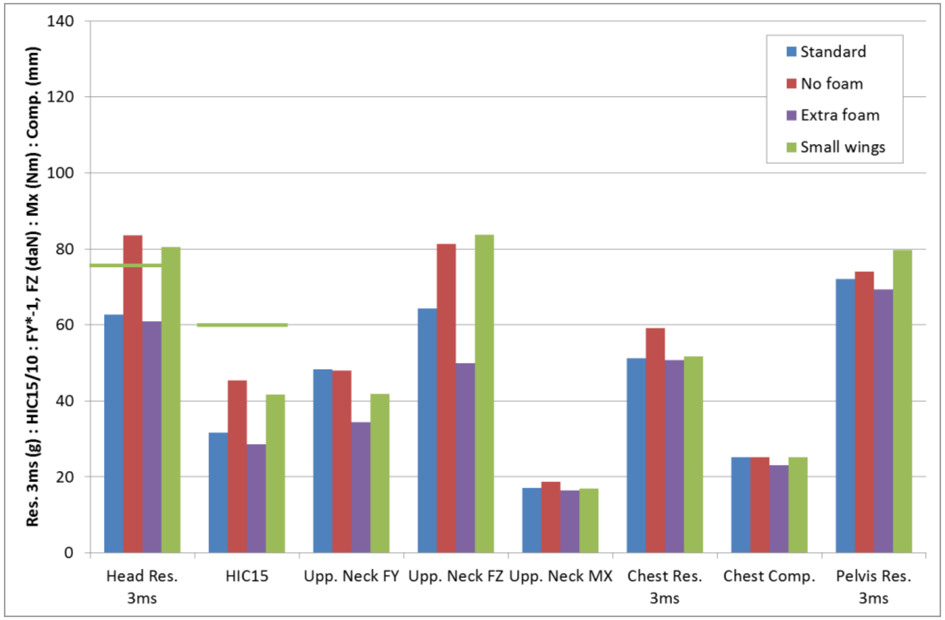
Head containment seems easy to achieve…

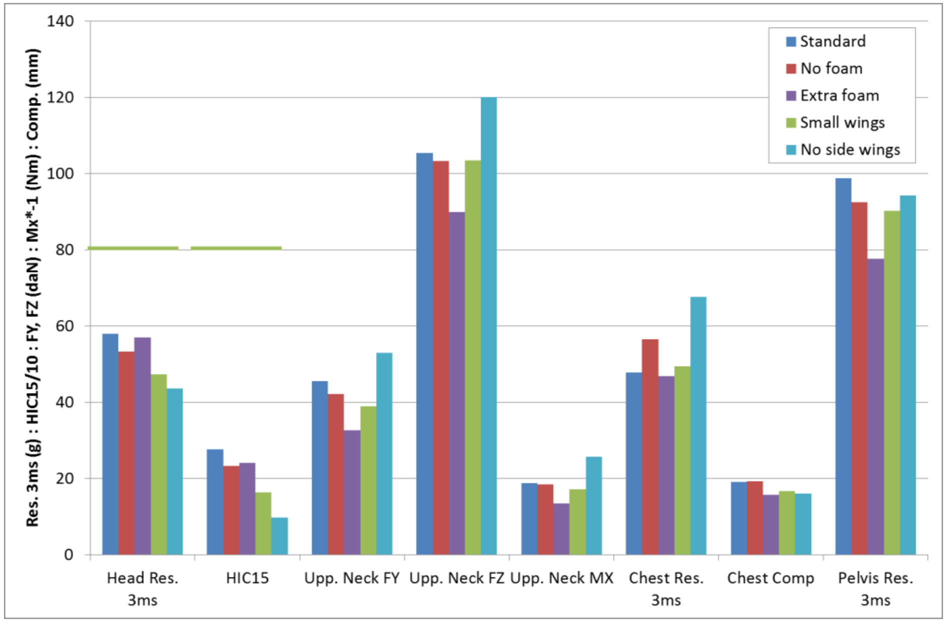






Dummy measurements were also consistent with the changes made to the CRS



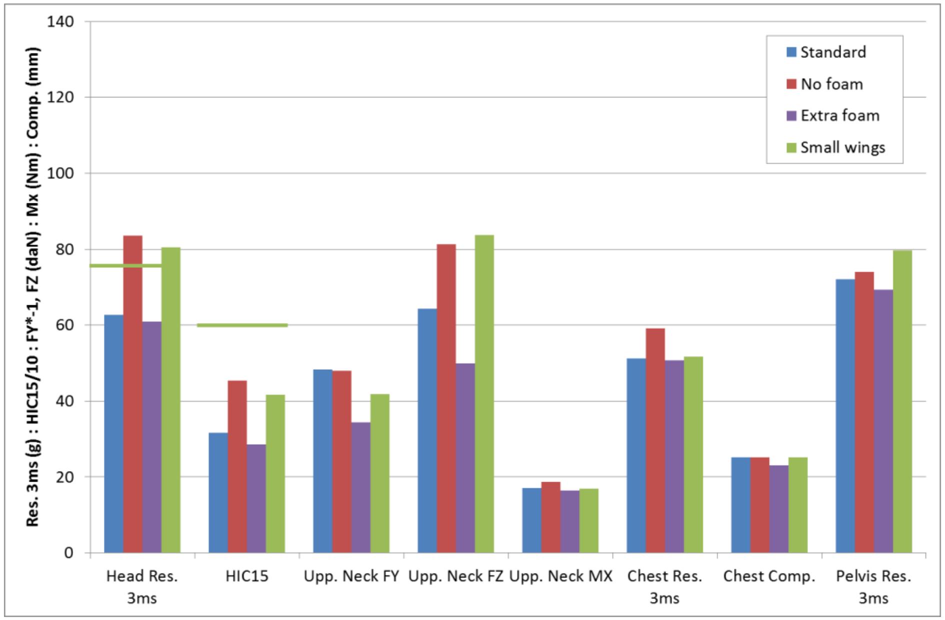


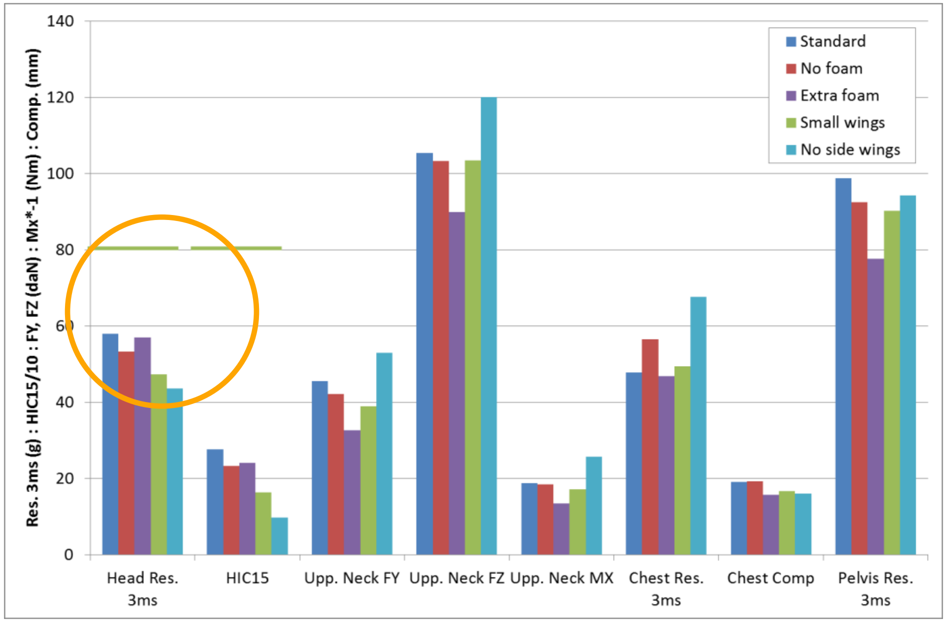
Q1.5 - rear-facing child restraint

Q3 - forward-facing child restraint

Rear facing child restraints met head acceleration requirement only with deep side wings and padding

Dummy measurements were also consistent with the changes made to the CRS





Q1.5 - rear-facing child restraint **Q3 - forward-facing child restraint**

Forward-facing child restraints met requirements regardless of side wing depth or presence of padding

The test procedure would not encourage these features

Side impact - Outstanding items

The side impact test conditions are reasonably similar to a car-to-car side impact but forward-facing child restraints can meet the requirements easily

- Essentials for robust assessment of side impact protection
  - Test conditions that are representative of real side impact: UN Regulation 95 and supermini cars
  - Test procedure that reproduces dummy loads in these conditions (head prioritised)
  - Test procedure that distinguishes differences in CRS and encourages features that increase protection

  - **The current test achieves most of these criteria, but a degraded forward-facing CRS can ‘pass’ the test**

Summary

- UN Regulation 129 intended to deliver **enhanced CRS**
  - ISOFIX
  - Q-Series
  - Side impact
- UN Informal Group ToR sets out activities GRSP envisaged for Phase 2
- Our research contributes to the evidence-base and technical justification
  - Challenges remain
  - Collaborative approach needed (Informal Group - Task Force – EEVC WG12 – Horizon 2020)

Thank you

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The presentation used accident data from the United Kingdom Co-operative Crash Injury Study (CCIS) collected during the period 2000-2009. CCIS was managed by TRL Limited, on behalf of the DfT (Transport Technology and Standards Division) who funded the project along with Autoliv, Ford Motor Company, Nissan Motor Company and Toyota Motor Europe. Previous sponsors of CCIS have included Daimler Chrysler, LAB, Rover Group Ltd, Visteon, Volvo Car Corporation, Daewoo Motor Company Ltd and Honda R&D Europe (UK) Ltd. Data were collected by teams from the Birmingham Automotive Safety Centre of the University of Birmingham; the Vehicle Safety Research Centre at Loughborough University; TRL Limited and the Vehicle & Operator Services Agency of the DfT.

The presentation also used accident data from the German In-Depth Accident Study (GIDAS). GIDAS is a joint project of the Federal Highway Research Institute of Germany and the German Association for Research on Automobile Technique. The analysis of GIDAS was carried out by the Traffic Accident Research Institute of TU Dresden GmbH under contract to TRL.